**CGS excursion Wednesday 5 September 2018 Birkhams quarry, St Bees Head and beach cliffs: visit to 2 Local Geological Sites**

Leader Sylvia Woodhead

A. **Birkhams quarry, St Bees Head,** a working quarry in St Bees Sandstone LGS 4/030

Meet in Sandwith village NX 965145 at 10.15 am, to car share. We hope to be allowed to take a maximum of 10 cars up the private road to the quarry, where the manager Steve Boam will show us around the quarry from 10.30-12.00. *Hard hats are required and hi-vis is recommended, with footwear appropriate to the weather conditions (if wet, wellingtons may be the best). Please keep together as a group within the quarry, as directed by Steve Boam.* After the quarry visit there will be time to study the 2 information boards (See attached 2), the blocks of rock outside the quarry and to examine the geology visible from St Bees Head.

We will then drive to St Bees beach car park. *The left hand car park is cheaper, £2.70 for 4 hours. We will meet briefly at the north end of the Promenade by the 'Wainwright Wall' (NX 961118), then walk across the footbridge over the small Rottington Beck to have lunch on the wave cut platform of St Bees Sandstone at NX 958118. The afternoon will involve a 3 km walk, along the shingle and sand beach to Pow Beck, returning on the footpath along the top of the moraine ridge.*

B. **St Bees beach cliffs** LGS 4/009 : Glacial Landforms of the last British-Irish ice sheet

The aims of the afternoon excursion are

- To assess the significance of the glacial till deposits exposed in the cliffs, and to discuss changing interpretations as to their formation.
- To test if it is possible to distinguish clasts of Scottish or Lake District origin
- To look for evidence of push moraines
- To assess the evidence for a post-glacial lake and/or meltwater channels

*Some background*: The LGS designation (1993) describes 2 tills, formed in glacial readvances (See attached 3).

*The Lowca Till*, a well consolidated coarse lodgement till with locally derived clasts suggesting a northerly derivation, is identified as Late Devensian and occurs at the foot of St Bees Head. This is separated by contorted outwash sands and gravels (*St Bees Sand and Gravel*). These are crudely cross bedded with clasts up to 2 metres long, thought to be the product of high energy meltwater flow. An overlying fine grained till (*St Bees Till*) is almost pebble-free sand and silt grade with marine fossils, identified as the Gosforth Oscillation. An upper *How Man Till* is identified as a Scottish readvance terminal moraine. An exposure of *submerged forest*, with roots in grey clay, dated at 8-9000years BP, pollen analysis from a kettle hole towards the southern end of the cliffs and present day mud flows were also identified. The variety of pebbles at the top of the beach are said to be 'brought by ice from both the Lake District and Scotland'. *(Is this account still valid?)*

The St Bees web site, www.Stbees.org.uk community/ geology, claims this is 'one of the best places in England to look at a freshly eroded cross section of a glacial moraine', & notes 'the cliffs are retreating 4-6 inches per year'. *(Are we happy with this explanation?)*

The St Bees cliff section has been identified as a *push moraine*, with folded and faulted glacifluvial and glacigenic sediments thrust to the south west as a thick ice wedge. The folds are said to be very clearly displayed in the St Bees Sands and Gravels, with the faults are much harder to see (Williams et al 2001).

During the last Ice Age the St Bees area was glaciated by radial ice from the Lake District (Ennerdale) and by unstable, surging and fast moving Irish Sea ice, from the Solway. To the north the 'St Bees valley', a former lake now peat filled, is blocked by glacial deposits. See Britice Map v2.0 (2017)

*The hypothesis is that the moraines were deposited by a fast moving Irish Sea ice stream.*

Clast shape within the deposits may reveal whether the deposit (diamicton) is a) Glacial b) Glacio-fluvial (meltwater) or c) coastal- derived from coast erosion

**Some possible hands-on activities: examination of diamicton (after M Hambury)**

- **Sorting**: estimate grain size distribution by means of rubbing a sample. Estimate the relative proportions of clay, silt, sand & gravel & the % of clasts
- Look for evidence of **bedding** (if present)
- **Clast fabric**: - shape & orientation of long axis of 50 pebbles
- **Shape of clasts**, measure a, b, c axes of 50 pebbles
- **Roundness** (of corners) (see attached 4)

Excursion Route- a walk south along beach

Site 1 NX 958118. The relationship between the St Bees Sandstone bedrock & the overlying glacial & glaciofluvial deposits of Lowca Till, overlain by St Bees Sand & Gravel & St Bees Till, may be studied here. Various explanations, including the critical wedge model, can be discussed.

Site 2: Gutter Foot, over Rottington Beck- is there any evidence of a meltwater channel here?

Site 3: Promenade- groynes have been constructed to stop longshore drift. Is there evidence that drift is occurring and if so in which direction?

Site 4: low cliffs at south end of Promenade, NX 962116- look for evidence of folding & deformation in the cliffs of St Bees Gravels

Site 5: BVG erratic NX 962117- consider the evidence from the variety of erratics on the beach

Site 6 Till cliffs NX 96351 11474- look for evidence of ice wedge deformation

Site 7 Till cliffs NX 96452 11374- as above

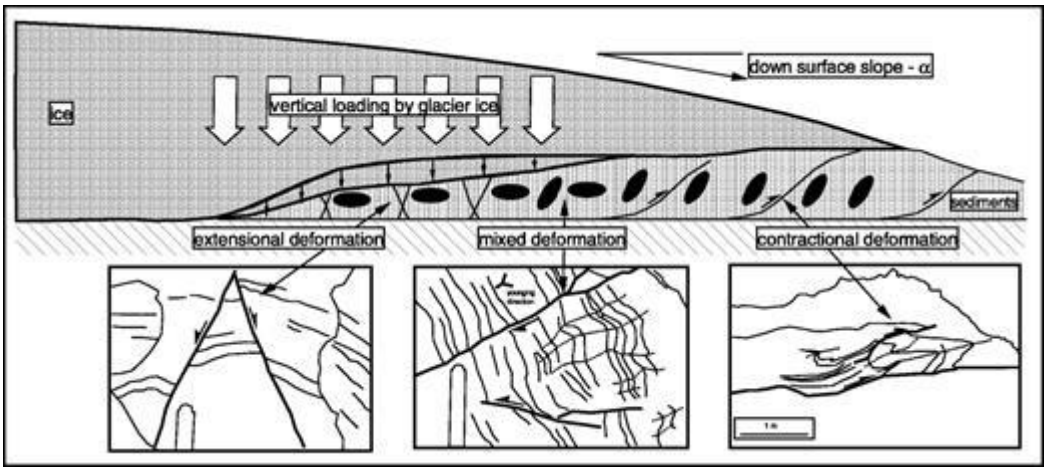
Site 7: Pow Beck NX 969107- is the submerged forest visible?

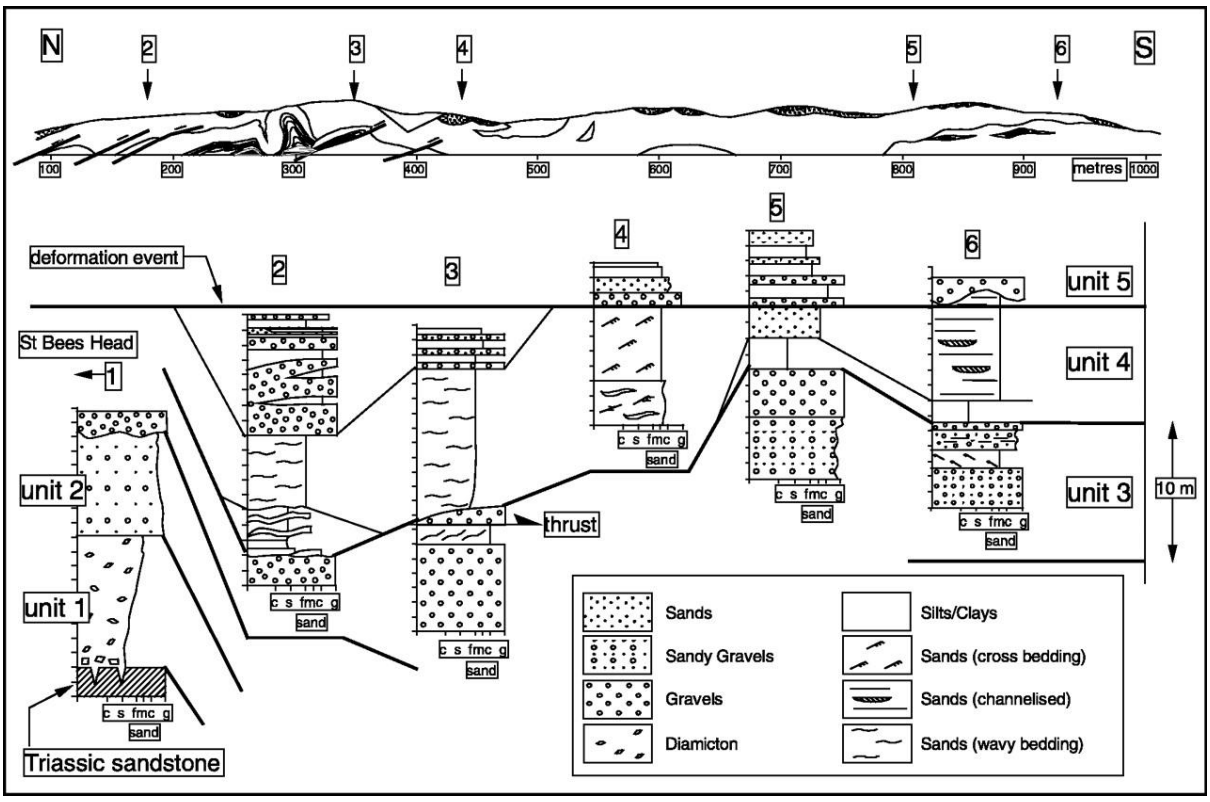
When walking back along the cliff top, consider the features displayed in the moraines and assess their position at the mouth of the St Bees Valley.

*Sylvia Woodhead*

**Late Devensian glaciotectonic deformation at St Bees, Cumbria: a critical wedge model,** G. D. WILLIAMS, P. J. BRABHAM, G. P. EATON and C. HARRIS, Journal of the Geological Society, 158, 125-135, 1 January 2001, **Abstract**

Glaciotectonic deformation of the Late Devensian sediments exposed at St Bees, Cumbria is represented by minor extensional faults resulting from ice-sheet loading of the unconsolidated sediments accompanied by thrusting and folding. The highly deformed northern part of the section has numerous thrust faults associated with fold structures that verge predominantly to the SE, but with some NW-vergent (backthrust) structures. A high-resolution seismic reflection survey confirms that the thrust structures form a linked fault system that detaches at, or slightly above bed rock, which is here composed of Triassic, St Bees sandstones. In the less deformed southern part of the section, the seismic survey has imaged bedding with a southerly component of dip in the St Bees sandstone cut by steep north-dipping extensional faults which, to some extent, control rockhead topography. An integrated approach combining structural geology and high-resolution seismic reflection surveying has enabled the construction of a balanced cross-section which estimates a minimum of 115 m (22%) cumulative shortening due to glaciotectonic processes. Minor structures observed in the St Bees cliffs and larger structures interpreted from the seismic profile are compatible with a critical wedge model for deformation caused by an overlying thick ice wedge with a SE-dipping surface slope.



Glacitectonics- a key approach to examining ice dynamics, substrate rheology and ice-bed coupling
JR Lee & E Phillips 2013 *Proceedings of the Geologists Association* 124 731-737

*Some comments*
Glacitectonics looks (with other evidence) at the imprint of deformation within deposits (folds, fractures, fabrics, & lineations) produced as ice overrides or pushes into pre-existing (glacial) sediments. These deformation structures exert a dominant control on the development and style of landslides.

Boulton 1986 recognised that a component of the forward glacier motion was accommodated by deformation of its substrate. A deformed 'substrate' is said to have a distinctive idealised glacitectonic structure, with vertical variation in cumulative strain, from undeformed at the base to highly sheared above. However the ice may stick or slip, producing a 'mosaic type pattern of structural styles'.

Proglacial glacitectonism refers to displacement of lithified or unlithified materials by the stresses applied by active ice. Landforms attributed to this have neem mapped in Europe & North America. Progress in understanding was made when this deformation was recognised as similar to thrust belts within continental collision, producing imbricate thrust structures and nappes. The conclusion was that the force applied by an ice mass is not lateral, but rotational, leading to the production of a series of wedges displaced upwards and down-ice (gravity spreading model).

One historical debate is whether different types of subglacial diamicton (melt-out till, lodgement till, subglacial till) can be recognised, or is all subglacial till essentially deformed?

There is also considerable research attempting to distinguish between subaqueous and subglacial processes, for example in the Late Devensian glaciation of the Irish Sea Basin.