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



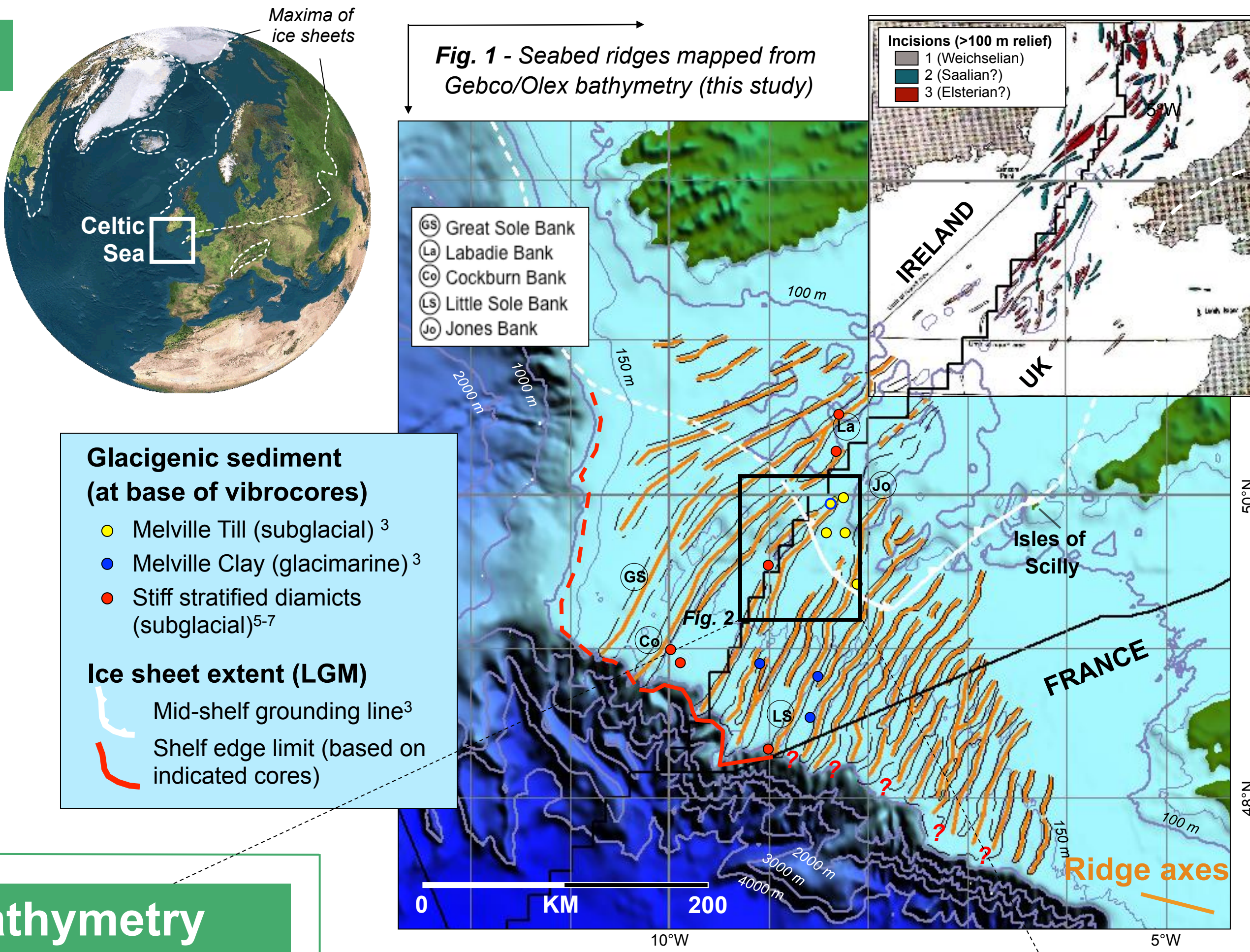
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Celtic Sea glaciation : open questions

- How far have ice sheets advanced SW into the Celtic Sea? Surprisingly, we are still not sure.
- Subglacial and glacial marine sediments cored in the 1970s on and between a system of shelf-crossing seafloor ridges^{1,2} indicated ice extent to at least the mid-shelf of the Irish and UK sectors^{3,4} (Fig. 1).
- Recent coring of subglacial sediments on and adjacent to ridges indicates ice extent >100 km farther seaward to the Irish & UK shelf edge⁵⁻⁷ (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^{5,6}.



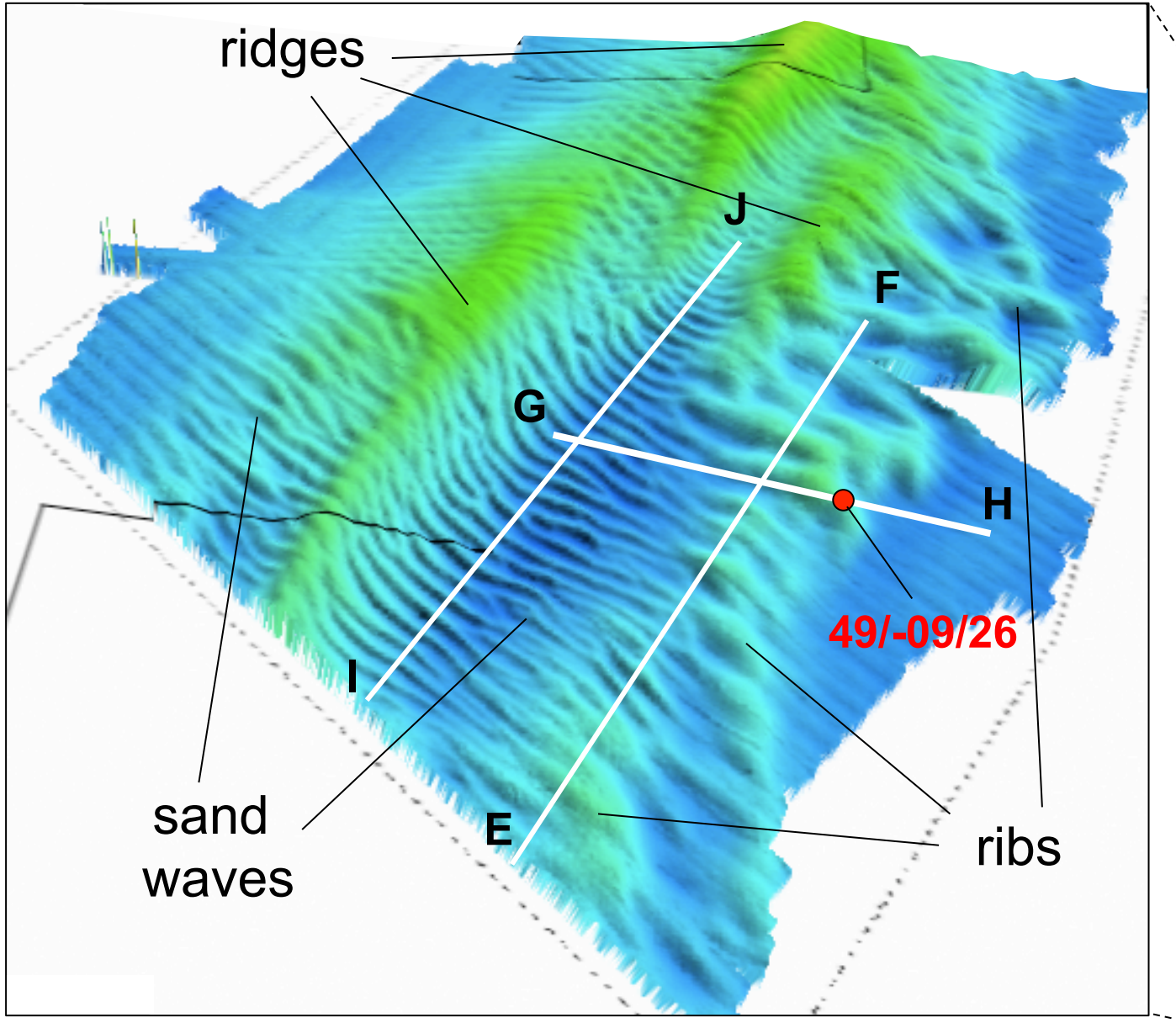
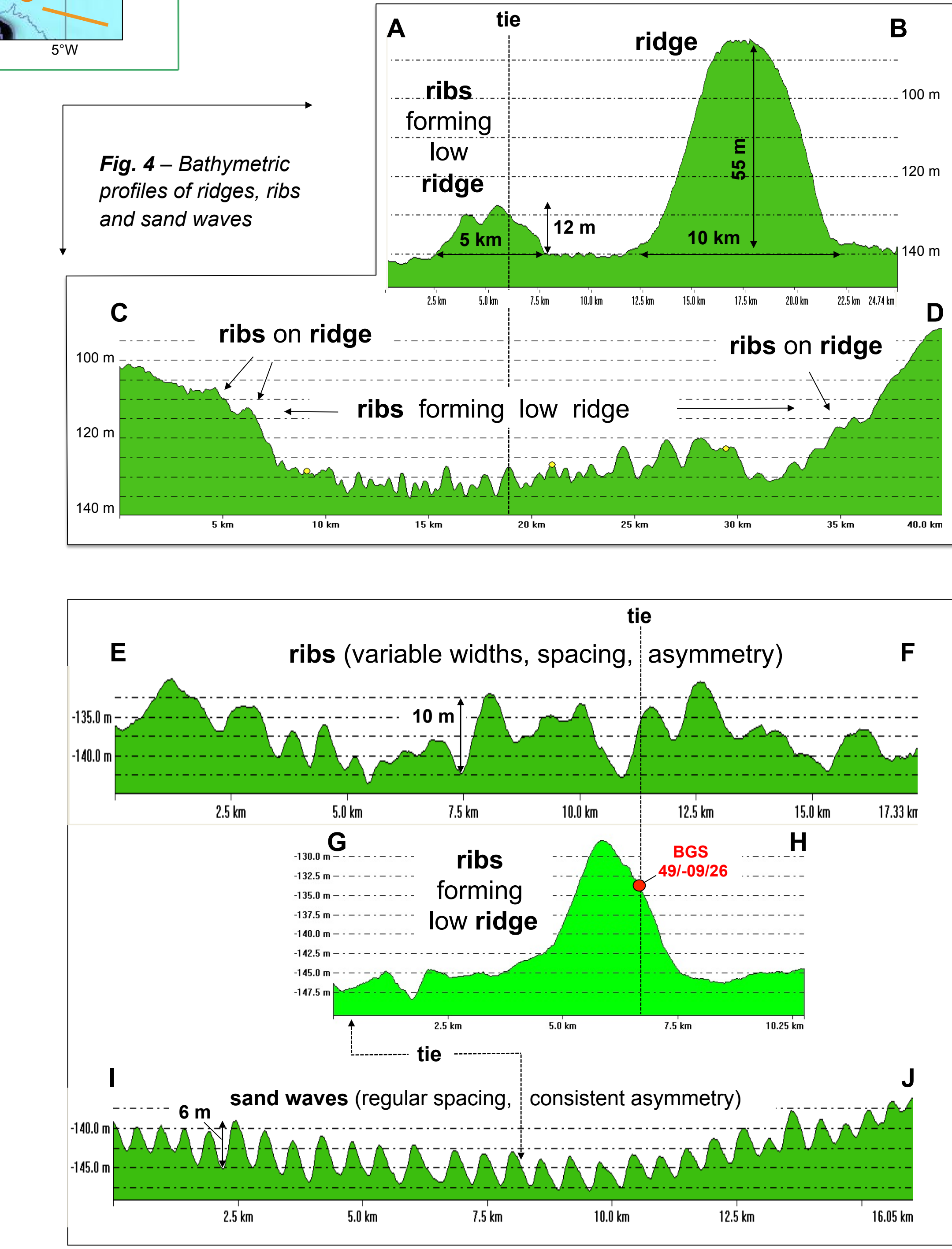
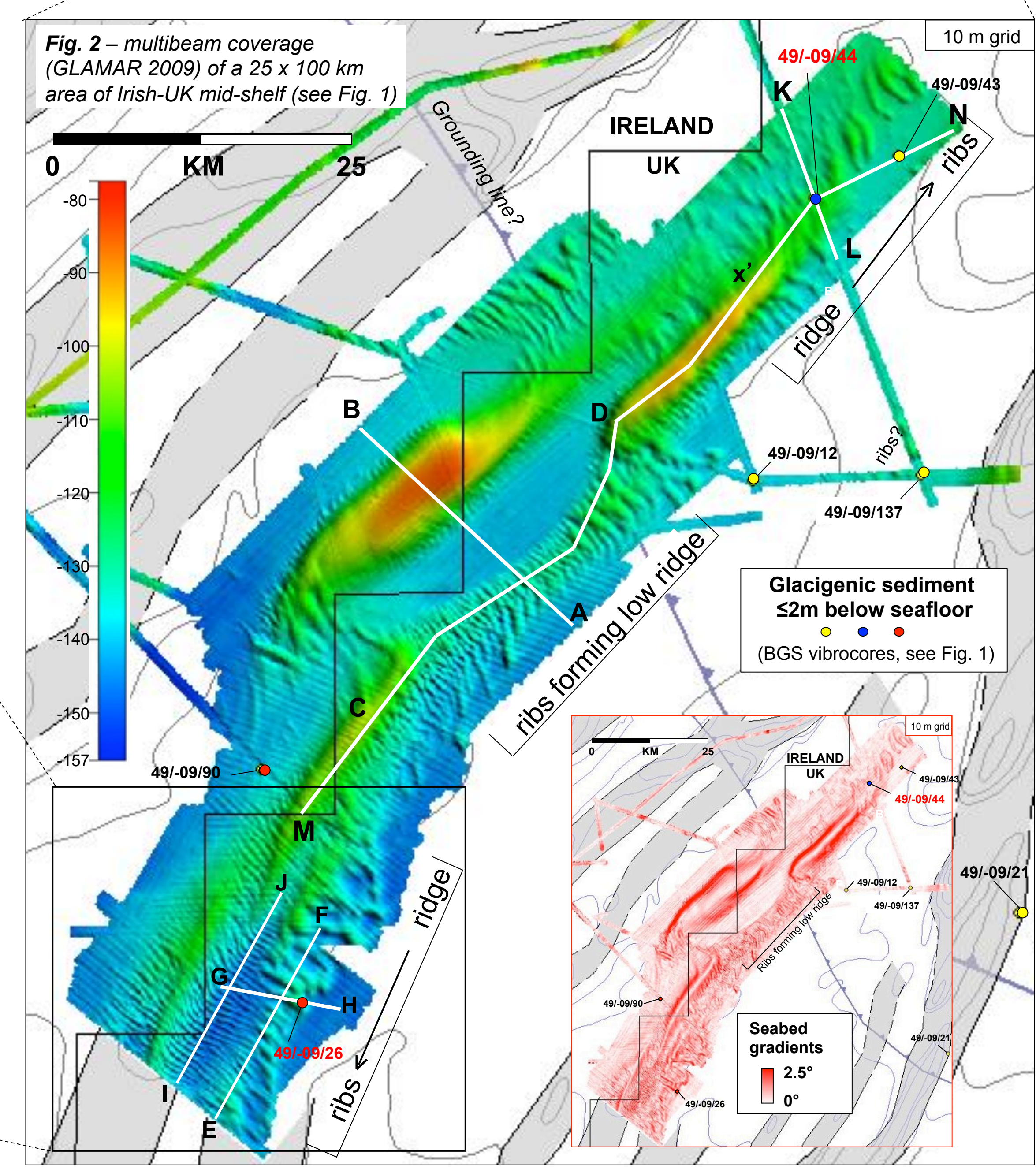
Regional submarine landforms

- ### North Celtic Sea : incisions⁸ (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

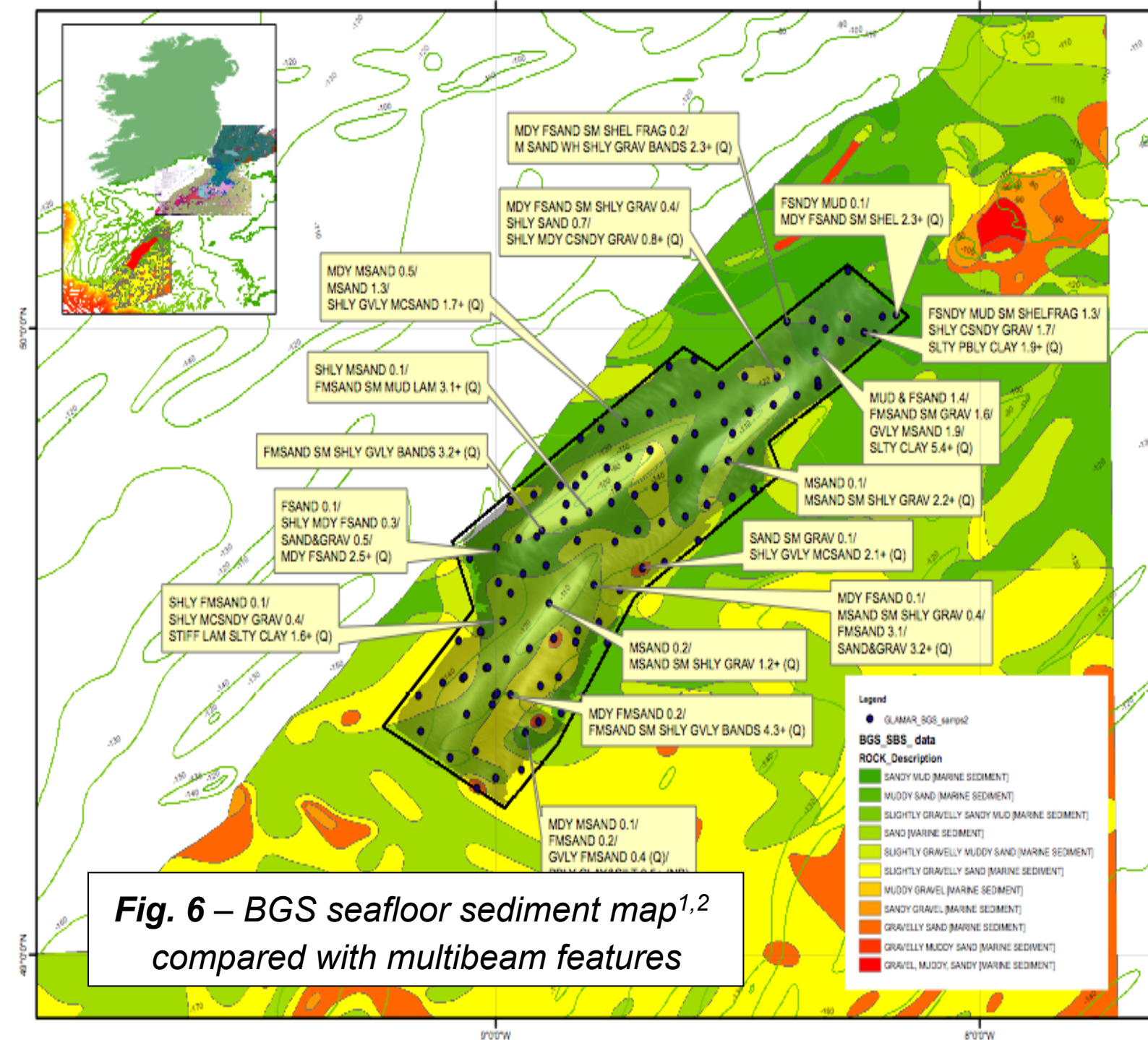
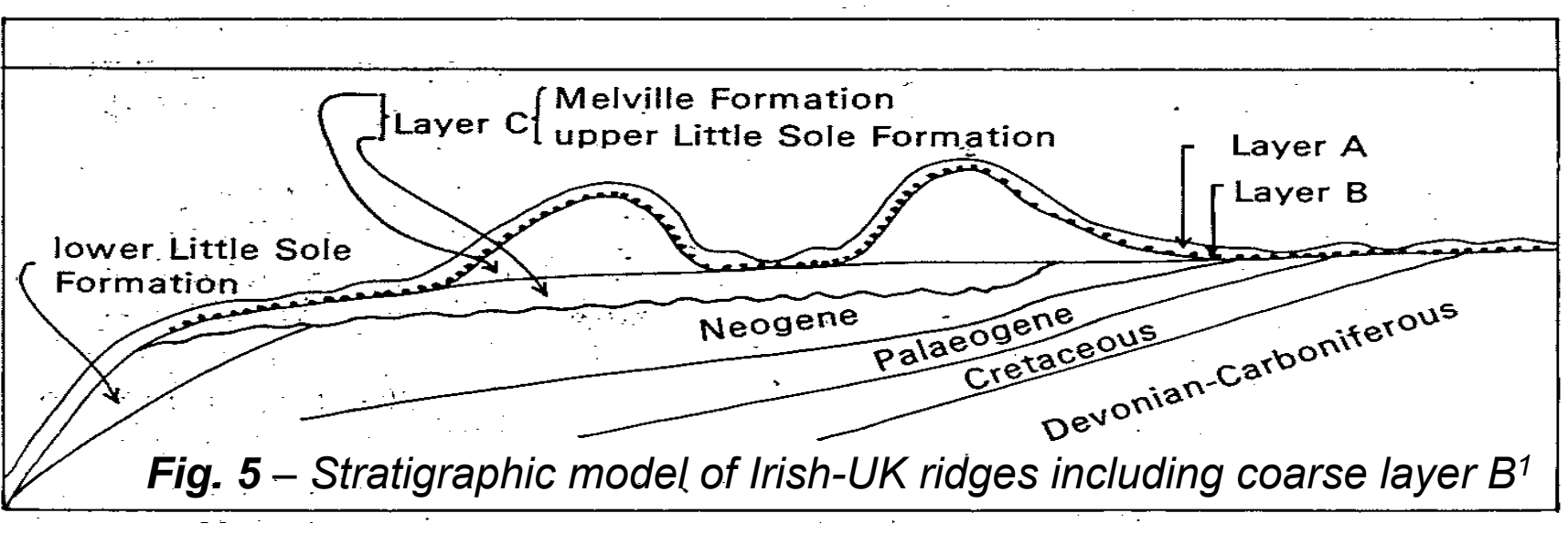
Rectilinear network of seafloor features :

- 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)



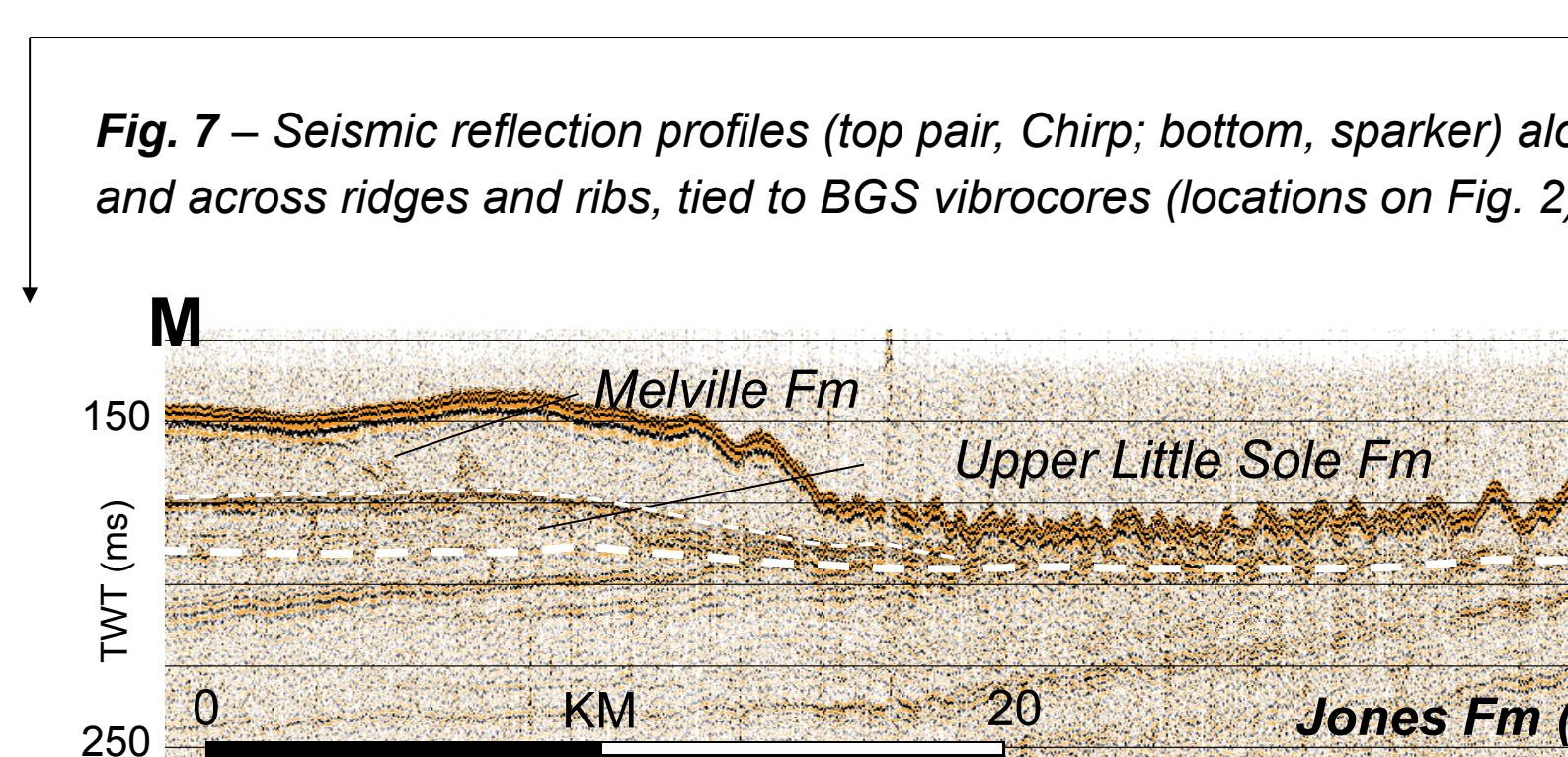
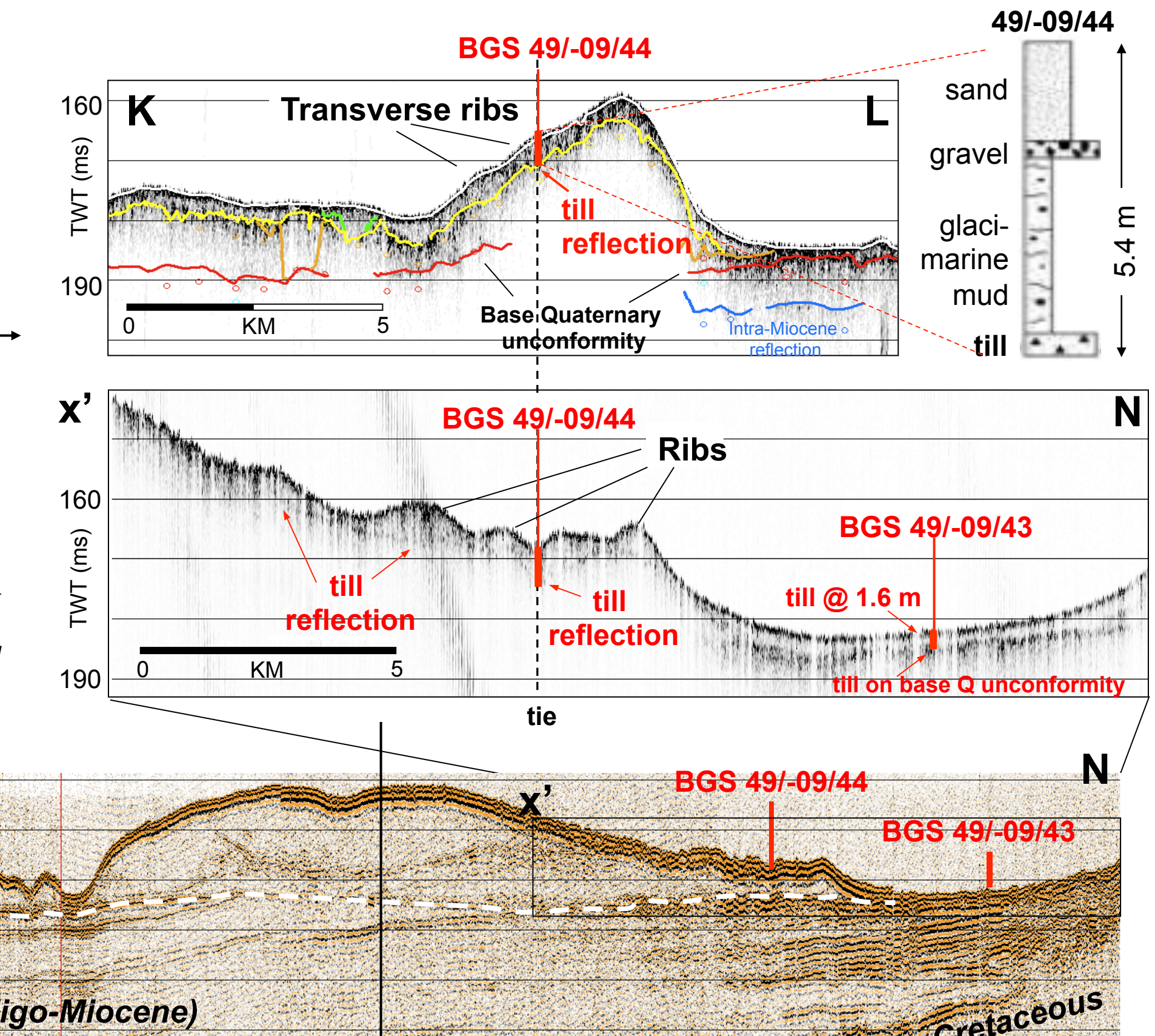
Glacialic drape of ridges and ribs ?

- Ridges shown to be truncated by a regional unconformity overlain by a fining-upward succession⁶ (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)^{1,2}



Glacialic sediments in ribs of study area supported by two vibrocores :

- 49/-09/44 : beneath layer B gravel at 2 mbsf, 3 m of glacial marine mud² 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)



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^{9,10}, formed by subaqueous outwash during ice margin retreat
 - Consistent with evidence of subglacial and glacial marine sediments in ridges and ribs in Irish and UK sectors
 - Broad implications for ice sheet extent and dynamics – notably in the French sector

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

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