

Field Trips and Reports

RGS Field Visit to Norfolk – Friday, May 18th to Sunday 20th, 2012 – Led by Professor Peter Worsley

Friday Afternoon – Introduction and sites on route to Stiffkey

Introduction to the Trip. Peter started by giving an introduction to the purpose of the field meeting week-end which was an observation of Quaternary events in the North Norfolk area. The sites that we were to visit over the next 3 days would only form part of the story of the Quaternary geomorphology evolution of the East Anglia area and an additional trip would need to be made to South Norfolk and Suffolk to obtain an understanding of the full story. Today's observations were looking at the last recognized cold climatic stage of the Pleistocene epoch - the Devensian - a name derived from a mythical Romano-British tribe of the Chester area (Roman Deva=Chester), the type site being Four Ashes, between Stafford and Wolverhampton. The final site to be visited at Hunstanton would also include an observation of the underlying Cretaceous solid geology of the Norfolk area.

Peter handed out a table (see Table 1 below) of the British Quaternary Stratigraphical succession classification which showed the stratigraphic succession and the type sites that have been used to define the succession, 75% of which are in the East Anglia area. These type sites provide evidence for numerous cold and temperate climatic stratigraphical stages, representing inferred climatic episodes of glacials, interglacials, stadials and interstadials.

RGS FIELD TRIP 18-20 MAY 2012

TABLE 1

BRITISH QUATERNARY STRATIGRAPHICAL CLASSIFICATION

STAGE	TYPE LOCALITY	NOTES ON BOUNDARIES, LITHOSTRATIGRAPHY, etc.
Flandrian	(Post-glacial, Holocene)	Begins at base of pollen zone IV (F I)
Devensian	Four Ashes, Staffordshire (pit) SJ 916082	<u>Late</u> 25 ka B.P. to end of Loch Lomond stadial
		<u>Middle</u> 50 ka B.P. to 25 ka B.P. includes Upton Warron interstadial complex
		<u>Early</u> That part of the Weichselian preceding 50 ka B.P. Includes Chelford interstadial
Ipswichian	Bobbitshole, Ipswich (excavation) TM 148414	Ipswichian lake muds (base at beginning of I I (zone c of West 1957))
Wolstonian	Wolston, Warwickshire (pit) SP 411748	Includes Baginton-Lillington gravels, Baginton sand, Wolston series, Dunsmore gravels. Lower limit at base of Baginton; Lillington gravels
Hoxnian	Hoxne, Suffolk (pit) TM 175767	Hoxnian lake muds (base at beginning of zone H I (zone Ila of West 1956))
Anglian	Corton, Suffolk (cliff) TM 543977	Lowestoft Stadial - Lowestoft Till
		Corton Interstadial - Corton Sands
		Gunton Stadial - Norwich Brickearth Cromer Till Base at bottom of lower till of the cliff section
Cromerian	West Runton, Norfolk (cliff) TG 188432	Estuarine sands, silts, freshwater peat (Upper Freshwater Bed). Base at beginning of zone C I.
Beestonian	Beeston, Norfolk (cliff) TG 169433	Gravels, sands, silts, (Arctic Freshwater Bed). Base at beginning of zone Be.I.
Pastonian	Paston, Norfolk (fore shore) TG 341352	Estuarine silts, freshwater peat. Base at beginning of zone P I.
Pre-Pastonian	Beeston, Norfolk (foreshore)	Gravels, sands, silts and muds. Base at beginning of zone Pre-Pa a
Bramertonian	Blake's Pit, Bramerton, Norfolk TG 298060	Marine shelly sand. Base at beginning of <i>Alnus</i> - <i>Quercus</i> - <i>Carpinus</i> biozone.
Baventian	Easton Bawents, Suffolk (cliff) TM 518787	Marine silt. Base at beginning of zone L 4 (pollen)
Antian		Marine shelly sand. Base at beginning of zone L 3 (pollen), LV (forams)
Thurnian	Ludham, Norfolk (borehole) TG 385199	Marine silt. Base at beginning of zone L2 (pollen), L III (forams)
Ludhamian		Shelly sand. Base at beginning of zone L I (pollen), L I (forams)
Pre-Ludhamian	Stradbroke, Suffolk (borehole) TM 122738	Red Crag. Lower limit uncertain. Basal Crag (Waltonian) may be Pliocene

The Devil Punchbowl doline. (chalk karst doline), East Walton Common, near Croxton, Thetford (Grid Reference: NGR TL 877-892). A doline is a roughly conical depression formed by the solution and/or collapse of underlying limestone strata forming karst terrain, sometimes referred to as sinkholes, although this term is usually more associated with the sight of sinking water. At the Devil's Punchbowl (DP) the underlying strata is chalk, mantled by subsequent glacial drift deposits. Some dolines, as at the DP contain surface water the level of which usually



fluctuates with the water table level of the underlying strata. The DP was dry, likely to be a reflection of the last 2 years of dry winters and springs. There are at the base and at the lower level of its sides a series of height markers to record the changing water table. This fluctuation in water levels is reflected in rings of vegetation found around the bottom and lower sides of the doline. DP is a very symmetrical sided feature and one wonders if human agency has been at work here. It is one of a number of dolines that are present in the Breckland of Norfolk, some of which are permanently flooded and form meres.

Walton Common, near East Walton at the edge of the Nar river valley - Cryogenic Mound features? (NGR TF 735 – 165). Sparks et al. considered these cryogenic features had collapsed during the Windermere Interstadial c. 14 ka to 13 ka and then reformed in the Loch Lomond Stadial c. 12.8 ka to 11.5 ka (See Sparks, West and Bell [1972], Presumed ground-ice depressions in East Anglia. Proc. of the Royal Soc. of London B239.354).

These relict cryogenic mound features take the form of circular to oval depressions surrounded completely or partially by a raised rim or rampart of sandy sediment. The depressions very often define a wetland with an organic soil or peat as at Walton Common (WC). The soft sediments that have formed within the depressions can often be used to date climatic and flora change since the Last Glacial Maximum. At WC depressions are found in clusters where individual physical features occasionally overlap. At WC these cryogenic mound features are in an area between elevated chalk capped by sand and stone superficial deposits to the East, and the Hoxian Nar Valley clays to the West.

It is speculated that during periglacial conditions, ground water moving through taliks (unfrozen zones) in the chalk, rises to the surface at the line of its contact point with the impermeable clays. Under permafrost conditions the water at its surface discharge point feeds an ice lens, which, as it grows, heaves the adjacent ground surface into an ice core mound by displacement of the surface sediment. When climatic conditions improve and the ground ice finally melts, a distinctive water filled depression with raised ramparts around its rim remains (see photo right) and as at WC, these mound features can be found in dense clusters.



Hunstanton Cliff – Cretaceous Carstone, Hunstanton Red Chalk and Ferriby Chalk Formations. (Grid Ref TF 672-413 to 679-424). The third site to be visited was at the seaside town of Hunstanton. Hunstanton Cliff is a west facing sea cliff up to 18 metres high that extends for 1.3 km NNE from Hunstanton promenade to St Edmund's Point, Old Hunstanton. The Cliff is a SSSI site of Cretaceous sedimentary deposits. There is a distinct colour contrast between the exposed strata from the rusty brown Carstone Formation, at the base of the exposure, to the brick-red of the Hunstanton Red Chalk Formation ('Red Chalk') and finally the white and grey colours of

the Ferriby Chalk Formation, at the top of the exposure (the type-site for the Ferriby Chalk being in Lincolnshire). The richly fossiliferous nature of the Red Chalk & Ferriby Chalk at this exposure has meant that numerous workers have made observations on the site since the early 1800's.



The sands of which the Carstone is formed were laid down during the Albian Stage of the early Cretaceous Epoch (c. 108 Ma), are likely to span a wide period of time. They are formed of coarse sand particles interspersed with rolled pebbles indicative of deposition in a high energy, shallow sea, near shore environment, with strong currents. The fossils reported in the Carstone include ammonite fragments, bivalves and traces of burrowing organisms.

The Red Chalk which is approximately 1 to 2 metres thick (which extends to 30 metres thickness in Yorkshire) was laid down c. 101 Ma. Its red colouration is due to ? windblown limonite. Macro fossils are common throughout the Formation which include belemnites, brachiopods, echinoids and corals. The contact between the Red and Ferriby Chalk Formations, the Paradoxia Beds, at the base of the Ferriby Chalk, is extremely complex, with visible depressions in the eroded top of the Red Chalk, filled by laminated structures, which may be algal stromatolites, suggesting very shallow, possible intertidal conditions at formation.

The Ferriby Chalk, which extends to the top of the cliff and is approximately 10 metres thick, was laid down c. 99 Ma. It contains brachiopods, belemnites, bivalves, echinoids and ammonites.



St Edmund's point - The elusive Till - Holkham (formerly Hunstanton) Till. Our final observation of the day was at St Edmund's Point, where the Cretaceous formations were observed again, save for the Carstone, which is not visible due to the exposed succession having a gentle easterly dip. Here the Red Chalk crops out at beach level.

The Holkham Till was very poorly exposed. Peter took a spade to the path leading down to the beach and came to the conclusion that this was till. David Ward removed a plastic bag full of similar material from a cliff top gully for analysis; results to

follow. The Holkham Till is close to its maximum extent and relates to the Last Glacial Maximum c.20 ka (see later report)

Report by David Price. Photos by Roger Lloyd and Chris Fone

Stiffkey and Telegraph Hill - Saturday Morning

Our 9 am start on Saturday took us no further than the back of the Red Lion where we were staying (Grid ref. TF 968434). In a 3 metre bank behind the car park there were exposures of till on top of weathered chalk. This point is less than a kilometre north of the furthest extent of the Devensian ice sheet (12.5 ka approx.). The deposits indicated dissolution of the chalk associated with the decay of the ground ice. The till contained large flints, chalk fragments, flint cobbles and pebbles of sandstone with a North Country origin in a fine matrix. In the Geological Survey local sheet this is named as the Red Lion till (Devensian). **Note Addendum to this report added by Professor Peter Worsley.**

We walked North through the ploughed fields beyond the car park, across the exposure of the Red Lion till. On the surface there were various small erratics, sandstones, igneous pebbles, lias mudstones and striated permo-trias pebbles indicating movement under the ice at some point on their journey.



The fields end with a shallow cliff above the Stiffkey salt marshes, a Flandrian deposit estimated to be 8-10 metres thick. These deposits are still accumulating with the aid of a westward longshore drift. The sea level has been approximately stable since 6 ka. To the East 1.5km, at Morston (Grid ref. TF 986443), there is a 1.5m wide exposure in the cliff margin. A diamict, 1m thick, lies over a raised beach (see photo left). The till here has been identified as the Holcombe till. Its distinctive red brown colour is also traceable for a long distance north of the Wash through Lincolnshire. The raised beach underlying the till is exposed for a depth of 1.5 metres but has been shown by excavation to be 3m deep with rounded pebbles and chatter marked flints. This beach is almost certainly related to the Ipswichian interglacial and thus perhaps 100 kyr earlier than the overlying till.

Kelling Heath and Telegraph Hill (Grid ref. TG 105424). This is a well marked feature approximately 12 km further East and 5 km inland. The land surface is flat and dipping gently to the South West. There is a covering of a typical acid heathland vegetation of gorse, heather and scrub with little cover over sands and gravels. On its North Eastern edge this feature is cut off steeply, it stands 30-40m above the fields. As the margin of the greatest extent of the Devensian ice sheet lies further to the North this feature must relate to an earlier glaciation. The flat and gently dipping sands and gravels are a glacial outwash (Sandur) in all probability from a phase of the Anglian glaciation. It has yielded plentiful Mesolithic artifacts, but none were found on this visit. After this site the group moved to Weybourne station on the North Norfolk railway where lunch and steam trains temporarily replaced glaciations as our main focus.

Report and photo by John Banks

Weybourne Hope and the Blakeney Esker - Saturday Afternoon

Weybourne Hope (Beach Road Car Park). From the car park we walked along the beach to the East. We stood on the ridge beside the beach looking westwards. Here we could see the saltmarsh and gravel deposits behind the beach bar (see photo below left). A transgression from the sea swept the gravel deposits in front of it and washed them ashore. This is effectively a fossil bar and therefore protected.

We then walked down to the beach heading Eastwards: here we saw the first sequence in the Weybourne Chalk Formation in the Upper Chalk: five lithological units make up the stratigraphy.



The lowest bed was the Chalk with clasts (see photo above right). This differs from that seen at Hunstanton yesterday, as it contains clasts of chalk in a chalk matrix.



After a short distance flints started to appear in the chalk and moving along the beach we saw the chalk breccia above it. This is in-situ chalk with flints: a fossiliferous conglomerate with jumbled beach flints and a fragmented shelly fauna. Above it was a black band dipping about 30 deg. It is irregular and in places vertical – a planar feature that has been deformed or folded, probably as the result of glacial action (see photo left). Above this was a layer of sands.

Above the Chalk is the Weybourne Crag (old name) now renamed Wroxham Crag, which is early Pleistocene in age. It is a layer of sands and gravels. There is a discontinuity in the bedding: with a very heavily deformed till. The slanted beds are shear planes formed by the glacial ice.

Returning towards the car park, we looked up to the higher sequences where the black band was still very irregular. A mass of chalky material is seen up in the cliffs, an example of glacial action displacing the crag materials and folding the bedding (see photo right). A large flint clast above is in a deposit of till with stratification, and to the right there are clear bands in the deposit.



Blakeney Esker, Wiveton Down, south of Blakeney. We parked in the car park at the Blakeney Esker, where an explanation board describes its formation and says it is the best Esker seen in England. Peter did point out that there is also a good example in Hunstanton. The text explained that where we were standing would have been under a glacier during a previous glaciation just outside the line of the last glacial maximum. The deposits of sands and gravels were left behind as a ridge (esker) when the glacier retreated. It is about 3 km in length with a typical sinuous form. We walked along to the end of the ridge where there was a view over the Glaven valley, where the Glaven river makes its way to the sea at Cley. Peter drew attention to the humps of sand and gravels seen in the fields below (now covered by trees) and ploughed round by farmers: these

deposits were probably left by the Anglian glaciation, as the valley is outside the last glacial maximum. He also told us about several past geologists and how their interpretations differed about formation of glacial features and their terminology.



Walking back along the ridge we stopped briefly at a point where there was a section visible in the wall of an old quarry cut into the esker. It looked like a raised beach, with rounded flint beach pebbles (see photo left). Some angular pieces are standing upright, a post-glacial effect. A brief walk back across the main road we went through 2 small gates to an area where another cross section outcrop could be seen, showing a very chalky till overlain by glacial outwash flints.

Report and photos by Pam Goldstone

Stone Hill and West Runton - Sunday morning.

On a damp, windy, overcast morning we went to Beeston Regis Heath to climb **Stone Hill**. Visibility was reduced, but we could see Beeston Hill at the coast to the north. The heath is frequented by adders, but none were evident in the rather reptile-unfriendly weather.



Standing at about 300' (90m) on top of Stone Hill (TG1707441799) Peter evoked a picture of the glacial landscape that would have existed during the Anglian Glaciation (see photo left with Beacon Hill in the background). We gazed northwards from the edge of the Sandar (an outwash plain formed by glacial meltwaters) which slopes southwards, towards Beeston Hill (or *Beeston Bump* as it is called locally). At 207' (63m) high, this kame of contorted drift dominates the view. [We had another view of Beeston Hill later from West Runton beach.]

The sands and gravels of Stone Hill are a Sandar, the edge to the north is the remains of an ice contact slope. So the outwash plain is 300' above the base of the glacier. One can only wonder at the height of the glacier! On the other side of Stone Hill are little dry valleys, formed in periglacial conditions when the ground was frozen and water could not drain into or through the gravels, but instead ran off the frozen surfaces creating these now dry valleys.

Beeston Hill and Stone Hill are part of the Cromer Ridge, which extends some 20km from north of Mundersley to south of Holt. This ridge is not a terminal moraine sensu stricto (as opined by Wiki) but a massive series of fluvial and ice thrust deposits. Beeston Hill is part of Beeston cliffs (TG167434 to TG171433), a SSSI and the type site for the Beestonian glacial stage, which preceded the Cromerian interglacial. The Cromerian Forest-bed, a complex of differing interglacials, representing a time span of a million years, contains a rich assemblage of angiosperm and vertebrate fossils, with fossilised tree trunks sometimes being exposed on beaches after a storm.

We parked on Briton's Lane, near Britons Lane Gravel Pit - a SSSI and the type site for the Britons Lane Gravels, also part of the Cromer Ridge - described as a huge stack of near horizontal layers of sand and gravel - but we didn't see these as we could not get access to the quarry. As an aside - this quarry is not the source of Pleistocene cannon-shot gravels. They come from quarries south of Holt. Cannon-shot gravels are beach pebbles, reworked during glaciation and then redeposited. They form a very distinctive (and attractive) local building stone, evident in the villages in this area - including Stiffkey (where we stayed) and Happisburgh.

Our next stop was West Runton Beach car park (TG1850843165). **West Runton** is the type site for the Cromerian Interglacial. There are various interesting features here, described below.



We walked across a chalk wave-cut platform or pavement around the coastal defenses and along the beach to the east to investigate the stratigraphy of the cliffs (see photo left with Roger Lloyd and David Price walking across the chalk pavement).

There are large Norwegian larvikite blocks here, not adorning shop fronts as in Reading, but forming part of the sea defences.

The dominant (non-geological) feature of this beach is the sea defenses. This part of the coast is being eroded quite rapidly and various attempts have been and are being made to protect the land.

West Runton Cliffs is another SSSI designated because of its rich fossil beds. The black peaty West Runton Freshwater Beds were deposited some 600 ka in a quiet river backwater and are rich in plant and animal fossils. It is here that excavations, between 1992 and 1995, revealed the near-complete skeleton of a huge extinct elephant, the steppe mammoth (*Mammuthus trogontheir*), an ancestor of the woolly mammoth (now in the Castle Museum, Norwich). The layer in which it was found represents a short time period of only 100-200 years at the end of Cromerian Interglacial – a post temperate sub stage prior to the next cold stage. We didn't find any elephants (see photo below left 'Digging for Elephants!'), but did find various bones and shells (see photo below right).



Below the peaty layers are alternating layers of fluvial gravels and sands with quartzites possibly brought in by an ancient Ancaster River (see photo left of a 1 m section).

The climax of the morning was two spectacular examples of sand bodies which had sunk into the till, displacing it laterally. One was between Wood Hill and Goss's Gap (TG1922043047) and the other near West Runton Gap (TG1831943195) (see photo below with David Price left of centre for scale). A layer of glacial outwash sand 6-7m thick was originally deposited on top of the diamict. It was probably deposited from the ice margins and could be a former kame which has sunk into the diamict. An esker may also have fed the outflow from which the sand was deposited.



Report and photos by Elaine Butler

Sunday afternoon

The first stop of the afternoon was in Overstrand where we viewed the site of a landslide in the late 1990's. The slip here has been stabilised by weighting the toe of the slip using large boulders of Larvikite brought by barge from Norway.

We then descended to the beach and proceeded in a south easterly direction to the cliffs at Sidestrand. It was noticeable that there were no clear exposures of till at this location. The structure consists of two chalk rafts each overlain by sand/gravelly successions of Wroxham Crag. The upper raft has been thrust over the lower and this can be seen in the photograph (see photos below).



The above is a crag succession of early Pleistocene age and is the same Wroxham Crag we saw on Saturday at Weybourne.

At this stage our leader discussed the number of glaciations. Proponents of the 'new glacial stratigraphy', heavily influenced by the characteristic wavy patterns in isotope ratio curves, suggested that a pre-Anglian glaciation was involved here. However, the youngest part of the Cromer Forest-bed can be found at beach level at this location, as well as a kettle hole fill at the top, dating from the Hoxnian interglacial, thus excluding the possibility of pre-Anglian glaciations here. Further proof has been provided by reference to vole tooth roots, the evolution of which has been studied in minute detail, and the rootless variety does not precede the Anglian.



Our final stop of the weekend was at Happisburgh. The photograph left shows the view along the coast and the erosive power of the sea at this location.

In the last decade, hand axes have been found at low tide, which have been dated to some 500 ka. This has prompted further excavation of an old river channel and this contains cruder finds of flint flakes that have been dated to about 850 ka using palaeomagnetism.

The Happisburgh till found here is Anglian in age, and the Cromer Forest-bed is found below. The bottom unit is a massive diamict, but this is followed by laminated deposits suggesting lacustrine environments succeeding the initial till deposition (see photo right). The initial laminations are very fine, suggesting a distal ponded water environment, perhaps fed by meltwater. Higher up the silt is overlain by cross bedded sands, followed again by laminated clays. The whole fits a model of two advances of an ice sheet separated by a glacio-lacustrine environment.



Report and photos by Edmund Shirley

Addendum; the 'Red Lion' Till

The 2012 May field meeting was held in North Norfolk and our indefatigable assistant field secretary Carole (and Newsletter Editor) was responsible for organising the accommodation logistics. She found that the Red Lion Inn in Stiffkey had both capacity and availability to take most of the party so that is where we stayed. From the perspective of the one organising the field programme this location fitted admirably although I had not originally envisaged this. Accordingly I set out to do some homework on the locality. For many years on field classes we had traversed the tortuous main road through Stiffkey and pointed out that the eponymous river was flowing in a deep valley related to a glacial diversion of drainage (see Brand *et al* 2002 for details) but that is about as far as it went.

Examination of the recently published British Geological Survey (BGS) sheet 130Wells-next-the-Sea revealed that a separate till unit – the Red Lion Till – distinct from the much more widespread Holkham Till, cropped out immediately north of the Inn. These two tills, along with the Ringstead Sands and Gravels constitute the Holderness Formation which relates to the incursion of the Late Devensian ice onto the north-west Norfolk coast at the Last Glacial Maximum c 20 ka BP (within the Dimlington Stadial). During a brief reconnaissance prior to the RGS trip, the Red Lion was visited and it was found that the main car park behind the pub was excavated into some 3m of till over chalk bedrock, the latter being coincident with the contact between the two lithologies. Within the car park the till was not well exposed although just to the west behind a stalled new housing site the uppermost chalk could be seen to be deeply shattered but the flat lying till base was undisturbed.

Jon Lee of the BGS had commented in an email received after the RGS visit that the Red Lion Till was discriminated from the Holkham Till by its intensely chalky character. During the RGS visit the till in the car park when excavated revealed what appeared to be Holkham Till and a subsequent

walk over the ploughed field to the immediate north showed a chalk poor weathered till surface. This was a puzzle at the time although post depositional decalcification was suspected since the till exposed at the Morston Raised Beach locality was chalk free.

Subsequently by chance a short paper on the sequence at the Red Lion has been located in my journal holdings (Hoare & Connell 2003). This was a report for the Quaternary Research Association (QRA) following the award of a grant from the QRA research fund. The following summarises the report. Behind the Red Lion a c. 50 m long face exposed three facies of banded or laminated diamicton (till), a. reddish brown - 5YR in the Munsell Colour Notation, b. yellowish brown – brownish yellow 10YR, and c. light yellowish brown 2.5Y. The uppermost a, corresponds to what we observed and notionally is typical Holkham Till but apparently it was formerly seen to be folded with the other two facies and the inferred ice movement was from a NNE and NE direction. The carbonate content of the matrix of 5YR at 15% was high for the regional Holkham till values. The other two were 32% and 51% respectively. Non-opaque heavy mineral analysis (epidote/zircon and amphibole/pyroxene ratios) of samples from all three facies, lie within those which characterise the Holkham (Hunstanton) Till and this led to the conclusion that the entire till sequence relates to a single ice advance.

References

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