The Little Ouse Headwaters Project Annual Talk 2006
by Professor Richard West FRS

The Frith and the Little Ouse and Waveney valley fens: origin and history

Introduction

This area of the Norfolk –Suffolk boundary along the Little Ouse and Waveney Rivers has always intrigued people interested in landscapes because of its most unusual, indeed unique, layout. Here there is a major valley, which goes east to west cutting into the plateaux of heavy land, boulder clay land, to the north and south. But at Lopham Ford, between South Lopham and Redgrave, is a stretch of level sandy ground which goes right across the valley, including the field called The Frith. This flat area separates the source of the Little Ouse from the source from the source of the Waveney. Thus, in Figure 1, the road between Redgrave and South Lopham, the B1113, goes right across the valley, with Redgrave and Lopham Fen to the east and Hinderclay and other Fens to the west.

Any Ordnance Survey map will tell you that this area is the source of Little Ouse and the source of the Waveney. The sources are only about 150m apart at the low height of about 25m O.D. In the block diagram you can see The Frith field, with the fens to east and west, as we come down into the valley from the higher boulder clay areas to north and south. Underneath all is the Chalk. The importance of the Chalk will come out later in the talk.

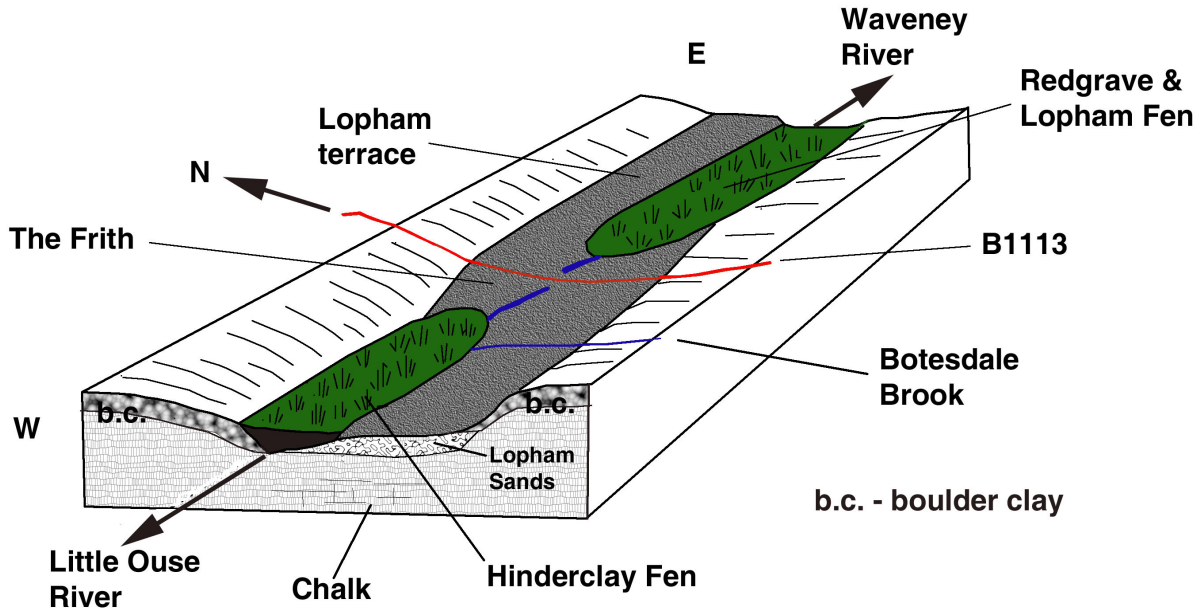

Figure 1

This arrangement is very odd because we have an east to west valley going right through here, and if you have a valley you should have a large river to form the valley. But there is no large river, just the sources of two rivers, one going to the Wash and the other to the North Sea. So, in effect, if you hadn't got The Frith, Norfolk would be isolated from Suffolk by these rivers. This is a very odd situation to have a through valley, apparently formed by a large river, but with no large river present, just a flat field and fens on either side. This is why the Frith is so interesting and unique (Figure 2).

We would expect this large east-west valley to have been formed by a large river – but there is no river. So we have to consider the origin of this situation. It aroused interest very early in the history of Norfolk and Suffolk landscape studies. The first reference to it was made in 1868 by the Rev. Osmond Fisher, a clergyman who had an interest in geology, as they often did in those days. He was never able to explain this situation to the satisfaction of his colleagues in the 1870s. He gave an explanation that was related to glaciation but it was not well received. After Osmond Fisher, the problem seems to have been forgotten – odd because it is a unique feature. But it has left the opportunity for me to investigate it !

Figure 2 The Frith from the north-west corner - the flat area is only 25m above sea level

In early 1950s I was a research student working in the Hoxne brick pits, near Diss, a famous archaeological site where Palaeolithic implements were some of the first to be discovered in Britain. They were recognised to belong 'to an age when people had not got the use of metals' by their describer, John Frere, in 1797. I spent some time at Mr Banham's brickyard in Hoxne, trying to work out the age of this Palaeolithic site. I used to bicycle in the area, from Hoxne to the picture house in Diss, and further afield, and in my travels around from time to time I went past The Frith. I wondered why it appears as it does in relation to these rivers, but never pursued the matter in detail. Four to five years ago I was walking round Redgrave and Lopham Fen and decided to have a go at working out why this situation exists. So, over the last few years I have been doing a lot of walking. The old proverb 'the dog that trots around finds a bone' is a good one for anyone interested in natural history and geology – and in the last four years I have found any number of 'bones' in the valleys of the Little Ouse and Waveney.

Attacking the problem

I have walked from Lopham to Brandon, and Lopham to Earsham, making notes on what I could see in the landscape and its underlying geology. I haven't done any laboratory work. I have worked from home and looked up what people have written about the valleys, using maps and aerial photos as well. It has been all a matter of using the eyes and the information provided in books and so on, trying to work out how the landscape developed. The only thing I have used is a soil auger about a metre long and I've used this as little as possible because it is quite hard work!

The Results

Remembering that all conclusions are subject to argument and discussion, I can report on my results..

There are two objectives in the project:

- What is the origin of the through valley in which The Frith is the central part?
- What is the origin of the valley fens – why do you have fens, well inland, well above sea level, practically in the centre of East Anglia?

The first thing to do is to look at what we can see now in the valleys east and west of Lopham Ford as we walk around.

Figure 1 shows the gradient of the present rivers and a plan of the two rivers. The Frith is at 25m O.D. in the headwaters area. If we look to west and east of this area, you will see that there are two very different landscapes. The landscape to west is where there are many heaths along the valley: Knettishall Heath, Rushford Heath, Barnham Heath, Thetford Heath etc. The whole area is covered by sand in the valleys, abundance of sand characterising the landscape with its characteristic flora and fauna and giving rise to the name Breckland. Under the sand is chalk.

To the east you have boulder clay, the heavy land, on the plateaus on either side, north and south, of the Waveney. But the sand actually goes east as well in the Waveney valley, e.g. north of Lopham Redgrave Fen, at Wortham Ling, and at Palgrave where the road crosses the Waveney from Palgrave to Diss - Low Lane. But, as you go further east the sand disappears and there are some very peculiar things going on. At Brockdish, the valley of the Waveney contracts suddenly to just a few hundred metres. Normally a valley expands slowly as you go down to the sea. Here it contracts to just over 2-300m wide at Brockdish, whereas near Hoxne it is over half a kilometre wide. Then, as you go beyond Brockdish, south of Harleston, you come to the huge embayment in the valley at Mendham Marshes, a flat area of marshland. But it doesn't last. By the Mendham pub (which celebrates Alfred Munnings) you find that the valley is only 150m wide again – so it has come in again - and then it slowly widens as you go down towards Bungay. The valley of the Waveney, with a low gradient, is not a simple valley, widening towards the sea. It is a very odd valley – a low gradient, a narrowing at Brockdish, a widening at Mendham Marshes, a narrowing at Mendham and then to the wetlands in the valley around Bungay and Beccles.

Thus the Little Ouse and Waveney valleys, joined at Lopham Ford, both have intriguing features. It is a challenge to try and explain how these features originated, especially since they give rise to the variation of the geology, which then gives the variation of natural history in the area, that we see today. To the west are the sandy areas with their Breckland character. These extend east to the borders of Hinderclay Fen and of Redgrave Lopham Fen and to Wortham Ling. The association of these sandy areas with the valley fens gives a selection of habitats from dry heath to fen, with a very different floras and faunas. Thus the geology is the key to the variation and diversity of the flora and fauna of the Little Ouse-Waveney system.

We have to explain why there is this variation in soils. No one has ever put forward any explanation of why the Breckland is so sandy. Where does the sand come from? The second question is the origin of the flat field, The Frith – there is no explanation of this blockage in the through valley. And the third thing to explain is the origin of the fens.

I want to talk first about the origin of the variation in the soils and habitats, which leads to the diversity in the flora and fauna of the area.

We have to go back to the great glaciation of East Anglia, which took place about 500,000 years ago, when a huge sheet of ice covered most of East Anglia. When it retreated it left the blue boulder clay that underlies all the heavy land of the Norfolk and Suffolk plateaus. When the ice retreated it left a landscape that is the basis of the present landscape. What did this landscape look like when the ice disappeared, and how did the landscape then change to what we see today?

My hypothesis about these changes, especially as they relate to the Little Ouse and Waveney valleys, is as follows, in four scenes, portrayed in Figure 3.

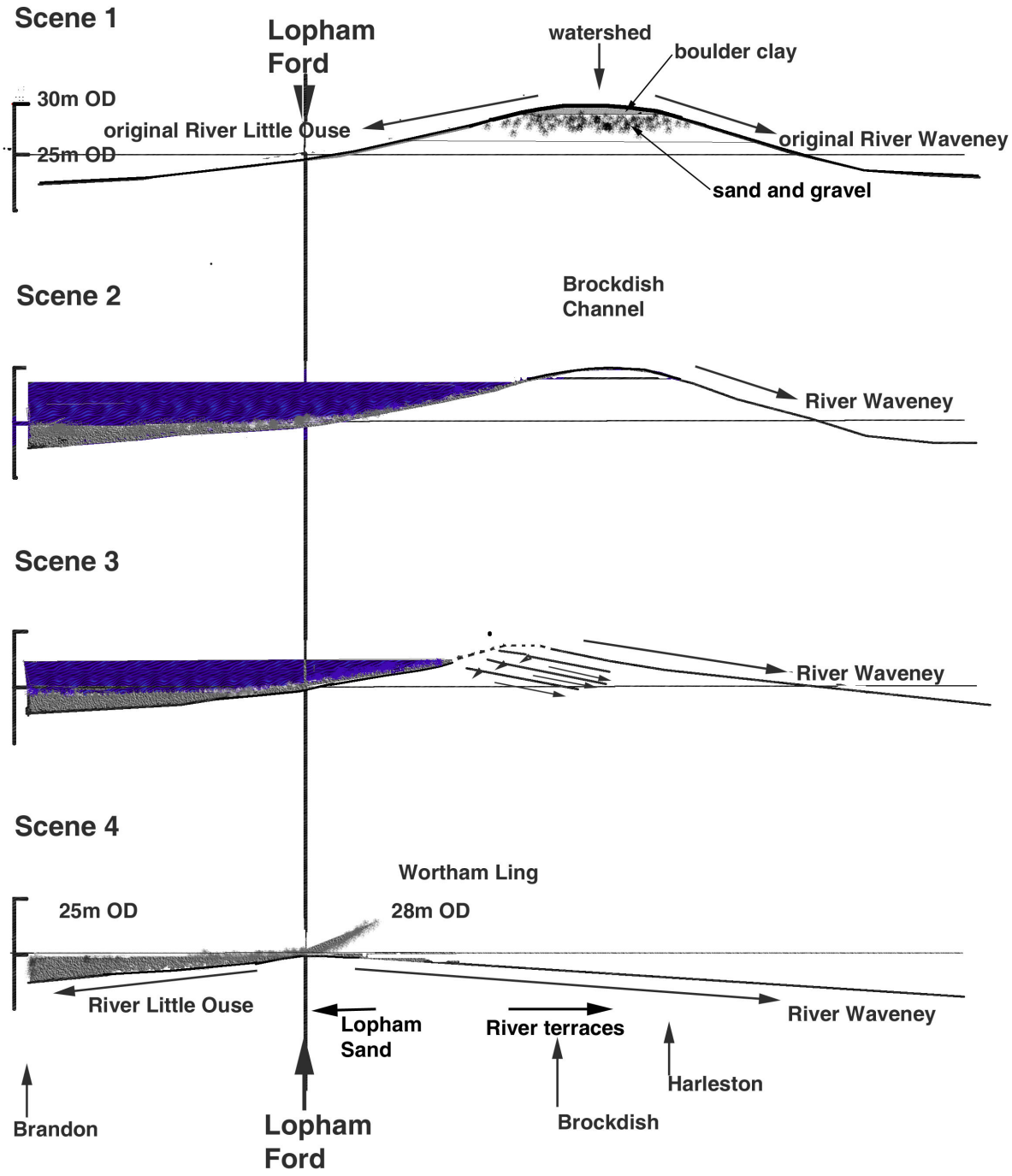

Figure 3 Four stages in the development of Little Ouse and Waveney Valleys:

Scene 1 After the retreat of the Anglian ice. The Little Ouse has its source near Brockdish, and the river flows west, past Diss and Lopham Ford, to The Wash. There was a watershed between the Little Ouse and the Waveney Rivers of that time round about where the Brockdish channel now is. It was at this time that the Little Ouse valley was excavated - the east-west valley that you see from the road at Lopham Ford. By the size of the valley this was an important river. The watershed between the Little Ouse and Waveney must have been at about or above 30m, 5-6m or more above the level of The Frith at Lopham Ford. This valley was in existence in the warm period that followed the Anglian Glaciation. And in this warm period (or interglacial) lived the Palaeolithic people who made the hand axes of Hoxne, some 3-400,000 years ago, at a site on a tributary of this valley.

Scene 2 A further glaciation. Following the warm period represented at Hoxne, at about 200,000 years ago, ice came into the Fenland and stopped somewhere around Brandon, not getting into the Little Ouse valley, but coming right down along the margin of the Chalk from Downham Market to Newmarket. What then happened to the Little Ouse River? What

happens to all the water coming down the Little Ouse, the Thet River and The Black Bourn (Ixworth river) in the Bury St Edmunds direction - these rivers had large catchments? The water, plus any from the drainage from the ice to the west, has to back upwards towards the source at Brockdish, with eventual overflow into the Waveney valley. So Scene 2 shows a large linear lake formed in Little Ouse valley, with an overflow channel, the Brockdish channel, formed. The sediment in the lake is sand, deposited during the flow of water to the east. Not much clay is deposited because the clay particles will be carried by the flow. Once the flow overrides the watershed at the source of the Little Ouse and Waveney Rivers of the time, it erodes the boulder clay first. The clay on the surrounding plateaux is only *ca* 10m thick – underneath is soft sand and gravel. Once the river get into the sand and gravel it carries it away in large quantities and gradually cuts down to form the overflow channel, down into the Waveney River of the time. So if you stand somewhere near Weybread, on the south side of the Waveney, say at the top of Stubbing's Lane, and look across Mendham Marshes, you can imagine water coming over the channel and scraping out this great embayment with the force of the water. So, my explanation explains the formation of Mendham Marshes as well as the channel at Brockdish.

Scene 3 The 'source' of the Waveney River moves west. As the river flowing east cuts down, the headwaters of the Waveney move west, the overflowing river cutting back through sands and gravels that don't stand up well to erosion.

Scene 4. The Fenland ice melts away at the end of the glaciation. The Little Ouse takes up its former route, the lake drains, and you end up with situation that you have now, with The Frith at the watershed and the sands of the originally upstream Wortham Ling at a higher level than The Frith, about 5m above the Waveney – you can see this when you go down steep hill from Wortham Ling to Roydon. The sands of the old lake bed, now exposed, become the characteristic sands of the Breckland.

So, this is my explanation of why Lopham Ford is as it is. As you cross the valley on the B1113, you are crossing the old valley of the Little Ouse when it was a much longer river with a source near Brockdish. Then the watershed separating the Little Ouse from the Waveney moved west, the Waveney capturing the headwaters of the original Little Ouse. The watershed is now at Lopham Ford, and the sandy areas you see in the valley are the sediments of the disappeared lake, well-preserved in the flat areas.

I hope the 4 scenes of Figure 3 explain why The Frith is there and how it originated.

Let us illustrate these explanations of the landscape changes:

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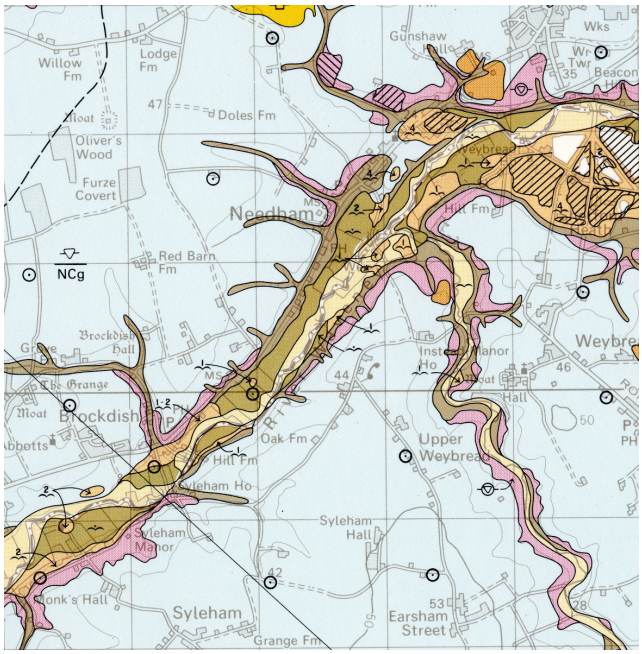

Figure 4 The British Geological Survey map shows the contraction of the Waveney valley at the Brockdish Channel and the expansion of the valley at Mendham Marshes, the latter the result of the overflow event .

Figure 5 From this view across the 250m width of the Brockdish channel you can see that this is an overflow channel and totally unlike the valley at Hoxne or further down towards Bungay

Awaiting image

Figure 6 This aerial photograph shows the straight Brockdish overflow channel with the Waveney snaking through it. The channel widens as you come near Needham

Figure 7 View south from Low Common Road, near Redgrave and Lopham Fen Visitor Centre. Why is it so flat? The bed of the old lake is exposed – a very flat surface because the lake sediments seal any underlying landscape features.

Figure 8 View east along Low Common Road, which follows the terrace along to the Suffolk Wildlife Trust Visitor Centre once you turn off the B1113.

Figure 9 Looking east across Hinderclay Fen, you can see the flat land of the sand of the lake bed, forming a terrace, on the right.

Figure 10 At the eastern end east of Hinderclay Fen, there is a relict Breckland flora on the terrace of sand on the right. The fen on the left and the Botesdale Brook, the true source of the Little Ouse, is in the trees.

Figure 11 At Wortham Ling is, again, part of the flat sandy lake bed. It is about 5m higher than Redgrave and Lopham Fen (upstream before the Waveney captured the Little Ouse) and so it is isolated here, well above the Waveney. The Waveney has cut down since the lake was here, leaving Wortham Ling stranded at a higher level than Lopham Ford.

Figure 12 Knettishall Heath - this flat area, with sandy soils and lowland heath, is again part of the old lake bed

Figure 13 On Rushford Heath a hole exposed 2.5m of sand of the lake sediment

Figure 14 Barnham Heath, looking east towards County Hole, where the Black Bourn joins the Little Ouse. This lowland heath, again on lake sands, has a small depression called The Mere – a kind of embryonic Diss Mere with chalk not far beneath, which has suffered solution leading to subsidence and a hollow.

All these features we have noted are readily visible today in the landscape – the sand, the lake bed, the Brockdish Channel, the Mendham Marshes etc., which I think is remarkable. All that is needed is to take a walk!

The origin of the sand of the Breckland.
The sands must derive from the sands of the Little Ouse Lake. It is this sand which occurs everywhere in the Little Ouse valley, where it may be several metres deep. But it is never very thick on the higher ground, to where it has been dispersed by wind in the long time since the drainage of the Little Ouse Lake, say 160,000 years ago. So the origin of the Breckland flora and fauna lies in the origin and geology of the Little Ouse Lake.

The Little Ouse Lake.
Is it possible to see the level of the Little Ouse Lake? I think there are two pieces of evidence.

- At Wortham Ling you get gravel coming into the sand near the surface, indicating that a small tributary entered the lake at this point, at *ca* 29m above sea level. This can be seen in ditches dug recently by the Council to control car parking. So this makes the height of the water in the lake at that time about 29-30m above sea level (no higher or the sands would have been more extensive).
- Curious evidence – I think that there are one or two places where you can actually see the shoreline of this lake. When the local British Geological Survey map was prepared

- in 1975, T. E. Lawson, who was mapping the land on a large scale, described what he called a 'prominent scarp'. It is on Shadwell Estate land, just west of Rushford, near Seven Hills (tumuli), on the north side of the Little Ouse valley – looking up from the valley I saw a sudden change from sand to Chalk (Figs. 15 and 16). The Chalk is Dr Lawson's prominent scarp.

Figures 15 and 16 The transition from sand (foreground) to chalk near Seven Hills, just west of Rushford

Is this the shore of the lake? Amazing, if preserved, and too good to be true! So I looked at the aerial photographs of the area. These show the soil patterns in Breckland, which come up especially well in dry summers: those of 1975 and 1976 were excellent summers for aerial photographers, if not for others. Figure 17 shows the Little Ouse, Rushford on the right, Seven Hills and the famous Breckland soil stripes, which are the result of freeze-thaw activity on a slope under an arctic climate (with polygons on flat ground). Here there is a boundary between stripes with a lot of sand (pale) and stripes with less (darker). I plotted contours on the photograph and levelled the scarp to get the height of the shore line – it lies between the 25 and 30m contours, so it looks as if this may well be the actual shoreline of the lake. It is similar in height to the Wortham Ling situation. I also made a series of auger holes that showed the sand increasing in depth towards the Little Ouse itself, as would be expected.

Figure 17 Aerial view of the transition between the sand and chalk, shown by the change in colour of the soil stripes north of the Little Ouse, below Seven Hills, west of Rushford

The valley fens

Finally I want to consider the origins of the valley fens. The area is underlain by Chalk under thin depths of glacial sediments such as the boulder clay. The Chalk is an aquifer with many springs emerging – for example at St Mary's Well near Thelnetham Church, Redgrave and Lopham Fen, Hopton Fen (east side) Market Weston (east side). The hydrology is complex and I have had help in interpretation from people in the Environment Agency. Water coming up dissolves the Chalk resulting in collapse. This happens especially in cold conditions – arctic or glacial conditions - because carbon dioxide is much more soluble at low temperatures and that dissolves the Chalk. The Breckland meres, with their fluctuating water levels, Langmere, Ringmere, Devil's Punch Bowl, etc., are thought to have a similar origin, and mark places where there has been collapse of the Chalk through solution. I think that it is the same with fens on either side of the Frith. It is certainly the case with Diss Mere – this has many metres of sediment, the oldest of which were deposited some 10,000 years ago - and it has been filling in ever since. There is another mere downstream in the Waveney valley – there is one called the Ley near Earsham. It is quite common to find these collapse features in the area of the Chalk.

If you put a borehole down at Redgrave and Lopham Fen you would go through the peat into lake sediments, a few metres thick, before reaching sand. These lakes formed 10-12,000 years ago and filled with sediment and later with peat, as the lakes filled with sediment. So, the origin of these meres and fens is related to the hydrology of the Chalk; they occur extensively the valley in the headwaters area.

It is extraordinary that The Frith has survived all these activities: collapse of the Chalk and erosion of the sand as the lake drained. It remains the one place where you can cross the rivers. How long will it stay there? If you have a very cold climate you get a very characteristic form of erosion of sands and wet sediments.

Figures 18 and 19 show the kind of collapse feature you get under conditions of freeze/thaw in arctic climates, a view in Banks Island in the Canadian Arctic. You can see a semi-circular

Figures 18 and 19 Collapse features on Banks Island in Banks Island

collapse caused by an accumulation of water on top of the frozen ground (permafrost). The water melts the frozen ground water and the walls collapse and so you get a semi-circular (cirque) feature formed. Look at the west side of The Frith and you find a very similar semi-circular structure. Could this be the result of a similar kind of erosion under very cold conditions during the last cold period and glaciation (110,000 to 10,000 years ago? If we have another cold episode, The Frith might be expected to disappear through this sort of erosion. The Little Ouse would capture some of the Waveney back again because, if you look at the gradients of the river (Fig. 1), that of Little Ouse is steeper and so it might work back into the Waveney.

Finally, everyone loves pingos – Figure 20 shows one on Banks Island, raised by the development of an ice mass underground, probably related to an underground spring. There is a Snowy Owl perch at the top! When the ice melts you are left with a hollow, such as are recorded in East Anglia, including those described from Market Weston Fen.

Figure 20 A pingo on Banks Island in the Canadian arctic

My conclusions.
These are the main results of my walkabout:

- The east-west through valley at The Frith is that of the original Little Ouse before a glacially-impounded lake was formed in its valley.
- The sand in Breckland is the sediment of this lake.
- The flat areas of the Breckland valley heaths originate from the old lake bed.
- The origins of the valley fens lie in the solution of the Chalk and the hydrology in the main through valley.
- The Angles Way long distance walk is almost designed to allow a walker to see most of these features, a really useful circumstance!

Acknowledgements
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