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A palynological investigation of the Chalky Till of the Marsh House Farm Borehole, North Norfolk

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A palynological investigation of the Chalky Till of the Marsh House Farm Borehole, North Norfolk

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Foreword

This report describes the palynology of four samples of Chalky Till from the Marsh House Farm Borehole, North Norfolk.

Contents

Summary

This report describes the palynology of four samples of Chalky Till from the Marsh House Farm Borehole, North Norfolk. The palynofloras of the uppermost interval, represented by samples 1 and 2 are both dominated by Carboniferous miospores. The majority of these forms are indicative of the Westphalian and the source is from the north-west. Jurassic material is present in sample 2; the majority of this are Mid-Late Jurassic miospores with small numbers of Jurassic and earliest Cretaceous microplankton. The latter indicate input from the early Toarcian, Oxfordian-early Kimmeridgian, Kimmeridgian and Portlandian-Ryazanian intervals of eastern England. Late Cretaceous dinoflagellate cysts are rare in both samples, despite the fact that the Till is rich in Chalk Group material. It appears likely that the Chalk Group incorporated into this Till is organic lean. Quaternary and non age diagnostic palynomorphs are also present.

Samples 3 and 4 from the lowermost part of the borehole both yielded abundant palynofloras which were overwhelmingly dominated by *Pediastrum*. These are most likely to have been derived from Quaternary (or possibly Neogene) lacustrine sediments. The ?Happisburgh Till of Norton Subcourse Pit, Norfolk is also rich in *Pediastrum*. The remainder of the palynofloras comprise *Botryococcus*, *Cyathidites*, indeterminate spores, *Tasmanites*. spp. and undifferentiated

Quaternary miospores. No Carboniferous to Cretaceous palynomorphs were observed; no Late Cretaceous palynomorphs are present, despite the Chalky nature of this sediment.

1 Introduction

Four samples of Chalky Till from the Marsh House Farm Borehole, North Norfolk were studied for their palynomorph content. Analyses of the palynological content helps determine the provenance of sediments and may help in the characterisation of specific units (e.g. Riding, 2001a,b,c,d). The location of the Marsh House Farm Borehole is TF 8641 4437. Appendix 1 lists the numbers and percentages of specimens per microscope slide in age-related groupings for samples 1 and 2.

2 Sample Details

The following table lists respectively the (informal) sample number, the BGS registration number (prefixed MPA), the collectors number and the depth in metres. All samples are of soft, clayey Chalk-rich Till. All samples were prepared using sodium hexametaphosphate, an alternative to mineral acid techniques.

1	MPA 51066	D5	1.40-1.55
2	MPA 51064	U1	9.10-9.55
3	MPA 51067	D37	16.40-16.50
4	MPA 51065	U2A	16.50-16.95

3 Palynology

In this section, the palynofloras are described sample-by-sample. Full listings of palynomorphs, including quantitative data, are held on the respective BGS micropalaeontology/palynology data sheets, which have been archived.

3.1 SAMPLE 1 AT 1.40-1.55 M (MPA 51066)

This sample produced a moderately abundant organic residue and palynoflora; 908 palynomorph grains were counted per microscope slide (Appendix 1). Preservation was fair and wood and plant tissue were also common. Amorphous organic material was present in relatively small proportions.

The most common and diverse palynomorph type are Carboniferous spores, which account for 53.1% of the entire palynoflora. Most prevalent are *Densosporites* spp. and *Lycospora pusilla*. Forms which are less common include *Alatisporites* sp., *Cingulizonates* spp., *Radiizonates aligerens*, *Reticulatisporites reticulatus* and *Tripartites* sp. The occurrences of *Radiizonates aligerens* and *Reticulatisporites reticulatus* indicate a probable Westphalian source for the majority of the Carboniferous input (Smith and Butterworth, 1967). Relatively small proportions (1.9%) of Jurassic miospores were observed including *Callialasporites microvelatus*. This taxon is not stratigraphically significant and probably is derived from Middle to Upper Jurassic strata. No Jurassic or Lower Cretaceous dinoflagellate cysts were observed. A single dinoflagellate cyst, *Hystrichosphaeridium tubiferum*, which was probably derived from the Chalk Group is present. Palaeogene and Neogene markers are absent. Quaternary miospores proved relatively common and represent 32.6% of the entire palynoflora. This points to the incorporation of

significant levels of Quaternary, or possibly Neogene, material. A total of 12.3% of the palynoflora comprise forms which are not stratigraphically significant.

This palynoflora is dominated by Carboniferous miospores, indicating that this Till includes significant levels of Westphalian sediments; the provenance of the Carboniferous material is from the north-west. Surprisingly, only one Late Cretaceous dinoflagellate cyst was observed. This Till is visibly rich in Chalk Group material and it is possible that the Chalk incorporated into this Till is especially organic lean.

3.2 SAMPLE 2 AT 9.10-9.55 M (MPA 51064)

This sample yielded an extremely abundant organic residue and palynoflora. A count of a single microscope slide produced a figure of 1396 palynomorph grains (Appendix 1). The palynomorph preservation was good to excellent and wood fragments were also common. Other plant tissues and amorphous organic material were also present in relatively small proportions.

Like sample 1, the most abundant palynomorphs are Carboniferous spores, which make up 66.8% of the palynoflora (Appendix 1). The most common forms are the long-ranging *Densosporites* spp. and *Lycospora pusilla*. *Cingulizonates* spp., *Cirratriradites saturni*, *Cristatisporites indignabundus*, *Endosporites globiformis*, *Radiizonates aligerens*, *Radiizonates* spp., *Reticulatisporites* sp., *Tripartites trilinguis* and *Tripartites vetustus* are also present but in lower proportions. The occurrences of *Cirratriradites saturni*, *Cristatisporites indignabundus*, *Endosporites globiformis, Radiizonates aligerens* and *Reticulatisporites* sp. indicate a probable Westphalian source for the majority of the Carboniferous input (Smith and Butterworth, 1967). However, the Carboniferous reworking may be multiphase because *Tripartites trilinguis* and *Tripartites vetustus* are characteristic of the Late Viséan to Early Namurian interval (Clayton and Butterworth, 1984).

Jurassic palynomorphs comprise 11.4% of the palynoflora. The majority of these are miospores were including *Callialasporites microvelatus*, *Callialasporites turbatus, Cerebropollenites macroverrucosus, Chasmatosporites* spp., *Cibotiumsporites juriensis, Classopollis classoides, Classopollis meyeriana* and *Perinopollenites elatoides*. This association probably represent input from Middle to Upper Jurassic strata. The Jurassic microplankton recognised is more stratigraphically useful. Clumps of *Halosphaeropsis liassica* represents the incorporation of early Toarcian material, probably the Whitby Mudstone Formation (Grey Shale or Mulgrave Shale members) of the Yorkshire Basin or equivalent strata in the East Midlands Shelf (Bucefalo Palliani and Riding, 2000). A single specimen of the dinoflagellate cyst *Gonyaulacysta jurassica* subsp. *jurassica* was observed. This distinctive form ranges from the Oxfordian to the early Kimmeridgian (Riding and Thomas, 1992). Additionally, the distinctive Kimmeridgian species *Cribroperidinium globatum* is rarely present. The latter two taxa indicate minor reworking of the Oxford Clay, Ampthill Clay and Kimmeridge Clay formations, probably from the East Midlands Shelf. Small levels (2.0%) of Late Jurassic/Early Cretaceous palynomorphs were observed. The typically Early Cretaceous spore genus *Cicatricosisporites* proved extremely rare (2 specimens per microscope slide). More common (1.9%) were dinoflagellate cysts which were all referable to the genus *Cribroperidinium*; many of these are typical of the Jurassic-Cretaceous transition. A single specimen of *Cribroperidinium gigas* was observed. This species is typical of the Portlandian to Ryazanian (Bailey, 1993). Therefore, these forms may have been derived from the Lower Spilsby Sandstone, Sandringham Sands or the Speeton Clay formations of Eastern England. Despite this Till being visibly rich in Chalk Group material, dinoflagellate cysts characteristic of the Chalk Group are extremely rare (0.3%). These include *Circulodinium distinctum, Odontochitina operculata* and *Spiniferites ramosus*. None of these three species are confined to the Cenomanian-Maastrichtian interval, however, their preservation and their pale coloration are typical of Chalk Group palynofloras. The Carboniferous and Jurassic palynomorphs are considerably more thermally mature. It is likely

that the Chalk Group incorporated into this Till is organic lean. Palaeogene and Neogene markers were not observed.

Quaternary miospores were present in moderate proportions (3.45%) and a single specimen of the typically Quaternary dinoflagellate cyst *Lingulidinium machaerophorum* was observed. A total of 16.0% of the palynoflora are forms which are not stratigraphically significant.

Like sample 1, The palynoflora of sample 2 is dominated by Carboniferous miospores, indicating that this Till includes significant levels of Carboniferous (largely Westphalian) material. The source of this Carboniferous material is thought to be from the north-west. The majority of the Jurassic element recognised are Mid-Late Jurassic miospores. Relatively small numbers of Jurassic and earliest Cretaceous microplankton indicate input from the early Toarcian, Oxfordian-early Kimmeridgian, Kimmeridgian and Portlandian-Ryazanian intervals. These were all derived from eastern England, north of the Marsh House Farm area. Late Cretaceous dinoflagellate cysts are extremely rare, despite the fact that the Till is visibly rich in Chalk Group material. Quaternary palynomorphs proved relatively sparse.

3.3 SAMPLE 3 AT 16.40-16.50 M (MPA 51067)

Sample 3 yielded a moderately abundant organic residue and an abundant palynoflora. A single microscope slide produced 4175 palynomorph grains which are overwhelmingly dominated by specimens of *Pediastrum*. This genus is a typically Cenozoic freshwater alga (Batten, 1996). The palynomorph preservation was fair to poor. Plant tissues proved relatively common and wood fragments were rare. Amorphous organic material is also present in moderate proportions.

The specimens of *Pediastrum* are thought to be derived from Quaternary or possibly Neogene sediments because of their pale colour. This is because they have virtually no body colour and thus have not been subjected to thermal alteration. The ?Happisburgh Till of Norton Subcourse Pit, Norfolk is also rich in *Pediastrum* (Riding, 2001d). The majority of the remainder of the palynoflora comprise undifferentiated Quaternary miospores. *Chenopodium* pollen is present in low numbers. Occasional specimens of *Botryococcus* (another freshwater alga), *Cyathidites*, indeterminate spores, and ?*Tasmanites*. spp. were also observed. No unequivocal evidence of palynomorphs from the Carboniferous to Cretaceous was observed. It is possible that the preparation procedure using sodium hexametaphosphate is related to the abundance of *Pediastrum*. The unusual nature of this palynoflora, however, is indicative of the incorporation of significant levels of lacustrine sediments of Quaternary (or possibly Neogene) age into this Till. No Late Cretaceous palynomorphs are present, despite the Chalky nature of this sediment.

3.4 SAMPLE 4 AT 16.50-16.95 M (MPA 51065)

This sample produced a similar organic residue and palynoflora to sample 3 (see section 3.3 above). A figure of 2442 palynomorph grains represent the content of a single microscope slide. Again *Pediastrum* is the dominant constituent, with 2431 grains per slide. The ?Happisburgh Till of Norton Subcourse Pit, Norfolk is rich in *Pediastrum* (Riding, 2001d). Other palynomorphs comprise *Botryococcus*, *Tasmanites* and undifferentiated Quaternary miospores (including *Selaginella*). No evidence of palynomorphs from the Carboniferous-Cretaceous interval are present; Upper Cretaceous palynomorphs are entirely absent. The non-acid preparation procedure may have exarcabated the abundance of *Pediastrum*. This palynoflora indicates the incorporation of Quaternary-?Neogene lacustrine sediments into this horizon.

4 Conclusions

The palynofloras of samples 1 and 2 are both dominated by Carboniferous miospores. The majority of these forms are indicative of the Westphalian and the source is from the north-west. Jurassic material is present in sample 2; the majority of this are Mid-Late Jurassic miospores with small numbers of Jurassic and earliest Cretaceous microplankton. The latter indicate input from the early Toarcian, Oxfordian-early Kimmeridgian, Kimmeridgian and Portlandian-Ryazanian intervals of eastern England. Late Cretaceous dinoflagellate cysts are rare in both samples, despite the fact that the Till is rich in Chalk Group material. It appears likely that the Chalk Group incorporated into this Till is organic lean. Quaternary and non age diagnostic palynomorphs are also present.

Samples 3 and 4 both yielded abundant palynofloras which were overwhelmingly dominated by *Pediastrum*. These are most likely to have been derived from Quaternary (or possibly Neogene) lacustrine sediments. The ?Happisburgh Till of Norton Subcourse Pit, Norfolk is also rich in *Pediastrum* (Riding, 2001d). The remainder of the palynofloras comprise *Botryococcus*, *Cyathidites*, indeterminate spores, *Tasmanites*. spp. and undifferentiated Quaternary miospores. No Carboniferous to Cretaceous palynomorphs were observed; no Late Cretaceous palynomorphs are present, despite the Chalky nature of this sediment.

Appendix 1 Listing of palynomorphs in age-related groups for samples 1 and 2

SAMPLE 1 (MPA 51066)

	Number	**%**
Carboniferous miospores	482	53.1
Jurassic miospores	17	1.9
Upper Cretaceous (Chalk Group) dinoflagellate cysts	1	0.1
Quaternary miospores	296	32.6
Non age-diagnostic palynomorphs	112	12.3

SAMPLE 2 (MPA 51064)

	Number	**%**
Carboniferous miospores	933	66.8
Jurassic palynomorphs (total)	159	11.4
Jurassic miospores	143	10.2
Jurassic microplankton	16	1.2
U/m Jurassic-L. Cretaceous palynomorphs (total)	28	2.0
Lower Cretaceous miospores	2	0.1
U/m Jurassic-l/m. Cretaceous dinoflagellate cysts	26	1.9
Upper Cretaceous (Chalk Group) dinoflagellate cysts	4	0.3

Quaternary palynomorphs (total)	49	3.5
Quaternary miospores	48	3.45
Quaternary dinoflagellate cysts	1	0.05
Non age-diagnostic palynomorphs	223	16.0

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