



# **Submarine geomorphology of the Celtic Sea continental shelf and the southern extent of glaciation on the Atlantic margin of Europe**

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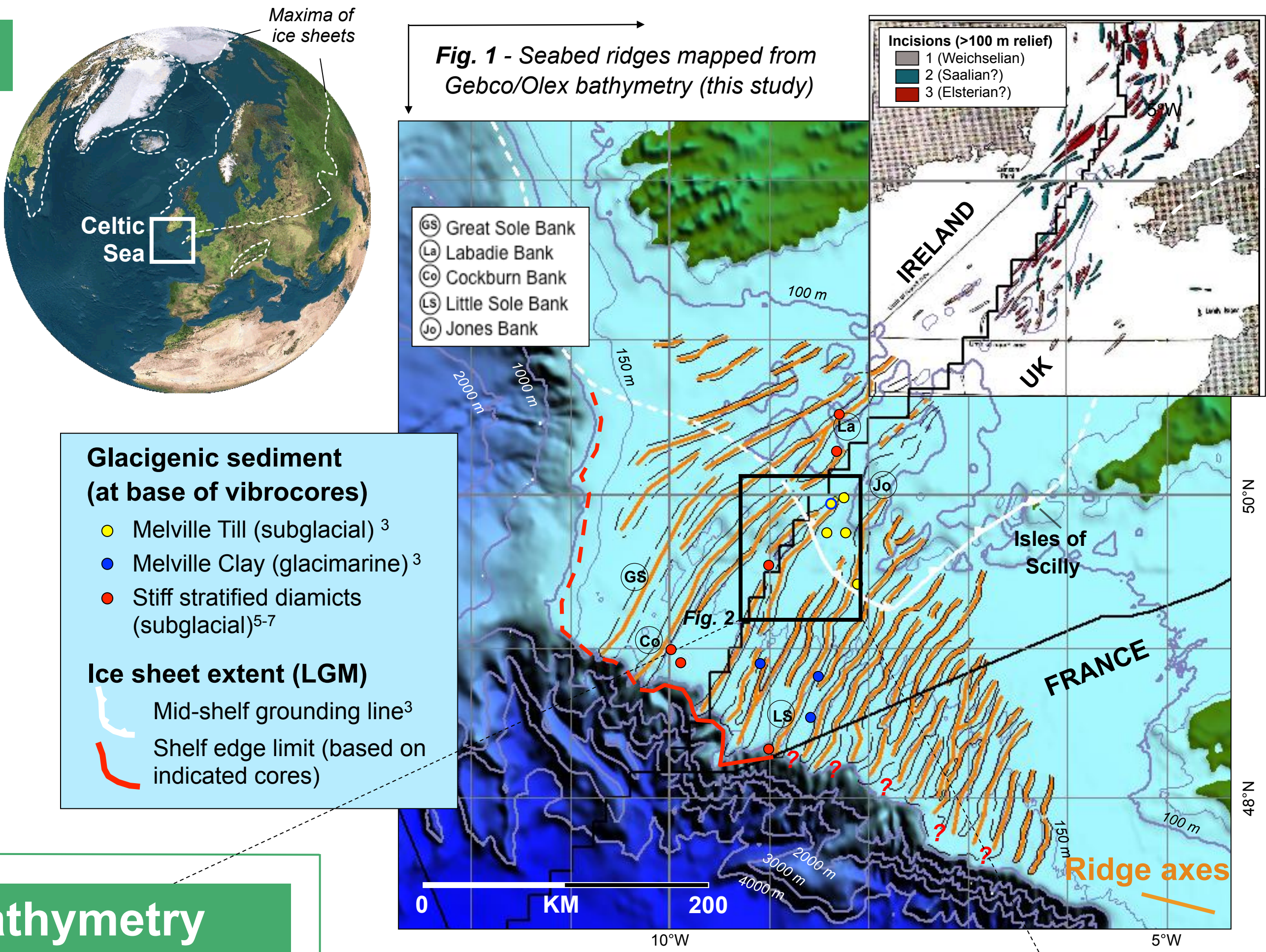
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## Celtic Sea glaciation : open questions

- How far have ice sheets advanced SW into the Celtic Sea? Surprisingly, we are still not sure.
- Subglacial and glacialine sediments cored in the 1970s on and between a system of shelf-crossing seafloor ridges<sup>1,2</sup> indicated ice extent to at least the mid-shelf of the Irish and UK sectors<sup>3,4</sup> (Fig. 1).
- Recent coring of subglacial sediments on and adjacent to ridges indicates ice extent >100 km farther seaward to the Irish & UK shelf edge<sup>5-7</sup> (Fig. 1, red line).
- Ice extent in the French sector remains unconstrained.
- What are the ridges? Integration of cores with seismic data suggests they could be a) post-glacial tidal sand banks, or b) relict glaciofluvial landforms<sup>5,6</sup>.



Inset - map of buried or partly infilled Pleistocene 'incisions' (>100 m in relief)<sup>8</sup>

## Regional submarine landforms

### North Celtic Sea : incisions<sup>8</sup> (tunnel-valleys)

- up to 250 m in relief, 5 km wide, 20 km long
- at least 3 stratigraphic levels (mainly infilled)
- meltwater drainage during at least 3 glaciations

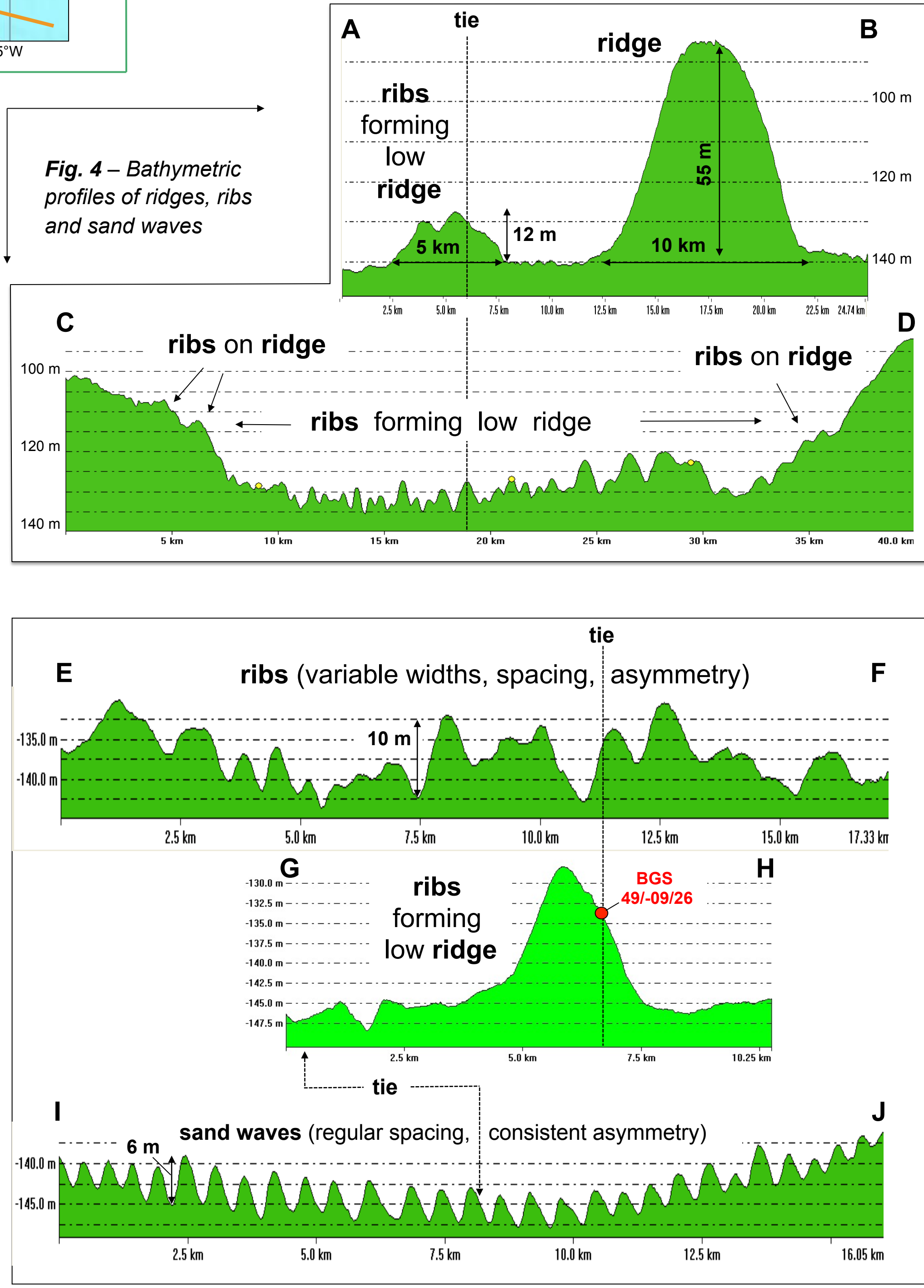
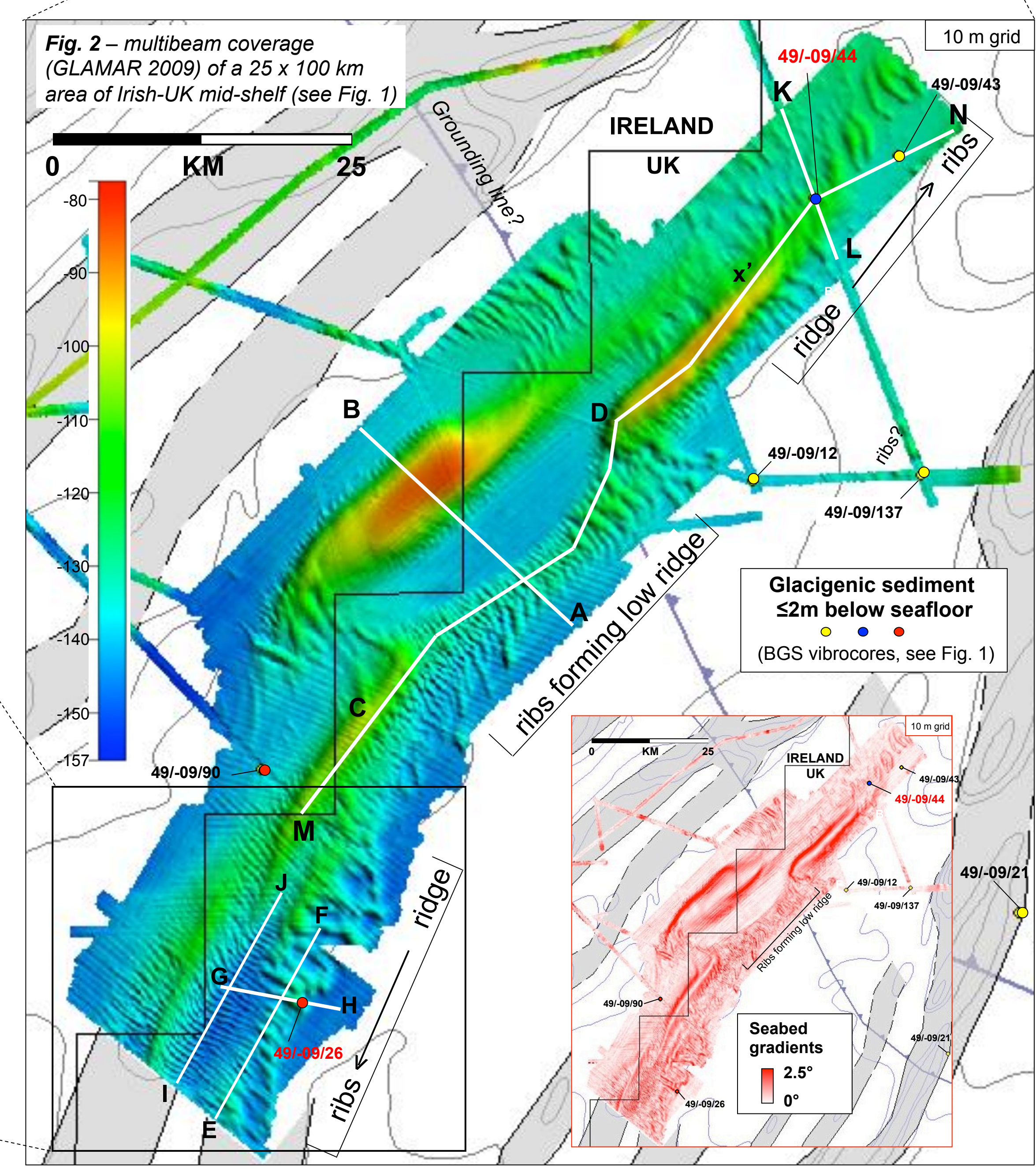
### Celtic Sea shelf : seafloor ridges

- up to 60 m high, 10 km wide, 300 km long
- fan-shaped, apex points to North Celtic Sea
- axial rotation of up to 80° (W-E to almost N-S)
- axial convergences seaward, some landward
- up & down axial profiles (segments 10s km long)

## Mid-shelf landforms from multibeam bathymetry

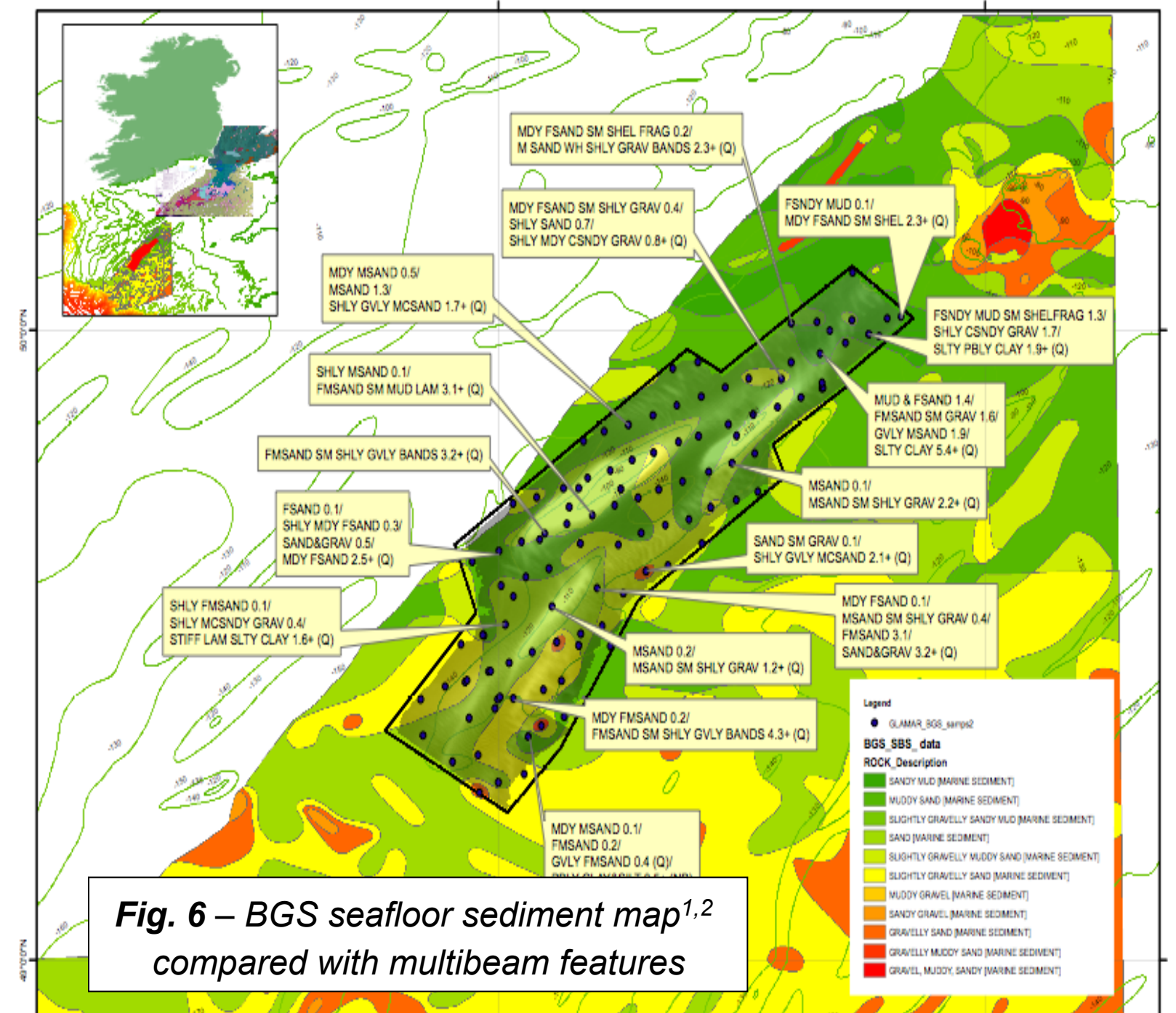
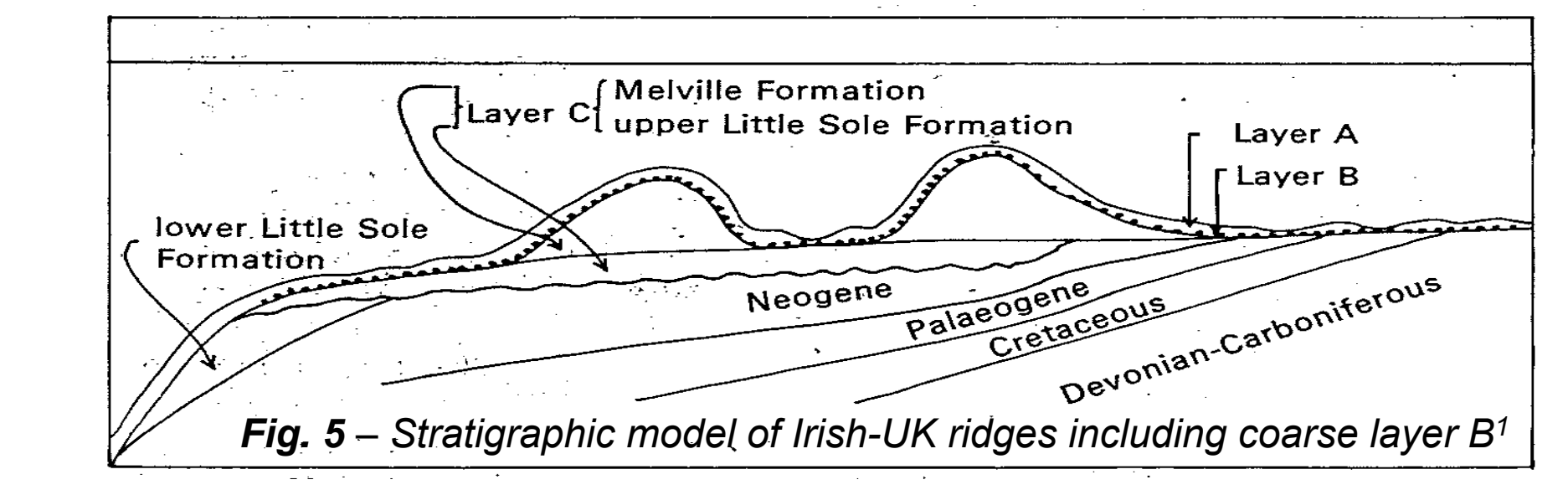
### Rectilinear network of seafloor features :

- Ridge segments** : en echelon elements up to 55 m high, 10 km wide and 10s km long
- Transverse ribs** : up to 15 m high, 1 km wide and 10 km long; arcuate to linear, no consistent spacing or asymmetry; occur both lateral to ridges and as axial extensions forming low ridges (see A-B vs C-D)
- Sand waves** : 3-7 m high, up to 0.6 km wide; consistent spacing, asymmetry, widths; occur in south of area, on and between ridges (see I-J)



## Glacigenic drape of ridges and ribs ?

- Ridges shown to be truncated by a regional unconformity overlain by a fining-upward succession<sup>6</sup> (layers A & B, Fig. 5)
- Sample & sonar data show layer B to include gravel (to >1 m size) of presumed glacial origin (ice-rafted or reworked till)<sup>1,2</sup>



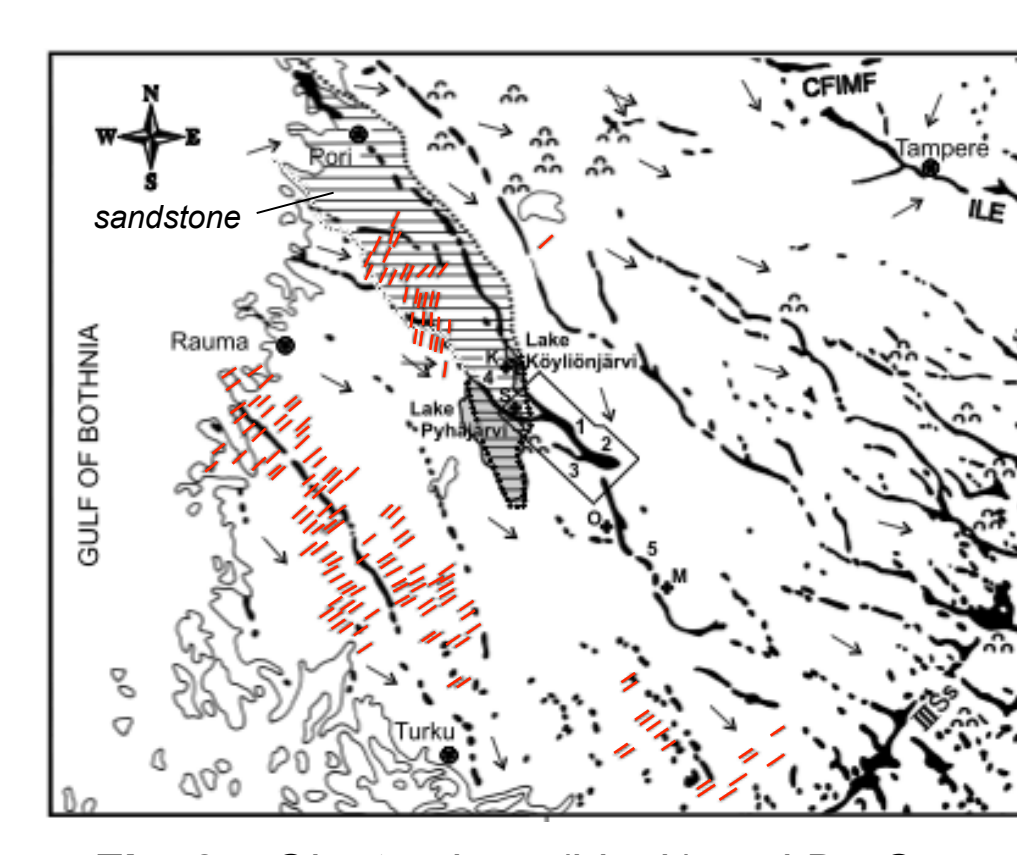
## Are we looking at tidal or glaciofluvial landforms ?

### Tidal banks and sand waves : too big + wrong morphologies ?

- Up to 50% higher than largest known tidal banks, and at upper limit of sand wave heights → low slopes imply that, if degraded, both were originally far bigger than any known features
- Lack morphologies consistent with the cyclonic flow systems typical of tidal systems (curvature into parallelism with bank crests, opposite symmetry on opposite sides of banks...)

### Giant eskerine ridges and glaciofluvial (De Geer) moraines ?

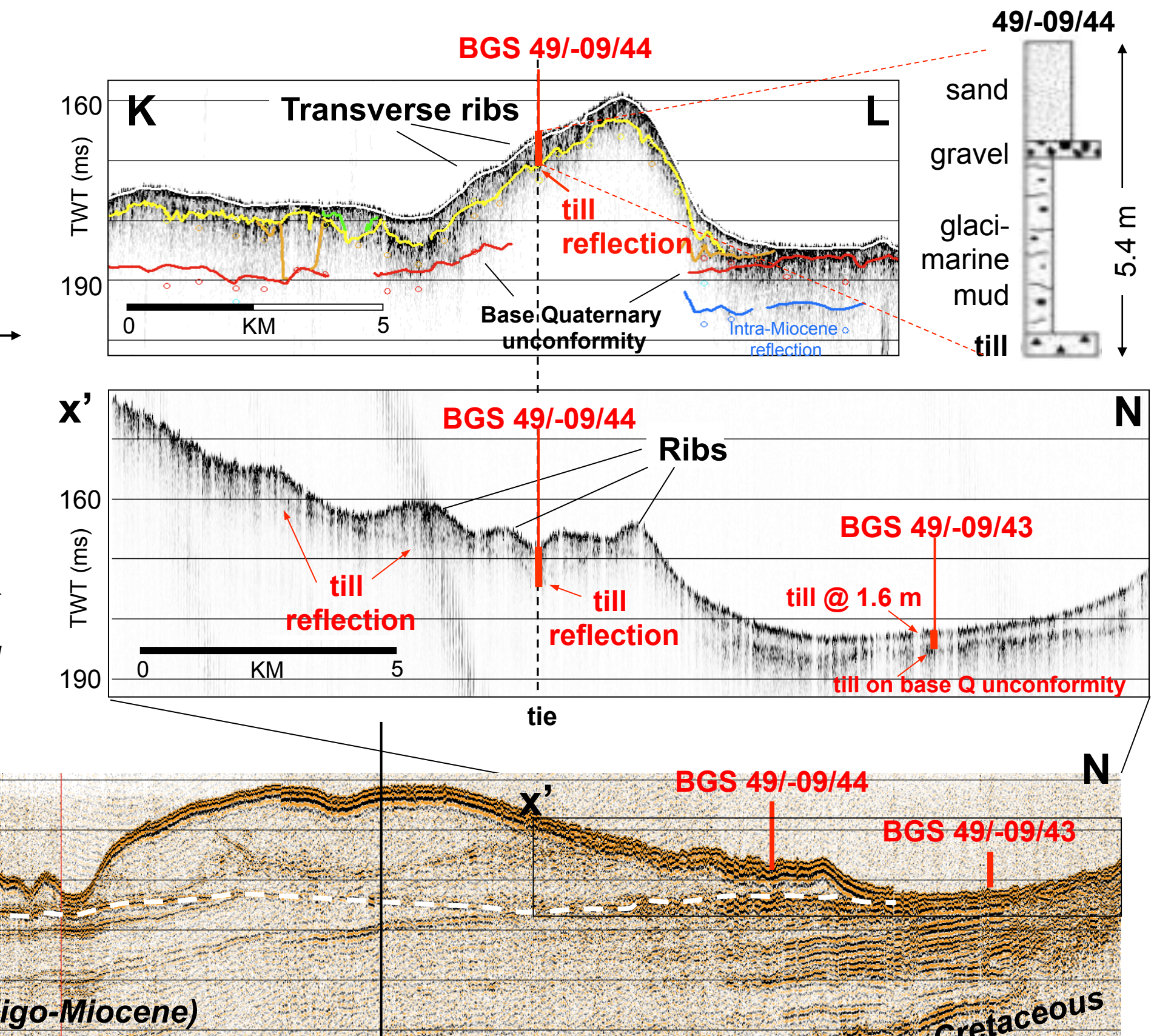
- Comparable to rectilinear networks of giant eskers (up to 10 km wide, 40 m high) and De Geer moraines in Canada and Finland<sup>9,10</sup>, formed by subaqueous outwash during ice margin retreat
- Consistent with evidence of subglacial and glacimarine sediments in ridges and ribs in Irish and UK sectors
- Broad implications for ice sheet extent and dynamics – notably in the French sector



### Glacigenic sediments in ribs of study area supported by two vibrocores :

- 49/-09/44 : beneath layer B gravel at 2 mbsf, 3 m of glacimarine mud<sup>2</sup> lies within transverse ribs, above Melville Till at base that correlates to a reflection extending across the ridge (Fig. 7, K-L, M-N)
- 49/-09/26 high : beneath layer B gravel at 0.5 mbsf, stiff sandy clay considered Neogene (BGS field log); located on ridge/rib 15 m high (Figs 2-4, G-H)

Fig. 7 – Seismic reflection profiles (top pair, Chirp; bottom, sparker) along and across ridges and ribs, tied to BGS vibrocores (locations on Fig. 2)



## These hypotheses invite testing through targeted acquisition of data from ridges and ribs in the Irish, UK and French sectors

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