

“ the detailed glacial history of northern East Anglia has important implications regarding climate change and the palaeogeography of western Europe during the past million or so years ”

Over the past few years, a small team of BGS geoscientists, together with staff and research students from the Department of Geography, Royal Holloway, University of London, have been steadily unravelling the detailed glacial history of northern East Anglia. The work has important implications regarding climate change and the palaeogeography of Britain and western Europe during the past million or so years.

The cliffs along the coast of north-east Norfolk expose a complex sequence of Quaternary glacial deposits overlying shallow marine sands and gravels of the Crag Group. With much of the cliffline

For over 100 years, the three tills (poorly sorted material comprised of clay, silt, sand and gravel deposited directly from ice sheets) in north-east Norfolk, commonly referred to in the literature as the three Cromer tills of the North Sea Drift Formation, were regarded as having been derived from ice that originated in Scandinavia. However, our studies of derived micro- and macro-fossils, clast assemblages and far-travelled pebbles within these tills indicate that the ice from which the tills were deposited originated in northern Britain rather than Scandinavia. The derived microfossils and clast assemblages reveal that the ice sheet passed over and eroded areas of

Cutting the ice in East Anglia

Unravelling the glacial history
a joint BGS/Royal Holloway research project

retreating rapidly, new exposures are frequently available for study. Inland, snapshots of the geology can be obtained from small active and disused sand and gravel workings and brick pits. Geological mapping of the intervening ground, at a scale of 1:10 000, has provided a regional framework on which to base the research. Trial pits have been dug and boreholes drilled to obtain additional information and further samples for laboratory analysis.

Carboniferous, Jurassic and Lower Cretaceous strata of northern and eastern Britain before reaching the coast of Norfolk. Only in a younger deposit, the Briton's Lane Sand and Gravel, that forms the highest part of the Cromer Ridge and overlies the above tills, is there any evidence of rock types, such as rhomb porphyry from the Oslofjord area of Norway, indicative of an undoubted Scandinavian source.



T Cullen, BGS © NERC

Boulder of rhomb porphyry derived from the Oslofjord area of Norway, found within the Briton's Lane Sand and Gravel at Beeston Regis.



R Hamblin, BGS © NERC

Briton's Lane Sand and Gravel overlying chalk-rich till at Glaven Pit, Glandford.



J Lee, BGS © NERC

Till ball in sand and gravel of the third terrace of the Bytham River at Leet Hill. Yellow strips are 10 cm each.

It was also generally believed that the three Cromer tills were overlain by the Lowestoft Till (formerly known as the Chalky Boulder Clay), that extends over much of eastern England, and deposited by the British Ice Sheet. Our field and analytical work has demonstrated that the Lowestoft Till does not overlie the Cromer tills but is actually the equivalent of the second of the three Cromer tills, thus invalidating the concept of the North Sea Drift Formation. Analysis of derived microfossils and far-travelled pebbles in the till confirm that the Lowestoft Till was deposited by British ice.

The Cromer tills and the Lowestoft Till were considered to have been deposited during a single glacial period, the Anglian, some 440 000 years ago. Our research has revealed that small balls of material reworked from the lowermost Cromer Till occur within the third terrace of the Bytham River, a pre-Anglian river that flowed from the English Midlands to East Anglia, before the river was obliterated by the ice that deposited the Lowestoft Till. The presence of the till balls in the terrace implies that they were formed during an earlier glaciation than the one which deposited the Lowestoft Till, probably during a cold period around 625 000 years ago.

Our geological mapping has confirmed that much of central-north Norfolk is underlain by locally derived, extremely chalky till commonly referred to as the 'marly drift'. This has generally been regarded as a variant of the Lowestoft Till, although one or two researchers have argued that it was formed during a more recent glaciation. Our research has demonstrated that the chalk-rich till is indeed younger than the Lowestoft Till. Dating of interglacial deposits overlying the chalk-rich till in west Norfolk suggests that the till was deposited during the preceding cold period around 350 000 years ago.

The Briton's Lane Sand and Gravel, which contains the Scandinavian-derived pebbles, overlies the chalk-rich till across much of northern Norfolk. This sand and gravel is believed to have formed during a more recent glaciation about 130 000 years ago. The presence of the Scandinavian material in these gravels implies that ice was continuous from Scandinavia to Britain. This has important implications in the formation of the Strait of Dover. It has long been believed that



R Hamblin, BGS © NERC

Geologist examining chalk-rich till at Glaven Pit, Glandford.

this was cut during the Anglian Glaciation, about 440 000 years ago, when ice blocked the North Sea and, as water continued to pour into this sea from the Rhine, Thames and other great rivers, the North Sea overflowed the then-continuous Chalk ridge running from Kent to northern France, cutting the Strait of Dover. However, palaeontological studies have demonstrated that the first interglacial period in which warm-water creatures were able to pass through from the English Channel to the North Sea, was that which succeeded the glaciation during which the Briton's Lane Sands and Gravels were formed. Recent archaeological work indicates that this was also the only interglacial period in which hominids did not enter England from the Continent, so it would appear that the Strait of Dover was not cut until this glaciation of 130 000 years ago.

A final ice sheet originating in northern Britain impinged on the northern coast of Norfolk during the Last Glacial Maximum cold period about 18 000 to 30 000 years ago, depositing both till and outwash sand and gravel at lower levels than the earlier ice sheets. Boreholes have delimited the area of an extensive proglacial lake associated with this ice sheet.

The research has thus demonstrated that ice sheets have affected East Anglia during five separate cold phases during the last million years. In this respect, Britain now has a glacial history that is in accord with other parts of Europe, and not anomalous as was the case in the past. ■

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