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Provenance of the Oadby Till at Buddon Wood Quarry, Mountsorrel, Leicestershire

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Provenance of the Oadby Till at Buddon Wood Quarry, Mountsorrel, Leicestershire

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Summary

A sample of the Oadby Till from Buddon Wood Quarry, Mountsorrel, Leicestershire was examined for its microfossil and palynomorph content, in order to determine the age and provenance of this deposit. Early Jurassic (Hettangian) Foraminiferida and Ostracoda were found, together with Late Cretaceous (late Coniacian-Santonian) Foraminiferida. The Early Jurassic microfauna was probably relatively locally derived from the east or northeast, but the late Cretaceous taxa must have been derived from the Chalk outcrop again to the east or northeast. The palynoflora indicates input from the Carboniferous, Late Triassic (Rhaetian), Jurassic (late Sinemurian, late Callovian-Oxfordian and Kimmeridgian) and Late Cretaceous. The dominant species, *Classopollis classoides*, is likely to be largely from the Triassic, so the dominant reworked element in this till is Rhaetian. The occurrence of Jurassic and Cretaceous palynomorphs from the east/northeast suggests that the relatively minor Carboniferous reworking is probably from the underlying Thrussington Till. This is as opposed to locally from the Swadlincote coalfield to the northwest, or from further away such as the northeast of England. The Rhaetian reworking is assumed to have been sourced locally, again from an easterly or northeasterly direction. The Blue Anchor Formation is typically organic-poor, hence the source of these palynomorphs is considered to be from the Westbury and/or Lilstock formations. The Jurassic input is assumed to be from the north or northeast. The principal Jurassic outcrop belt in the UK could have potentially sourced all the late Sinemurian, late Callovian-Oxfordian and Kimmeridgian input. The Chalk Group dinoflagellate cysts are also interpreted as having being sourced from the east or the northeast. Integration of the calcareous microfaunal and palynological evidence indicates that the Oadby Till from this locality contains stratal units of Carboniferous, Triassic, Jurassic and Late Cretaceous age. Because of the presence of Jurassic and Late Cretaceous elements, the ice apparently travelled to Mountsorrel from the east or northeast.

1 Introduction

A single sample of the Oadby Till from Buddon Wood Quarry, Mountsorrel, Leicestershire was submitted for calcareous microfossil and palynological analyses in order to determine its provenance. The sample was collected by J. N. Carney at NGR SK 5656 1524; the collector's number is JNC 914 and it was registered as MPA 54463. The analyses were carried out in support of the re-survey of the Leicester Sheet (156). Stratigraphically, it is from a horizon 10 cm above the top of the Mercia Mudstone Group. It has a dark grey matrix with various clasts, including mudstone and chalk.

2 Calcareous Microfossils

The following calcareous microfossils were recorded:

Early Jurassic Ostracods
- *Bairdia* sp.
- *Cytherelloidea circumstricta*
- *Ektyphocythere moorei*
- *Ogmoconchella ellipsoidea*

Early Jurassic Foraminifera
- *Lingulina tenera tenera*
- *Marginulina* sp.
- *Nodosaria* sp.

Late Cretaceous Foraminifera
- *Dicarinella canaliculata*
- *Gyroidinoides nitidus*
- *Hedbergella brittonensis*
- *Heterohelix* sp.
- *Osangularia cordieriana*
- *Valvulineria lenticularis*

The calcareous microfauna encountered in the sample comprised common Early Jurassic ostracods, frequent Early Jurassic foraminifera and rare Late Cretaceous foraminifera. Occasional holothurian schlerites were also observed. No Pleistocene ostracods or foraminifera were encountered.

The Early Jurassic ostracods (see above) are assigned to the Hettangian (late *P. planorbis* to *S. angulata* zones). The occurrence of *Marginulia* sp, however, suggests an age within the later part of that range, as the genus generally appears in the uppermost *A. liassicus* zone, but becomes common only in the 'mid' *S. angulata* zone. It is assumed that these ostracods were sourced locally from the east/northeast.

The Late Cretaceous microfauna comprises long-ranging species, but no older than 'mid' Coniacian Foraminiferal Zone BGS 14 (*M. coranguinum* zone) and no younger than the Santonian part of BGS 18 (*U. socialis* zone), at which level *Hedbergella brittonensis* apparently became extinct. The provenance of the Chalk Group clasts is considered to be the Upper Burnham to Lower Flamborough Chalk formations of eastern and northeastern England (i.e. Lincolnshire and Yorkshire) or the Upper Lamplugh/Lower Jukes formations of the southern North Sea Basin, i.e. coeval with the Seaford Chalk Formation of southern England.

3 Palynology

3.1 THIS STUDY

In this section, the palynoflora is described. A full listing of palynomorphs, including quantitative data, is held on the respective BGS palynology data sheet, which has been archived. Table 1 illustrates the numbers and percentages of the several age-based palynomorph groups.

The sample produced an abundant and well-preserved organic residue and palynoflora (Table 1). The palynoflora is overwhelmingly dominated by the gymnospermous pollen *Classopollis classoides*, with lesser proportions of other gymnosperm pollen, spores, acritarchs, dinoflagellate cysts and miscellaneous microplankton. *Classopollis classoides* ranges throughout the Mesozoic and was classified as 'non-age diagnostic' for the purposes of Table 1. Other non-age diagnostic forms were also observed, such as acanthomorph acritarchs, *Botryococcus*, fossil (i.e. pre-Quaternary) bisaccate pollen grains and *Tasmanites*.

The spores include moderate levels (5.1%) of Carboniferous spores, largely comprising *Lycospora pusilla*. Other forms recognised include *Densosporites* spp., *Endosporites globiformis* and *Tripartites trilinguis*. These are indicative of input from Namurian and Westphalian strata. *Endosporites globiformis* and *Tripartites trilinguis* are Westphalian and Late Viséan/Namurian markers respectively (Smith and Butterworth, 1967). Reworked Carboniferous spores are known from younger pre-Quaternary strata, such as Late Triassic sediments. Normally, the proportions of reworked Carboniferous material in Mesozoic successions are relatively low and hence these spores are interpreted as being probably derived from underlying Thrussington Till, or possibly directly from Carboniferous strata.

Palynomorphs of Triassic age are also moderately common (5.2%) (Table 1). These include *Kraeuselisporites reissingeri, Ovalipollis ovalis, Rhaetogonyaulax rhaetica* and *Ricciisporites tuberculatus.* It is probable that many of the specimens of *Classopollis classoides* are also from the Triassic. This association is indicative of the Rhaetian Stage (Morbey, 1978; Morbey and Dunay, 1978; Powell, 1992).

Significant levels (14.8%) of Jurassic dinoflagellate cysts and miospores were also observed. The miospores are relatively long ranging forms and include *Callialasporites* spp., *Cerebropollenites macroverrucosus, Ischysporites variegatus, Neoraistrickia gristhorpensis* and *Perinopollenites elatoides*. This assemblage is indicative of the Middle and Upper Jurassic. The Jurassic dinoflagellate cysts however, indicate the input of strata of various ages. The occurrence of *Liasidium variabile* is evidence of the incorporation of late Sinemurian age (Riding and Thomas, 1992). There is no evidence of the reworking of Toarcian/Aalenian units because species such as *Nannoceratopsis gracilis/senex* are absent. The remainder of the Jurassic dinoflagellate cysts are significantly younger than *Liasidium variabile.* Some of these taxa are characteristic of the late Callovian-Oxfordian interval. These comprise *Clathroctenocystis asapha, Gonyaulacysta eisenackii, Gonyaulacysta jurassica* subsp. *jurassica, Nannoceratopsis pellucida* and *Scriniodinium crystallinum*. These forms are indicative of input from the Oxford Clay Formation, West Walton Beds and Ampthill Clay Formation succession (Thomas and Cox, 1992). Also present, are characteristically Kimmeridgian taxa such as *Cribroperidinium globatum, Endoscrinium luridum, Hystrichosphaerina orbifera, Leptodinium* sp., *Perissieasphaeridium pannosum, Systematophora areolata* and *Systematophora* spp. This confirms the incorporation of the Kimmeridge Clay Formation (Riding and Thomas, 1992). The occurrence of *Gonyaulacysta jurassica* subsp. *jurassica* and *Endoscrinium luridum* indicates the probable presence of Lower Kimmeridgian strata (Riding and Thomas, 1992).

Extremely low levels of dinoflagellate cysts characteristic of the Late Cretaceous were encountered in low proportions (0.3%). These include representatives of *Cribroperidinium* and

Cyclonephelium. These morphotypes are not especially biostratigraphically significant, however are consistent with the presence of the Chalk Group in this sample.

No evidence of input from the Lower Palaeozoic, Devonian, Permian or the Palaeogene-Quaternary was observed.

In conclusion, the reworked palynoflora from this sample indicates significant input from the Carboniferous, Late Triassic (Rhaetian), Jurassic and Late Cretaceous. It seems likely that the dominant taxon, *Classopollis classoides*, is from the Triassic, hence the dominant source of allochthonous sediment in this till is from the Rhaetian. The nearest Carboniferous rocks are from the Swadlincote coalfield to the northwest of Mountsorrel. However the occurrence of Jurassic and Cretaceous palynomorphs from a easterly/northeasterly direction (see below) strongly suggests that the Carboniferous reworking cannot be from the Swadlincote coalfield. Carboniferous sources from northeast England are also considered unlikely because of their distance from Mountsorrel and the extent of penetration westwards of the Oadby Till. The latter would imply a strong easterly or perhaps northeasterly source, probably from the North Sea. It seems most probable that these Carboniferous spores were reworked from the Thrussington Till. Riding (2005) reported that the Thrussington Till is extremely rich (between 41% and 100% of the assemblage) in Carboniferous spores. It appears likely that the Carboniferous elements were reworked into the Oadby Till during the passage of this ice-sheet across the Thrussington Till; this is therefore an example of multiphase reworking. This theory is supported by the widespread occurrence of the Thrussington Till to the east and north of Buddon Wood. The Rhaetian reworking was sourced locally potentially from the Blue Anchor, Westbury and Lilstock formations. The Blue Anchor Formation tends to be organic-poor, hence the source of these palynomorphs is deemed to be from the Westbury and/or Lilstock formations. *Rhaetogonyaulax rhaetica* tends to be confined to the Westbury and Lilstock formations (Warrington et al., 1995; Warrington, 1997). The Jurassic input is most likely to be from the north or northeast, where the principal outcrop belt of Jurassic strata is located. This broad outcrop could have potentially sourced the late Sinemurian, late Callovian-Oxfordian and Kimmeridgian input. The Chalk Group dinoflagellate cysts are also interpreted as being sourced from the east or the northeast.

3.2 COMPARISON WITH OTHER STUDIES

Riding (2004) reported on a sample of the Oadby Till from the Thrussington district. This sample yielded low levels of Carboniferous spores and was dominated by Rhaetian palynomorphs that were interpreted as having been sourced locally. No Jurassic or Cretaceous material was observed.

4 Conclusions

A sample of the Oadby Till from Buddon Wood Quarry, Mountsorrel, Leicestershire was examined for its microfossil and palynomorph content, in order to determine the age and provenance of this deposit.

4.1 CALCAREOUS MICROFAUNAL EVIDENCE

The calcareous microfauna in the sample comprises Early Jurassic ostracods and foraminifera and rare Late Cretaceous foraminifera. The Early Jurassic markers were sourced relatively locally from the east or northeast and are typical of the Hettangian, probably within the *A. liassicus* and *S. angulata* zones. The Late Cretaceous microfauna are indicative of a ‘mid’ Coniacian (*M. coranguinum* zone) to Santonian (*U. socialis* zone) age. The Chalk Group clasts are hence interpreted as being sourced from the east or northeast, from the Upper Burnham to

Lower Flamborough Chalk formations of eastern and northeastern England, or the Upper Lamplugh/Lower Jukes formations of the southern North Sea Basin.

4.2 PALYNOLOGICAL EVIDENCE

The palynoflora indicates input from the Carboniferous, Late Triassic (Rhaetian), Jurassic (late Sinemurian, late Callovian-Oxfordian and Kimmeridgian) and Late Cretaceous. The dominant species, *Classopollis classoides*, is likely to be largely from the Triassic, so the dominant reworked element in this till is Rhaetian. The occurrence of Jurassic and Cretaceous palynomorphs from the east/northeast suggests that the relatively minor Carboniferous reworking is probably from the underlying Thrussington Till. This is as opposed to locally from the Swadlincote coalfield to the northwest, or from further away such as the northeast of England. The Rhaetian reworking is assumed to have been sourced locally, again from an easterly or northeasterly direction. The Blue Anchor Formation is typically organic-poor, hence the source of these palynomorphs is considered to be from the Westbury and/or Lilstock formations. The Jurassic input is assumed to be from the north or northeast. The principal Jurassic outcrop belt in the UK could have potentially sourced all the late Sinemurian, late Callovian-Oxfordian and Kimmeridgian input. The Chalk Group dinoflagellate cysts are also interpreted as having being sourced from the east or the northeast.

4.3 SYNTHESIS

Integration of the calcareous microfaunal and palynological evidence indicates that the Oadby Till from this locality contains stratal units of Carboniferous, Triassic, Jurassic and Late Cretaceous age. Because of the presence of Jurassic and Late Cretaceous elements, the ice apparently travelled to Mountsorrel from the east or northeast.

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Grains per slide	Carb. spores	Triassic	Jurassic	Cretaceous	Non age-diagnostics
2902	149 (5.1%)	152 (5.2%)	429 (14.8%)	8 (0.3%)	2164 (74.6%)

Table 1. The overall number of palynomorphs per microscope slide, and the numbers and percentages of palynomorphs respectively of Carboniferous to Cretaceous age in this study.