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A palynological investigation of archaeological materials from Burrough Hill, Leicestershire

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A palynological investigation of archaeological materials from Burrough Hill, Leicestershire

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Foreword

This report describes a study of the palynology of six samples from the archaeological site at Burrough Hill, south of Melton Mowbray in Leicestershire in order to determine the source of these materials.

Contents

Summary

The six samples studied yielded palynofloras dominated by Jurassic taxa. The most significant lithostratigraphical unit contributing to sample 1 is the Oxford Clay Formation of Callovian–Oxfordian age. By contrast, the principal element in samples 2–6 is the Lower Toarcian part of the Whitby Mudstone Formation (the Grey Shale and Mulgrave Shale members). Minor levels of Carboniferous and Quaternary/Holocene material were also recovered throughout. Certain samples also yielded rare Permian, Late Triassic and Early Cretaceous material. The glacial tills of Eastern England are typically rich in Jurassic and Carboniferous palynomorphs. This means that the clay samples analysed were originally collected from local tills. The non-Jurassic elements are too abundant and varied for them to have been reworked or otherwise introduced into the respective *in situ* Jurassic units. The fact that samples produced mixed Jurassic palynomorphs is entirely consistent with the till provenance hypothesis. Furthermore, the Jurassic units identified here are typically organic-rich, such as the Lower Toarcian Whitby Mudstone Formation, the Oxford Clay Formation (Callovian–Oxfordian) and the Kimmeridge Clay Formation (Kimmeridgian–Tithonian). These units are typically well-represented in the

glacial tills of eastern England, which yield palynomorph associations as varied as the ones recovered here, and in similar relative proportions. The samples may all have a single provenance, and the disparity in the sources for sample 1 and samples 2-6 may simply reflect local differences within a single till unit. However this contention may prove difficult to firmly establish.

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1 Introduction

This report describes a study of the palynology of six samples from the archaeological site at Burrough Hill, in Burrough on the Hill, 11 km south of Melton Mowbray in Leicestershire. This study was undertaken in order to help better understand the source(s) of the materials used in the construction of this Iron Age Hillfort.

2 Sample Details

The six samples are listed below. The columns represent the (informal) sample number, the collector's sample number and the BGS sample registration number (prefixed MPA) respectively.

1	3	MPA 62634
2	9	MPA 62635
3	13	MPA 62636
4	4072	MPA 62637
5	5/S040/S041	MPA 62638
6	5/S063/S004	MPA 62639

3 Palynology

The six palynofloras are described in this section. The six clay-rich samples were prepared using the extraction technique of Riding and Kyffin-Hughes (2004). Percentage data on palynomorphs in six age-related groups, and the distribution of kerogen types are presented in Tables 1 and 2 respectively. The kerogen and palynomorph associations are broadly similar throughout.

3.1 SAMPLE 1 COLLECTOR'S NUMBER 3 (BGS SAMPLE MPA 62634)

This sample yielded a very rich palynoflora which is dominated by Jurassic marine and terrestrially-derived palynomorphs. The Jurassic pollen and spores include bisaccate pollen, *Callialasporites* spp., *Cerebropollenites macroverrucosus, Chasmatosporites* spp., *Classopollis classoides, Cyathidites spp., Ischyosporites vaerigatus, Obtusisporis juncta, Perinopollenites elatoides* and *Vitreisporites pallidus.* Jurassic dinoflagellate cysts overwhelmingly dominate the marine palynomorphs. These include *Chytroeisphaeridia chytroeides, Endoscrinium galeritum, Fromea tornatilis, Gonyaulacysta centriconnata, Gonyaulacysta eisenackii, Gonyaulacysta jurassica* subsp. *adecta, Gonyaulacysta jurassica* subsp. *adecta* var. *longicornis* (large morphotype), *Korystocysta gochtii, Leptodinium subtile, Mendicodinium groenlandicum, Nannoceratopsis senex,* ?*Nannoceratopsis* sp., *Pareodinia* sp., *Rhynchodiniopsis cladophora, Rigaudella aemula,* ?*Scriniodinium crystallinum, Scriniodinium dictyotum, Sentusidinium* spp. and *Systematophora areolata*.

The Jurassic dinoflagellate cysts indicate that the principal rock unit which contributed to this sample is the Oxford Clay Formation. The species with the shortest stratigraphical range is *Gonyaulacysta centriconnata,* which is confined to the Late Callovian to the Early Oxfordian

(Riding and Thomas, 1992). The occurrences of taxa such as *Fromea tornatilis*, *Gonyaulacysta eisenackii*, *Gonyaulacysta jurassica* subsp. *adecta* var. *longicornis* (large morphotype) and *Rigaudella aemula* are consistent with this age assessment (Riding, 1987). The Late Callovian to the Early Oxfordian age of the key markers strongly suggest that the Oxford Clay Formation input was from the Stewartby and/or Weymouth members of this unit. There are minor indications of input from the Early Toarcian due to the presence of rare specimens of *Nannoceratopsis senex*, together with *Chasmatosporites* spp. (Srivastava, 1987; Riding et al., 1999). Furthermore, *Systematophora areolata* is consistent with some minor input from Upper Jurassic strata (Riding and Thomas, 1988; 1992). Rare Carboniferous spores (*Densosporites* spp. and *Lycospora pusilla*), and extremely sparse Quaternary/Holocene material is also present.

To summarise, the majority of the palynoflora from this sample is from the Oxford Clay Formation or its correlatives. Minor levels of Early and Late Jurassic input were also discerned, together with low proportions of Carboniferous and Quaternary/Holocene input. This mixed assemblage is consistent with a glacial till unit which is largely comprised of the Oxford Clay Formation.

3.2 SAMPLE 2 COLLECTOR'S NUMBER 9 (BGS SAMPLE MPA 62635)

Sample 2 produced a moderately abundant palynoflora which was reasonably well-preserved. It is dominated by the pollen grains undifferentiated bisaccate forms and *Classopollis classoides*. Other pollen recognised include *Chasmatosporites* spp., *Perinopollenites elatoides* and *Vitreisporites pallidus*. Spores were also present, for example *Cyathidites* spp. and *Retitriletes austroclavatidites*. *Classopollis classoides* is restricted to the Mesozoic, and the palynomorphs listed above are entirely consistent with a Jurassic source, although none of these have very restricted stratigraphical ranges. No Triassic or Cretaceous indices were observed. *Callialasporites* and identifiable dinoflagellate cysts are entirely absent. The presence of relatively common specimens of *Chasmatosporites* spp., in the absence of *Callialasporites* spp., is most characteristic of the Early Jurasssic (Srivastava, 1987).

Carboniferous spores, largely *Densoisporites* spp and *Lycospora pusilla*, are present in significant numbers, but these are subordinate to the Jurassic palynomorphs. One specimen of the Visean–Bashkirian marker *Tripartites vetustus* was observed (Smith and Butterworth, 1967). Additionally, one specimen of a striate bisaccate pollen grain was recognised. This morphotype is characteristic of the Permian. Some material from the Quaternary/Holocene was also observed, such as filicalean spores, together with sparse non-age diagnostic microplankton such as *Botryococcus*.

In summary, the majority of the palynoflora from this sample is of undifferentiated Early Jurassic age, probably the Lower Toarcian part of the Whitby Mudstone Formation, with some minor Carboniferous and Permian input. The varied character of this assemblage is indicative of glacial till unit which is largely comprised of Early Jurassic strata.

3.3 SAMPLE 3 COLLECTOR'S NUMBER 13 (BGS SAMPLE MPA 62636)

This sample produced a moderately abundant organic residue and palynoflora, which exhibits relatively good preservation. It is dominated by Jurassic taxa. The pollen/spores comprise bisaccate pollen, *Callialasporites* spp., *Cerebropollenites macroverrucosus*, *Chasmatosporites* spp., *Classopollis classoides, Cyathidites* spp. and *Ischyosporites vaerigatus.* Bisaccate pollen, *Classopollis classoides* and *Cyathidites* spp. are especially prominent. Jurassic dinoflagellate cysts are also present and comprise *Cribroperidinium globatum, Egmontodinium polyplacophorum, Escharisphaeridia* spp., *Gonyaulacysta jurassica* subsp. *adecta, Korystocysta gochtii, Meiourogonyaulax* sp., *Nannoceratopsis senex, Pareodinia sp., Rhynchodiniopsis cladophora* and *Systematophora areolata.* The presence of *Nannoceratopsis senex* is characteristic of the Lower Toarcian part of the Whitby Mudstone Formation (Riding et al.,

1999; Bucefalo Palliani and Riding, 2000). Furthermore, *Gonyaulacysta jurassica* subsp. *adecta, Korystocysta gochtii, Meiourogonyaulax* sp. and *Pareodinia* sp. are characteristic of the Callovian (e.g. Riding, 2005). *Cribroperidinium globatum, Egmontodinium polyplacophorum* and *Systematophora areolata* are indicative of input from the Late Jurassic. *Egmontodinium polyplacophorum* is a marker for the Tithonian (Woollam and Riding, 1983). Hence input from the Kimmeridge Clay Formation is indicated.

Very small levels of the Carboniferous spores *Densosporites* spp. and *Lycospora pusilla* were noted. Input from the Quaternary/Holocene was also encountered, such as the spore *Polypodium vulgare*, together with rare non-age diagnostic microplankton such as *Botryococcus*.

In conclusion, sample 3 produced a mixed assemblage of Carboniferous, Jurassic and Quaternary/Holocene palynomorphs. This input is chiefly of Jurassic age. The highly varied character of this assemblage is consistent with a glacial till unit which is largely comprised from Jurassic sedimentary rocks.

3.4 SAMPLE 4 COLLECTOR'S NUMBER 4072 (BGS SAMPLE MPA 62637)

Sample 4 yielded produced a relatively abundant residue which is dominated by amorphous organic material, palynomorphs and wood. The palynoflora is of low diversity, and is dominated by characteristically Jurassic pollen and spores. These are dominated by the pollen species *Classopollis classoides,* and collectively they represent ca. 95–98% of the palynoflora. The Jurassic pollen and spores also comprise bisaccate grains, *Callialasporites* spp., *Chasmatosporites* spp., *Cerebropollenites macroverrucosus*, *Contignisporites sp.* and *Perinopollenites elatoides*. The typically Early Toarcian dinoflagellate cyst *Nannoceratopsis senex* was also observed in low proportions, together with the typically Jurassic prasinophytes *Cymatiosphaera* spp. and *Tasmanites* spp. This, together with the abundant amorphous organic material, indicates input from the Lower Toarcian part of the Whitby Mudstone Formation (Riding et al., 1999; Bucefalo Palliani at al., 2002).

Small proportions of Carboniferous spores are present. These are *Densosporites* spp., *Lycospora pusilla* and *Tripartites vetustus*. *Densosporites* spp. and *Lycospora pusilla* are relatively long-ranging, but *Tripartites vetustus* is a marker for the Visean to Bashkirian interval (Smith and Butterworth, 1967). Some input from the Quaternary/Holocene is also present, including the spore *Polypodium vulgare*, together with rare long-ranging microplankton such as the alga *Botryococcus*.

In summary, this sample produced a mixed assemblage of Carboniferous, Early Jurassic and Quaternary/Holocene palynomorphs. This input is chiefly of Early Jurassic age, probably largely from the Lower Toarcian part of the Whitby Mudstone Formation. The heterogeneous character of this palynoflora is consistent with a clay from a glacial till unit which was largely composed of Lower Jurassic sedimentary rocks.

3.5 SAMPLE 5 COLLECTOR'S NUMBER 5/S040/S041 (BGS SAMPLE MPA 62638)

This sample produced a moderately abundant organic residue which is dominated by woody fragments. The palynoflora is not particularly diverse, and is dominated by pollen and spores of Jurassic aspect; these account for approximately 90–95% of the palynoflora. These forms comprise bisaccate grains, *Chasmatosporites* spp., *Cerebropollenites macroverrucosus*, *Classopollis classoides* and *Cyathidites* spp. Of this association, *Chasmatosporites* spp. and *Classopollis classoides* are by far the most common. Some prasinophytes were observed, largely *Tasmanites* spp. with some *Cymatiosphaera* spp., which also may be indicative of Jurassic input. No Jurassic dinoflagellate cysts were observed. The dominant Jurassic assemblage is indicative of an Early Jurassic age, i.e. from the Whitby Mudstone Formation. The genus *Chasmatosporites*

is most characteristic of this Epoch (Srivastava, 1987). The co-occurrence of *Classopollis classoides* and prasinophytes, together with the absence of *Callialasporites* spp. and dinoflagellate cysts, is entirely consistent with significant input of Early Jurassic age, probably largely from the Lower Toarcian part of the Whitby Mudstone Formation.

A single specimen of the saccate pollen species *Ovalipollis ovalis* was observed. This species is most characteristic of the Late Triassic, but is known in low proportions in the Hettangian. This specimen is most likely to have been derived from the Rhaetian. Very small numbers of the Carboniferous spore genus *Densosporites* spp. were also recognised.

Some input from the Quaternary/Holocene was also noted; these include the monolete spore *Polypodium vulgare*. Also present are small levels of long-ranging microplankton such as the freshwater/brackish algal genus *Botryococcus*.

In summary, this sample produced a mixed Carboniferous, latest Triassic, Early Jurassic and Quaternary/Holocene palynomorph assemblage. The majority of the input is of Early Jurassic age, probably largely from the Lower Toarcian part of the Whitby Mudstone Formation. The mixed nature of this flora is consistent with a clay derived from a glacial till unit which was largely comprised of Lower Jurassic strata.

3.6 SAMPLE 6 COLLECTOR'S NUMBER 5/S063/S004 (BGS SAMPLE MPA 62639)

Sample 6 yielded a relatively abundant organic residue which is dominated by dark wood phytoclasts and palynomorphs. The palynoflora is moderately diverse, and is dominated by typically Jurassic pollen and spores. These represent around 90–95% of the palynomorph assemblage. These include bisaccate grains, *Callialasporites* spp., *Chasmatosporites* spp., *Cerebropollenites macroverrucosus*, *Classopollis classoides, Contignisporites* sp., *Cyathidites* spp. and *Perinopollenites elatoides*. Of these, *Classopollis classoides* is the most abundant. Jurassic dinoflagellate cysts were also observed in very low proportions, and include *Cribroperidinium longicorne, Nannoceratopsis senex* and *Mancodinium semitabulatum*. Some characteristically Jurassic prasinophytes were observed, largely *Cymatiosphaera* spp., *Halosphaeropsis liassica*, *Tasmanites* spp. This assemblage is clearly derived from different Jurassic intervals. *Chasmatosporites* spp., *Halosphaeropsis liassica*, *Nannoceratopsis senex* and *Mancodinium semitabulatum* are highly characteristic of the Early Toarcian interval, specifically the highly carbonaceous strata deposited during the Early Toarcian Oceanic Anoxic Event (Riding et al., 1999; Bucefalo Palliani at al., 2002). This indicates input from the Grey Shale and Mulgrave Shale members of the Whitby Mudstone Formation. *Cribroperidinium longicorne* is a reliable marker for the Kimmeridgian to Early Tithonian (Riding and Thomas, 1988). This means that some Kimmeridge Clay Formation has been incorporated into this sample. Of these two organic-rich lithostratigraphical units, by far the majority of the palynomorphs are from the Lower Jurassic Whitby Mudstone Formation. It is possible that some Middle Jurassic units contributed to this sample, but these cannot be positively identified (to group/formation/member level).

The gymnosperm pollen *Ovalipollis ovalis* is present in extremely low numbers. This material was probably derived from the Rhaetian. Small numbers of the typically Early Cretaceous spore *Cicatricosisporites* sp. and the Carboniferous spores *Densosporites* spp. and *Lycospora pusilla* were also recognised.

Some probable input from the Quaternary/Holocene was also noted; these are largely fungal remains such as hyphae. Low levels of non-age diagnostic microplankton such as *Botryococcus* were also encountered.

In summary, this sample produced a highly heterogeneous Carboniferous, latest Triassic, Early Cretaceous, Early and Late Jurassic, and Quaternary/Holocene palynomorph assemblage. The

majority of the input is of Early Toarcian (Early Jurassic) age. The mixed nature of the assemblage is consistent with a clay from a glacial till unit which was largely composed of Lower Jurassic strata.

4 Conclusions

All six samples yielded palynofloras dominated by Jurassic taxa. The most significant lithostratigraphical unit contributing to sample 1 is the Oxford Clay Formation of Callovian–Oxfordian age. By contrast, the principal element in samples 2–6 is the Lower Toarcian part of the Whitby Mudstone Formation (the Grey Shale and Mulgrave Shale members). Minor levels of Carboniferous and Quaternary/Holocene material were also recovered throughout. Certain samples also yielded rare Permian, Late Triassic and Early Cretaceous material. The glacial tills of Eastern England are typically rich in Jurassic and Carboniferous palynomorphs (Lee et al., 2002; 2004; Riding et al., 2003; Hamblin et al., 2005; Pawley et al., 2005; Davies et al., 2011; 2012). This means that the clay samples analysed were originally collected from local tills. The non-Jurassic elements are too abundant and varied for them to have been reworked or otherwise introduced into the respective *in situ* Jurassic units. The fact that samples produced mixed Jurassic palynomorphs is entirely consistent with the till provenance hypothesis. Furthermore, the Jurassic units identified here are typically organic-rich, such as the Lower Toarcian Whitby Mudstone Formation, the Oxford Clay Formation (Callovian–Oxfordian) and the Kimmeridge Clay Formation (Kimmeridgian–Tithonian). These units are typically well-represented in the glacial tills of eastern England, which yield palynomorph associations as varied as the ones recovered here, and in similar relative proportions (Lee et al., 2002; 2004; Riding et al., 2003; Hamblin et al., 2005; Pawley et al., 2005; Davies et al., 2011; 2012). The samples may all have a single provenance, and the disparity in the sources for sample 1 and samples 2-6 may simply reflect local differences within a single till unit. However this contention may prove difficult to firmly establish.

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Sample no.	Carb. (%)	Permian (%)	Triassic (%)	Jurassic (%)	Early Cret. (%)	Quaternary	non age-diagnostics
1	<1	...	...	ca. 97 (OCF)	...	<1	<1
2	<1	<1	...	ca. 96 (WMF)	...	<1	<1
3	ca. 1	...	...	ca. 97 (mixed)	...	<1	<1
4	<1	...	...	ca. 97 (WMF)	...	<1	<1
5	<1	...	<1	ca. 87-92 (WMF)	...	ca. 5-10	<1
6	<1	...	<1	ca. 95-97 (WMF)	<1	ca. 1-3	<1

Table 1 – The distribution of age-related palynomorph groups in the six samples studied. The numbers in the cells represent the approximate percentages of the respective palynomorph group. Three dots (…) indicate the absence of the respective palynomorph group. OCF – Oxford Clay Formation; WMF – Whitby Mudstone Formation.

Sample no.	Black Wood	Plant Fragments	Palynomorphs	AOM
1	C/Ab	P	Ab	C
2	C/Ab	P	C	P/C
3	C/Ab	C	C/Ab	P
4	C	P	C	C/Ab
5	Ab	P	C	P/C
6	Ab	P/C	Ab	C/Ab

Table 2 – The semiquantitative distribution of the major kerogen phytoclasts in the six samples studied. Ab – abundant; C – common; P – present.