Rialtas na hÉireann
Government of Ireland

The Standard Stratigraphic Nomenclature of Offshore Ireland

An Integrated Lithological, Biostratigraphic and Sequence Stratigraphic Framework

Offshore Quaternary: Integration with the new standard stratigraphic nomenclature of offshore Ireland

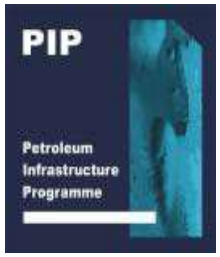
IQUA Offshore Research Symposium, GSI, November 23rd, 2018

Dr Kara English

Rialtas na hÉireann
Government of Ireland

- Project Overview
- Main Sequence Boundaries
- Pliocene
- Pleistocene
- Proposed Framework for Quaternary
- Future Work Directions

Project Overview



Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

- 4 year project with objective to create an **updated, consistent** and **official stratigraphic framework** for offshore Ireland ranging from the Palaeozoic to Quaternary.

- Ireland's **offshore** stratigraphic nomenclature is currently informal, a unified scheme has never been published, one of the few countries with O&G activity without such scheme; as a result industry/academia left to devise own names

- Project was initiated, steered and funded by the Irish Shelf Petroleum Studies Group (ISPSG) consisting of members of the Petroleum Infrastructure Programme (PIP) who hold offshore Atlantic acreage.

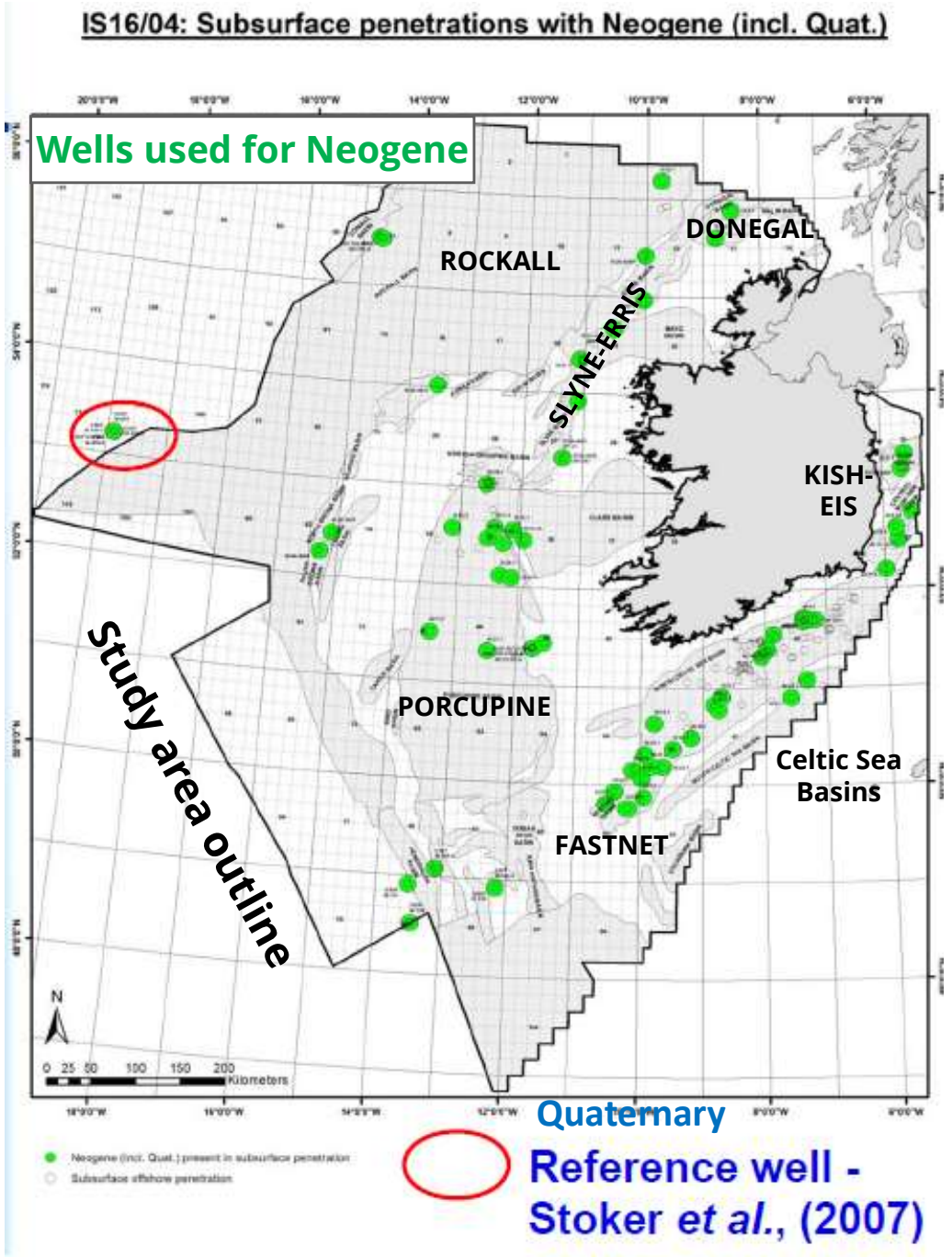
Contributors

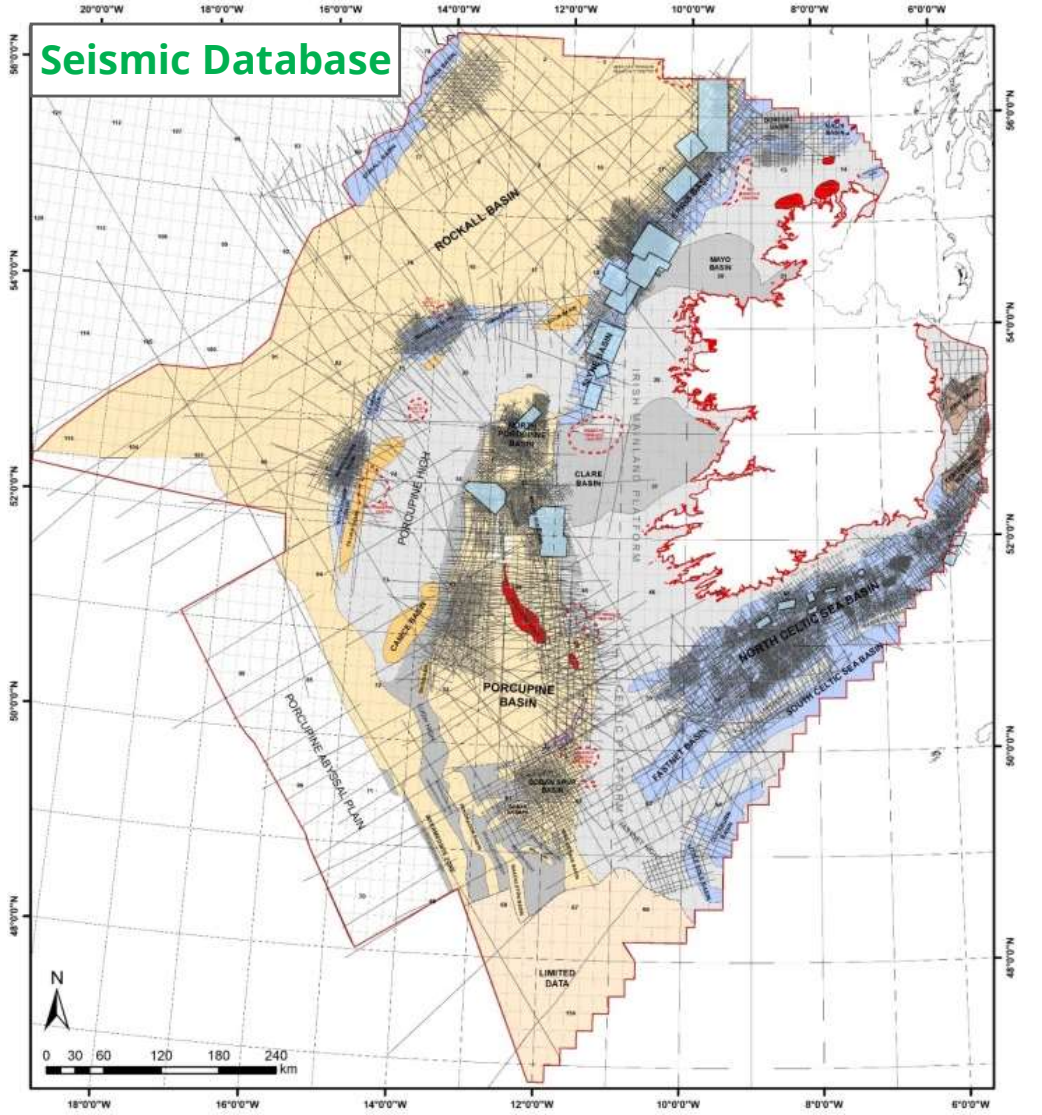
- Work was carried out by contractors **Merlin Energy Resources Ltd** in association with Palaeodate Ltd., Network Stratigraphic Ltd, Riley Geoscience, IGI, and Dunford Exploration. **PM Phil Copestake, Lead Biostratigrapher Nigel Ainsworth.**

- Work was peer-reviewed by an **industry Steering Group** and a **newly formed Stratigraphic Committee** consisting of experts in relevant offshore stratigraphy (Professor Pat Shannon, Professor Peter Haughton, Dr David Naylor, Professor George Sevastopulo, Dr Shane Tyrrell, Tony Doré, Clare Morgan, Dr Kara English, Michael Hanrahan)

- Quaternary section received feedback from Dr Stephen McCarron, Professor Peter Coxon, Martyn Stoker, the GSI and the BGS.

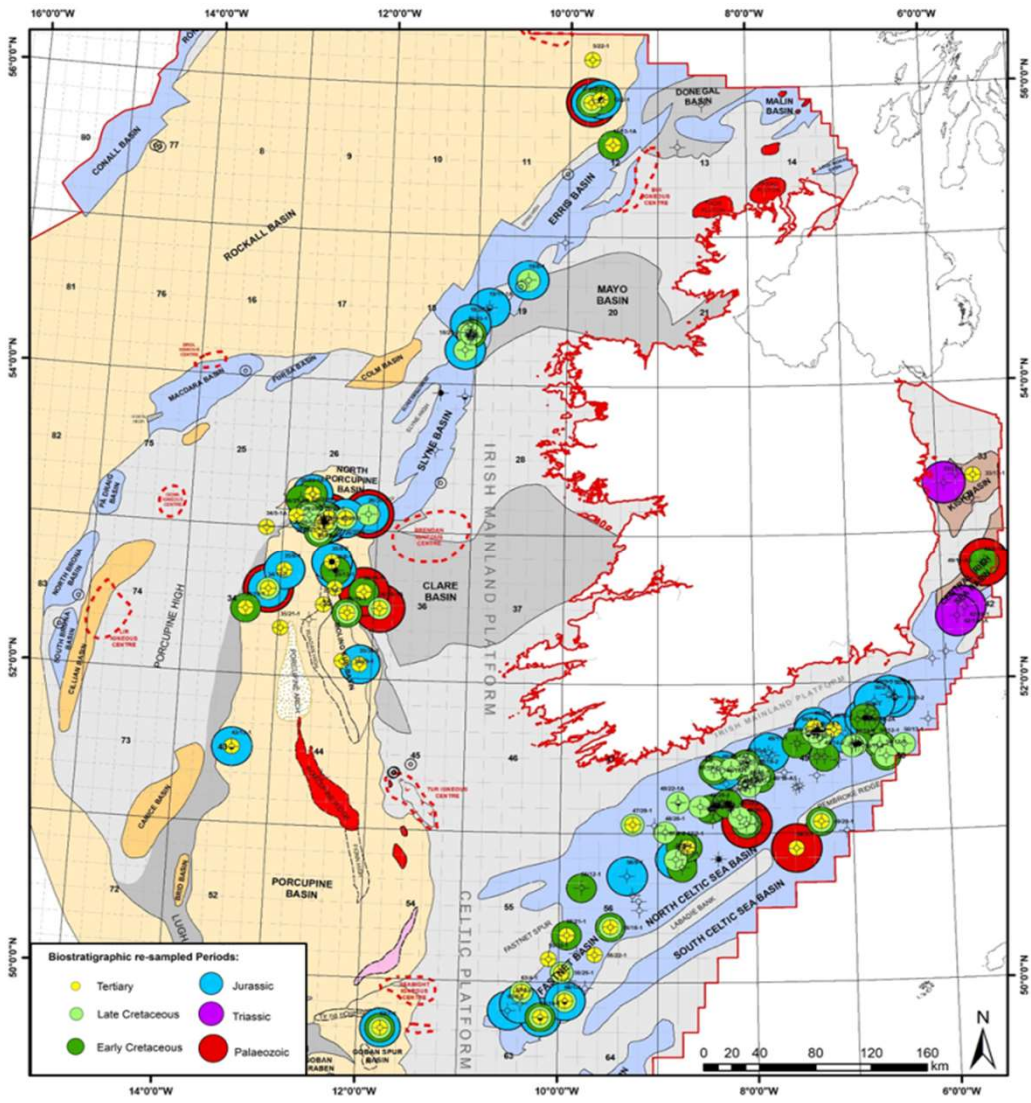
Study Area


IS16/04: Subsurface penetrations with Neogene (incl. Quat.)
Wells used for Neogene
ROCKALL
DONEGAL
SLYNE-ERRIS
KISH-
EIS
PORCUPINE
Celtic Sea
Basins
FASTNET
Study area outline
N
0 25 50 100 150 200
Kilometers
Neogene (incl. Quat.) present in subsurface penetration
Subsurface offshore penetration
Quaternary
Reference well -
Stoker et al., (2007)


Seismic Database
ROCKALL BASIN
MAYO BASIN
SLYNE BASIN
CLARE BASIN
PORCUPINE HIGH
PORCUPINE BASIN
PORCUPINE ABYSSAL PLAIN
CANNA BASIN
NORTH CELTIC SEA BASIN
SOUTH CELTIC SEA BASIN
FASTNET BASIN
LIMITED DATA
N
0 30 60 120 180 240
km

Project Methodology

- Analysis of **~200 boreholes** including petroleum wells, DSDP, IODP, ODP, and shallow boreholes, sea bed cores
- Existing interpretation of biostratigraphy, lithology, petrophysical logs; plus **re-dating** of >3300 cutting samples
- Seismic interpretation included **60 seismic horizons** tied chronostratigraphically across basins
- **Igneous dating** (Ar-Ar) of 10 samples
- Unified scheme; comparison of results with existing publications, and schemes in the UK



New Biostratigraphic Resampling

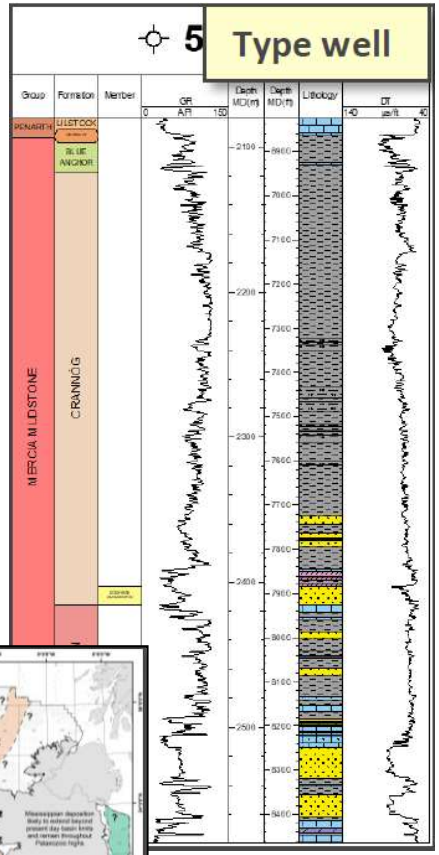
New Nomenclature

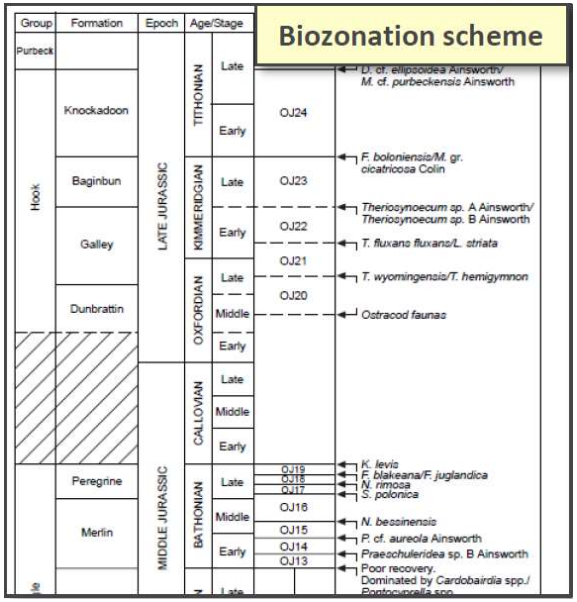
- International Stratigraphic Rules (Murphy and Salvador, 1999)
- Total of 250 lithostratigraphic units were defined
- >200 new unit names were assigned to the offshore, and over 30 UK names were used where appropriate, the rest used existing names
- To be adopted as a standard for the offshore area

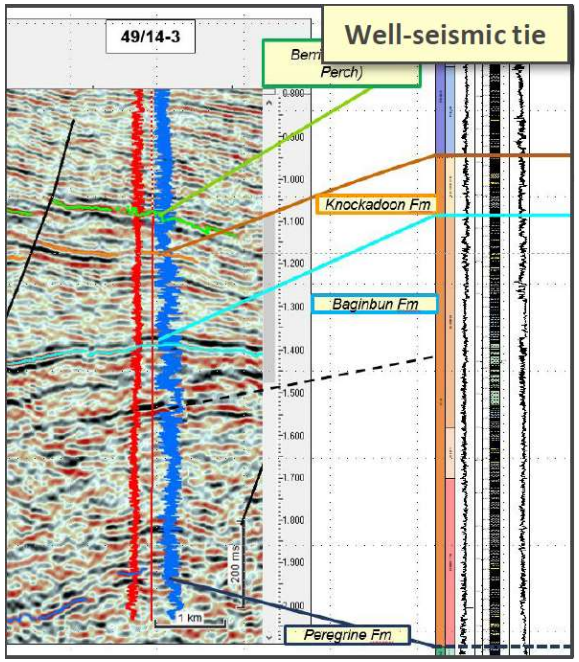
System	New Names Theme
Neogene /Quaternary:	Irish artefacts and jewellery
Paleogene:	Irish bays
Upper Cretaceous:	Native fish in Irish waters
Lower Cretaceous:	Native fish in Irish waters
Upper Jurassic:	Irish peninsulas, headlands and points
Middle Jurassic:	Irish birds
Lower Jurassic:	Irish lakes
Triassic:	Irish archaeology, boats and musical instruments
Permian:	Irish landscapes
Upper Carboniferous:	Native Irish plants
Lower Carboniferous:	Seashells
Devonian:	Irish colours
Igneous rocks:	Dark Celtic folklore

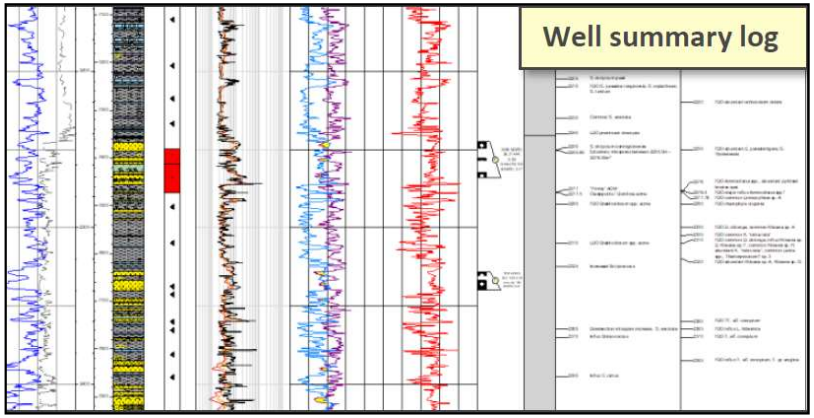
Project Deliverables

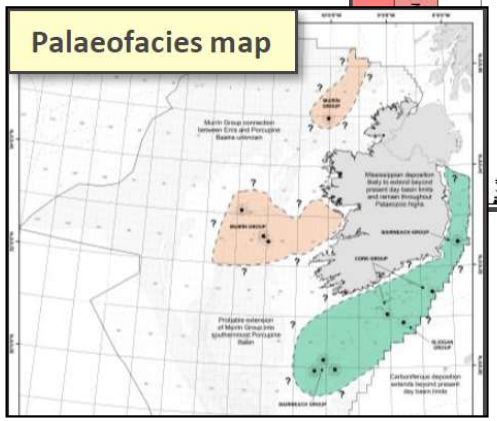
- Atlas
- Descriptions of the lithostratigraphic units
- Illustrated type sections & reference wells
- Well summary logs for each borehole
- Distribution maps, palaeofacies maps
- Well-seismic ties, regional seismic lines
- Sequence stratigraphy scheme
- Biozonation scheme
- Stratigraphic summary charts
- **2019 PAD Special Publication**



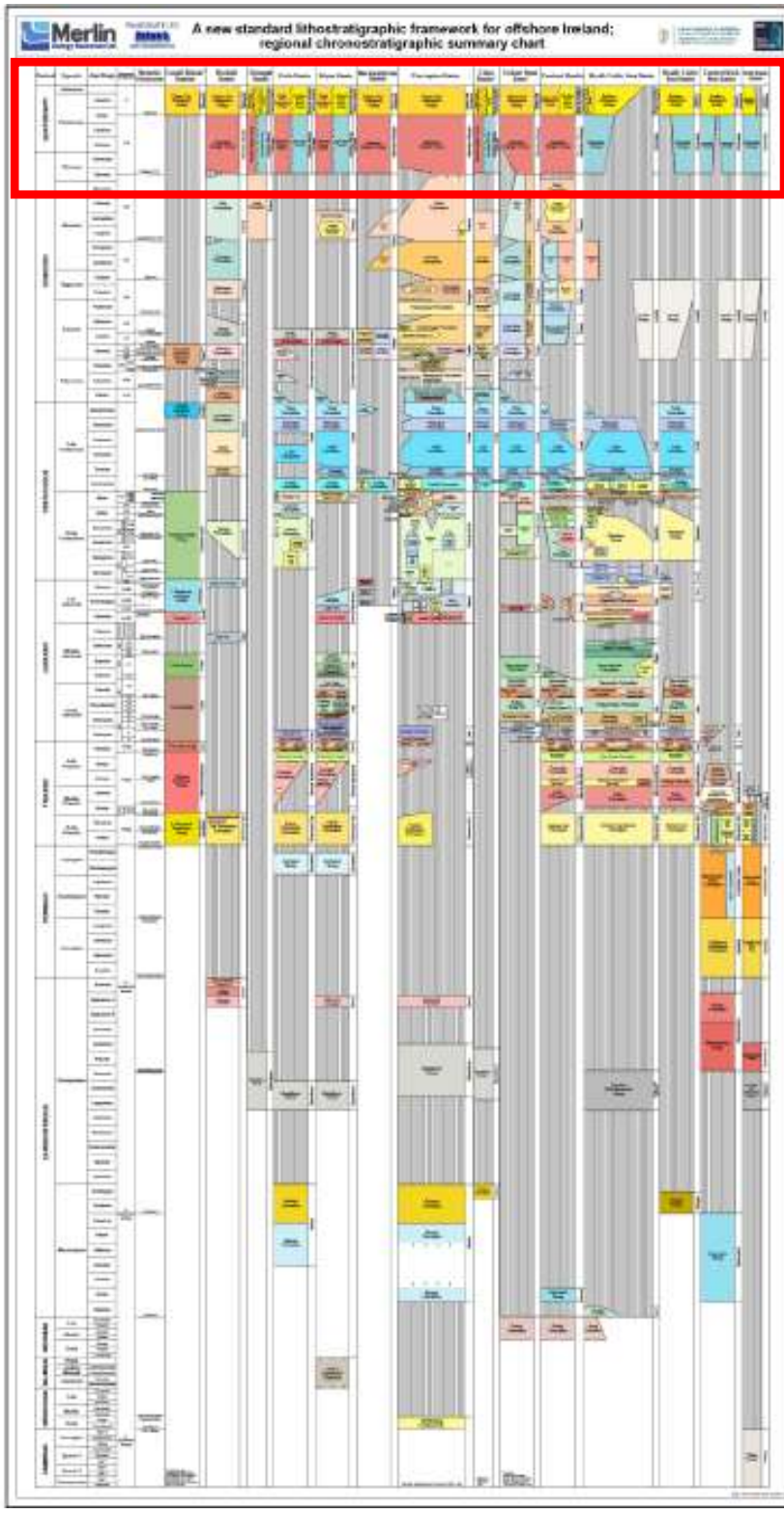




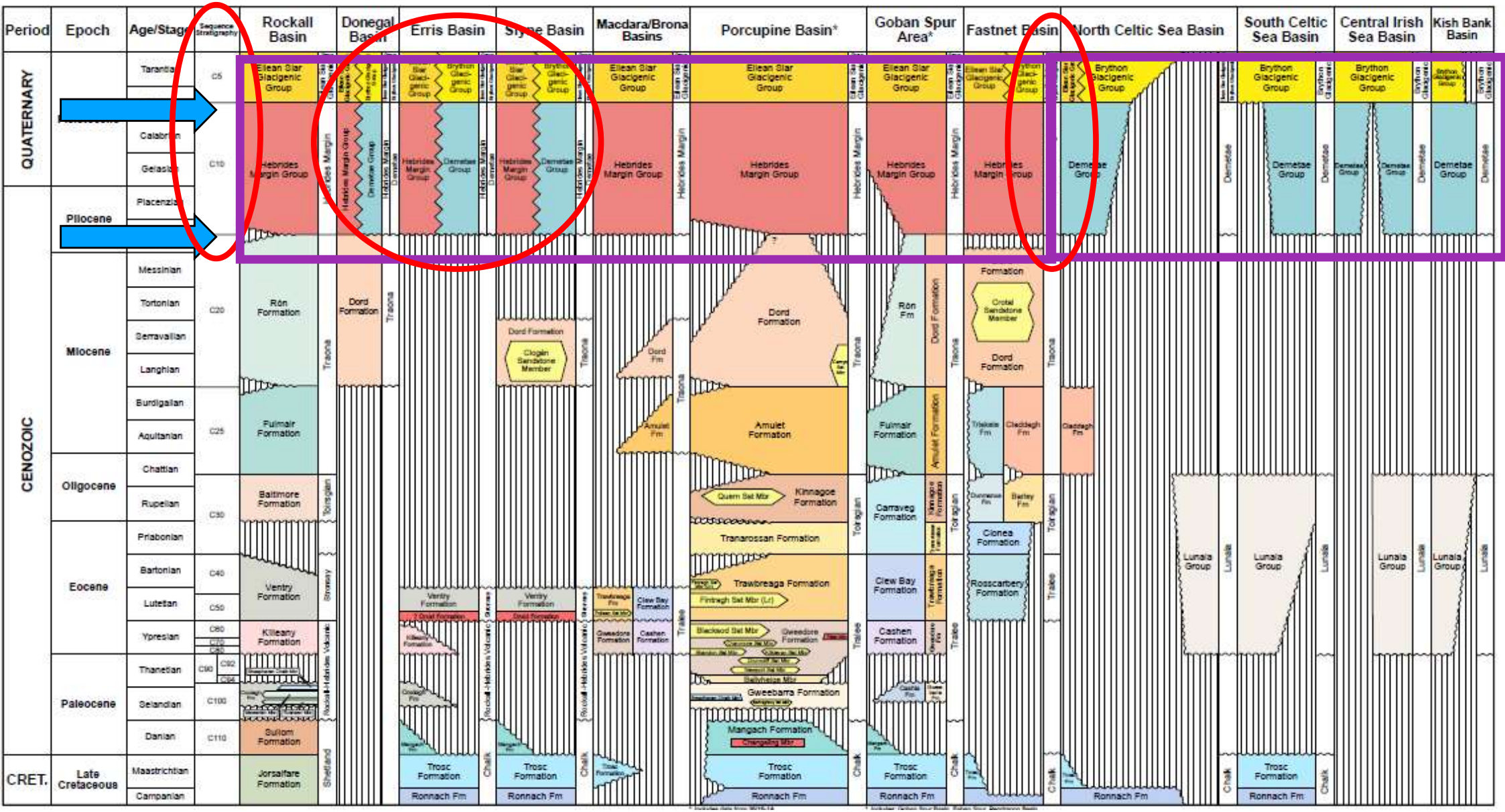




Palaeozoic to Quaternary– A New Framework



Cenozoic to Quaternary

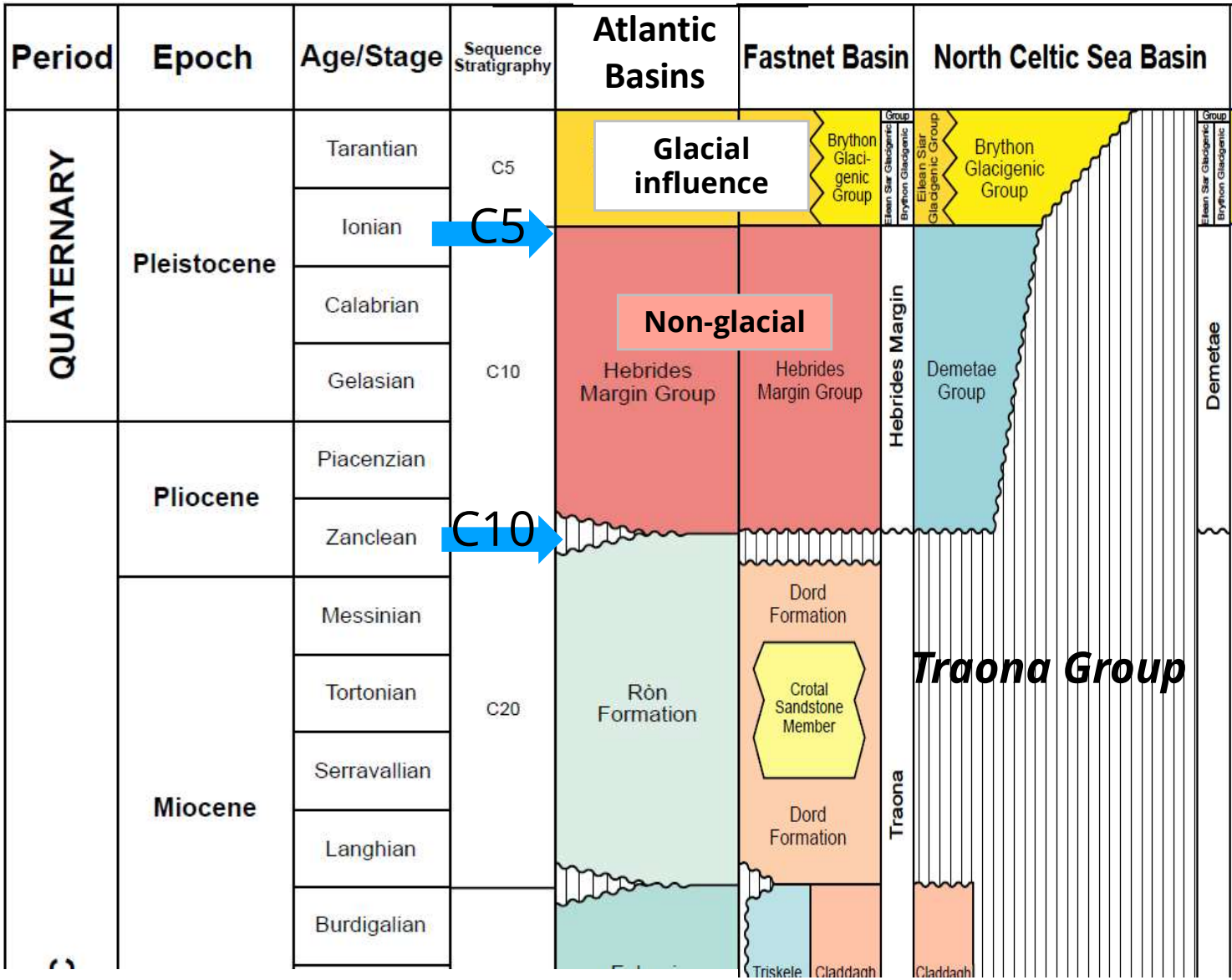


Unconformities and Sequence Boundaries

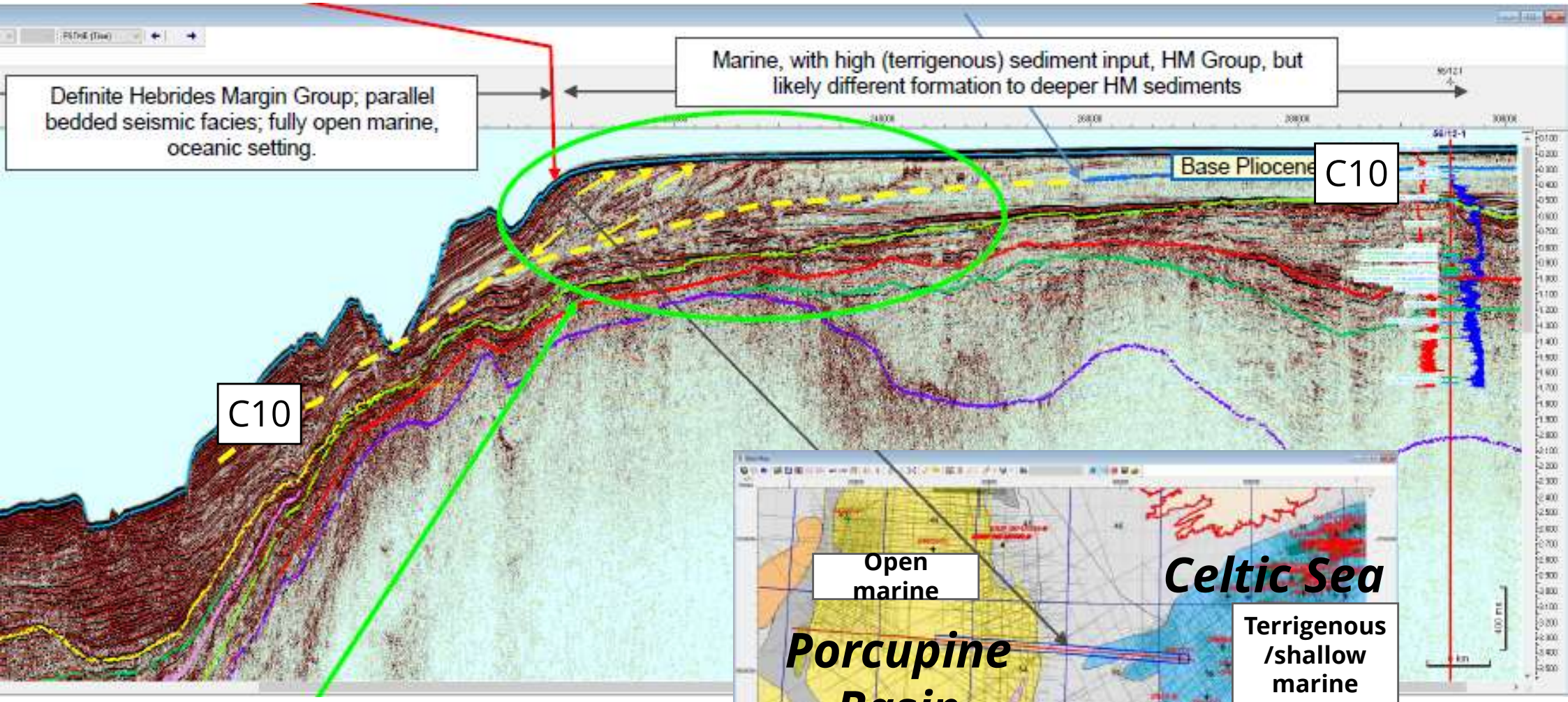
Major sequence boundaries determined at:

- Intra Early Pliocene =C10
- Intra Pleistocene =C5 – regional unconformity onset of shelf wide glacial activity

Seismic; biostratigraphic evidence, type well results eg ODP-981 penetrated intra-Early Pliocene marker (Stoker et al., 2001, 2002)



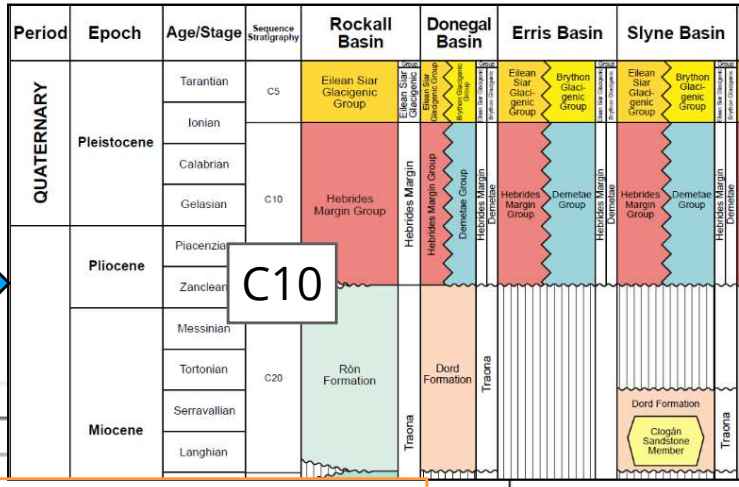
Base Pliocene Sequence Boundary C10



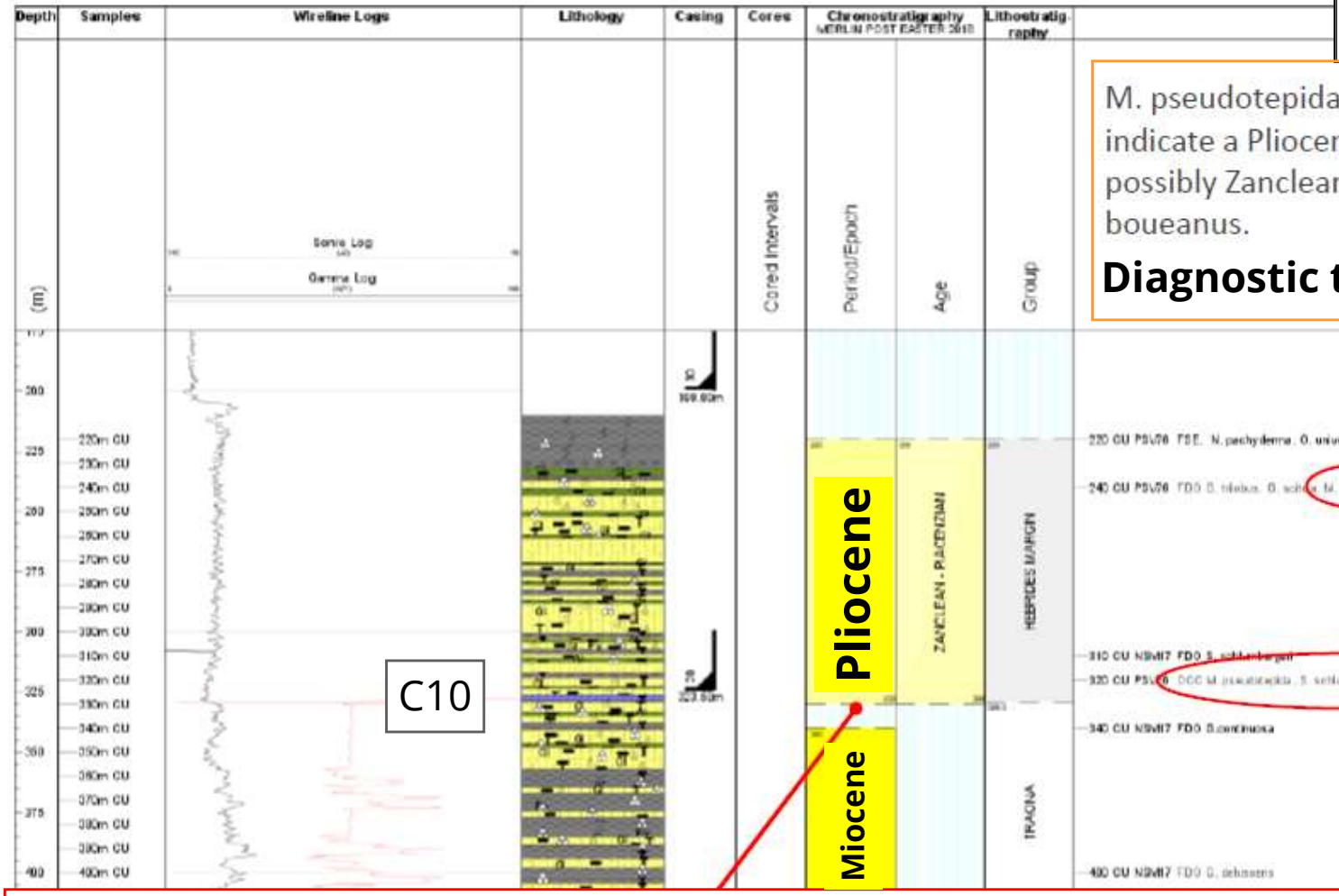
- Base Pliocene seismic horizon **(blue)**
- Most likely = C10 in Porcupine –Rockall areas. **(yellow dashed line)**
- **Terrigenous to marine transition**

Pliocene

- **Fossil evidence supports seismic unconformity**
- **Depositional Environment**

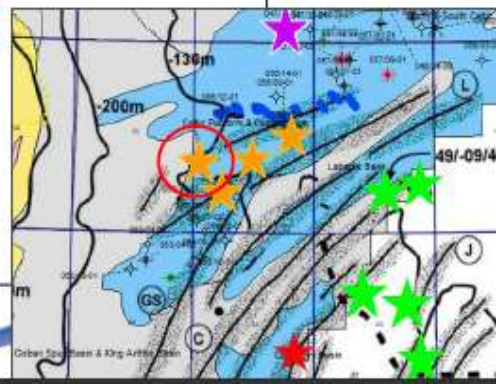


Well 56/21-1



M. pseudotepida and S. schlumbergeri indicate a Pliocene age (Piacenzian to possibly Zanclean). Note presence of F. boueanus.

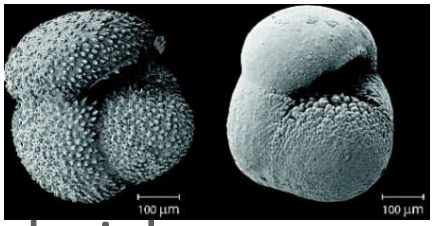
Diagnostic taxa (open marine)



Regional Unconformable boundary (**Intra Pliocene on Miocene/Tortonian)** corresponding to a regional marker base C10

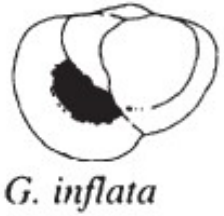
Pliocene Sequence

Globorotalia inflata



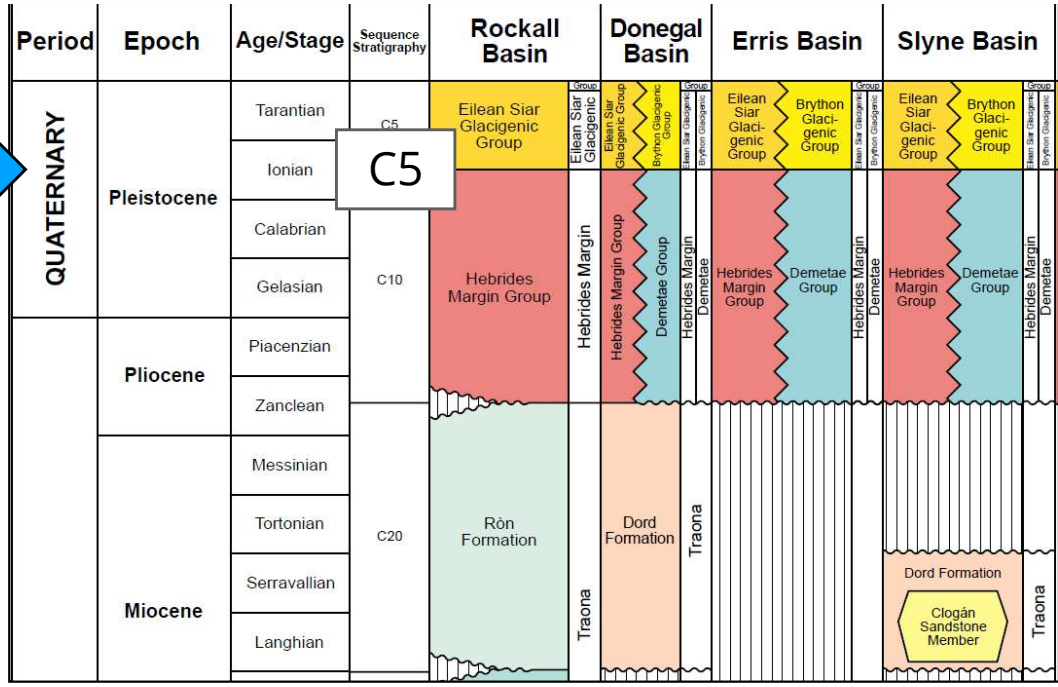
Groeneveld&Chiessi, 2011

- The offshore Pliocene stratigraphy is predominantly pre glacial
- Atlantic Basins data indicate fully open marine;
  - ***Pliocene markers include***


G. inflata

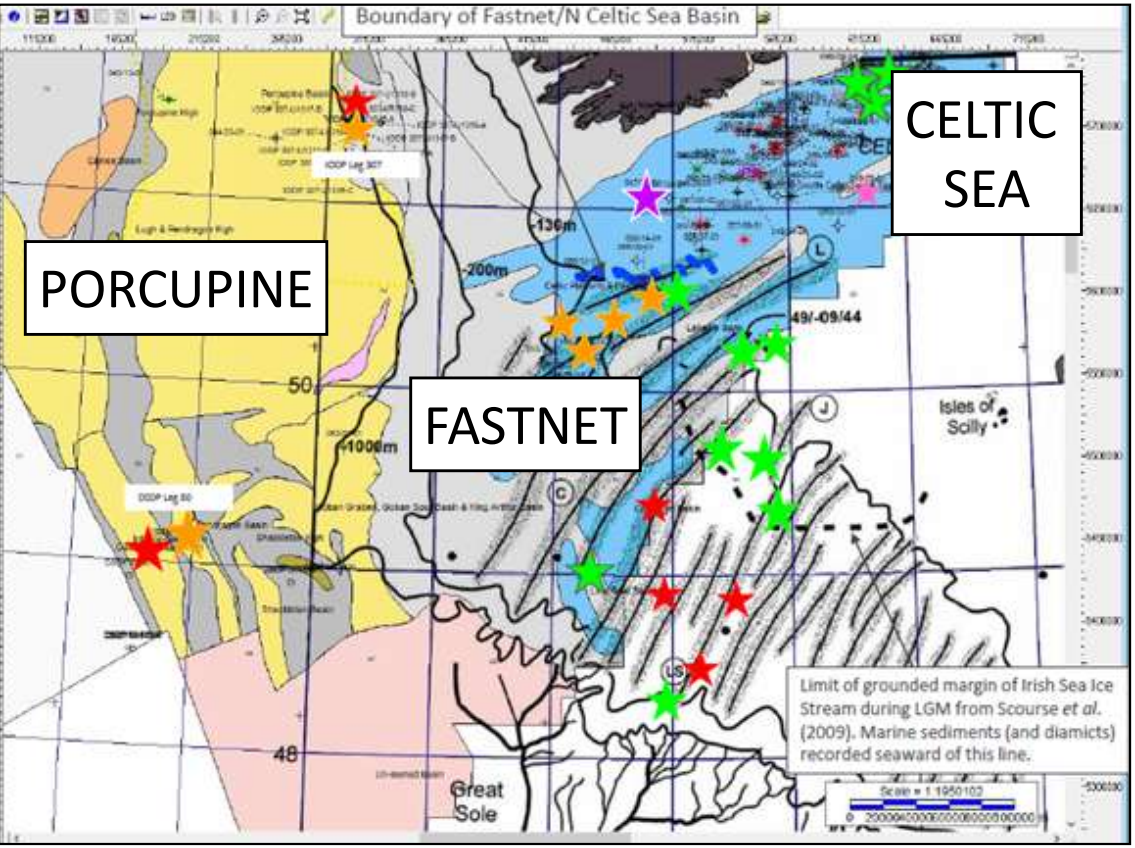
    - ***G. inflata***: Planktonic foraminiferid that does not range below the Piacenzian (late Pliocene), therefore a Hebrides Margin Group (or younger), open marine marker.
    - ***C. grossus***: Marine benthic foraminiferid that is restricted to the Hebrides Margin Group (Gelasian to Piacenzian)
    - ***M. pseudotepida***: Marine benthic foraminiferid that has an extinction event close to the top of the Piacenzian (HM Group) and an inception in the Zanclean, close to 4.6 Ma (just below the base of the HM Group). Pragmatically, although not exclusively, an HM Group marker.
    - ***F. boueanus:*** Marine benthic foraminiferid that has a documented extinction event close to the top of the Zanclean. Recorded in Traona Group, but can range into base of HM Group.
- Pliocene southern basins (e.g. North Celtic Sea) indicate paralic/marginal marine, contain different fossils than above.
- Fastnet Basin has both open marine and marginal marine and marks the transition

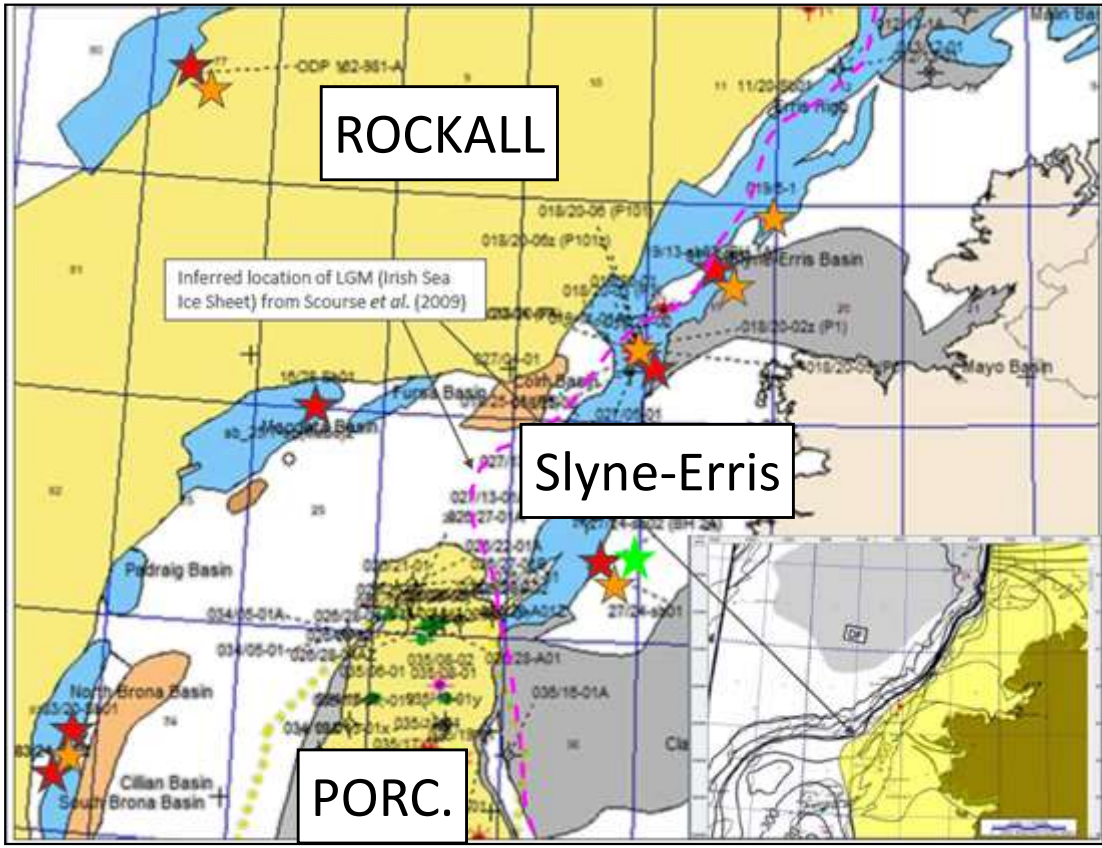
Upper Pleistocene



- C5 sequence, unconformity separates glacial (above) and non-glacial processes (below)
- Atlantic margin –marine facies
- Celtic Sea sediments dominated sub-ice processes, overcompacted
- Mixing along Atlantic margin; reworked from the shelf area
- Pleistocene divided into 2 Groups based on dominant **facies & interaction with the ice sheet**

Well data review of Last Glacial Extent





Glacimarine

Marine

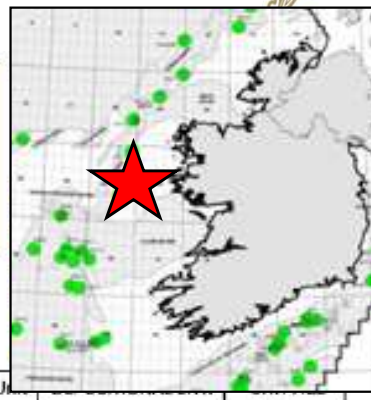
Tills

Non marine/paralic

- Pleistocene intervals of all wells characterised
- Outboard Porcupine & Rockall dominantly marine
- Celtic Sea and East Irish Sea dominantly tills and non marine / paralic
- Transition occurs within Fastnet basin, and along western margin

Atlantic Margin Pleistocene

- C5 and C10 & grouping apply to McCarron et al 2018
- Some indicating of terrigenous sediments with marine suggesting interfingering along Atlantic margin



27/24-sb01 (BH2)

Diamicts - Brython Group? Not seen in more 'outboard' 19/13-1

Pleistocene age sediments with **open marine** biofacies signal, together with diamicts – possible interfingering of Eilean Siar and Brython Groups?

Upper Pleistocene

Late Pliocene

C5

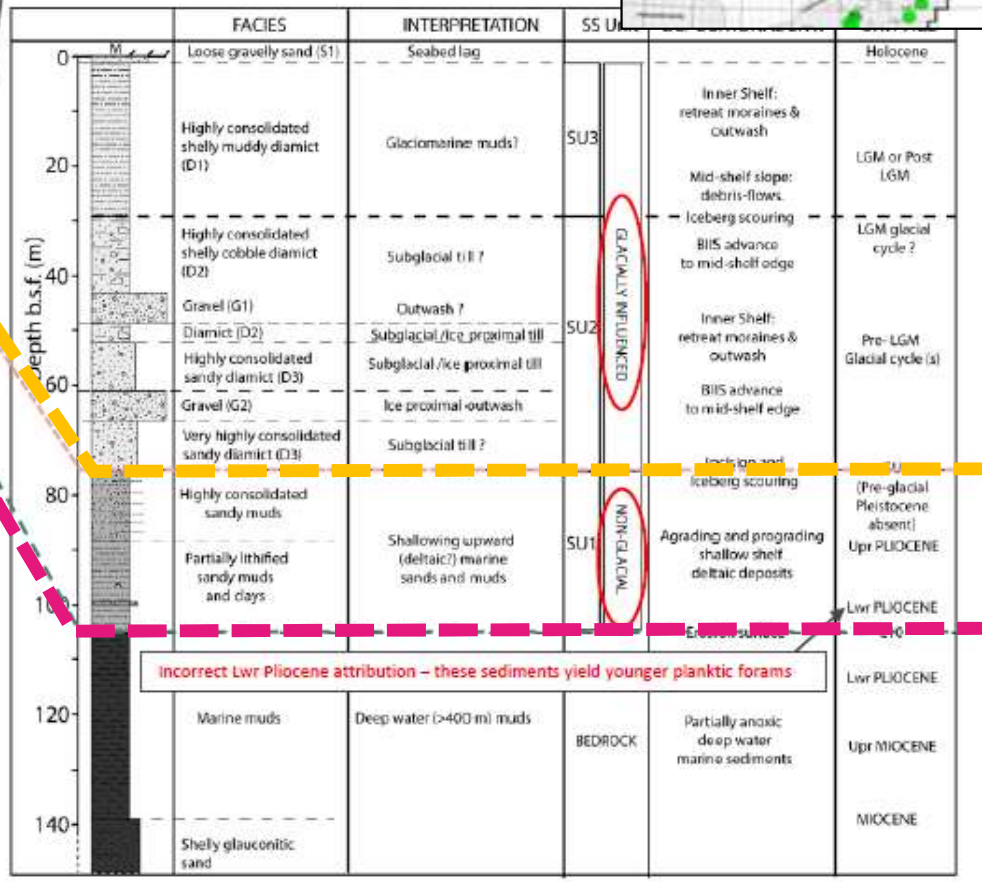
C10

C10 sequence boundary

(M.pseudotepida recorded on BH2A)

Intra Pleistocene sequence boundary; base of glacial influenced sediments; "Mid Pleistocene Glacial Unconformity" of Stoker et al. (2011). Note pre-glacial Pleistocene absent here. Mid Pleistocene unconformity has cut down into the Upper Pliocene at the base of the Eilean Siar Glacigenic Gp.

27/24-sb01 (BH2)



Incorrect Lwr Pliocene attribution – these sediments yield younger planktic forams

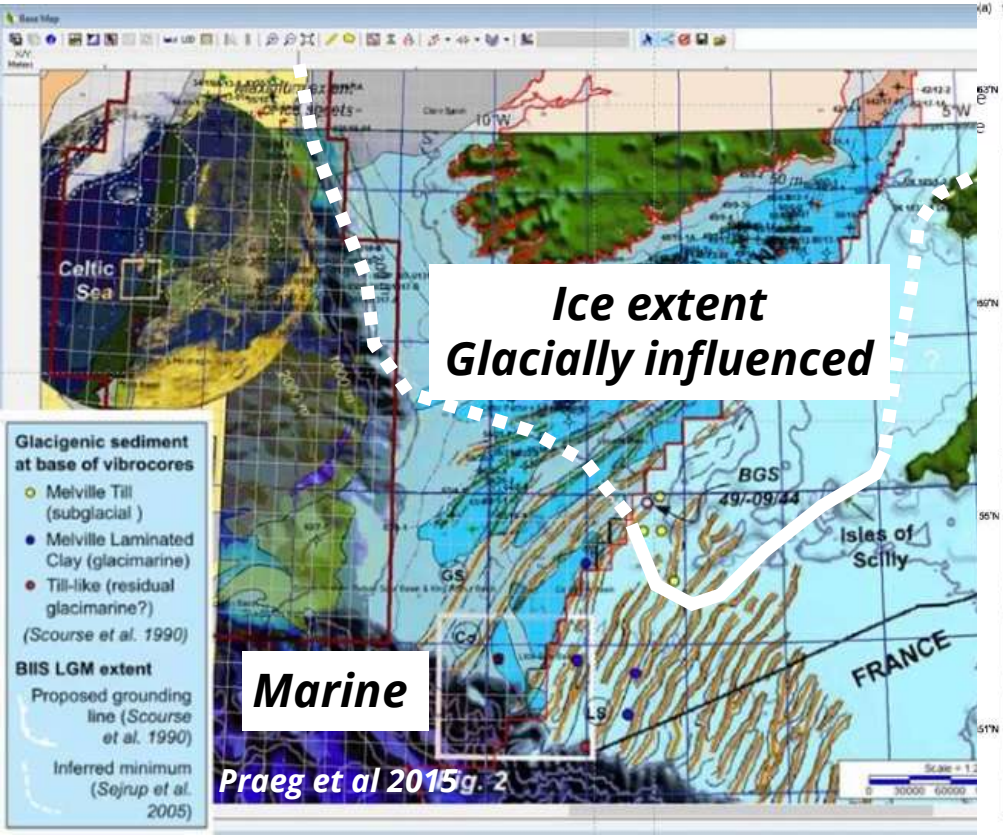
From study

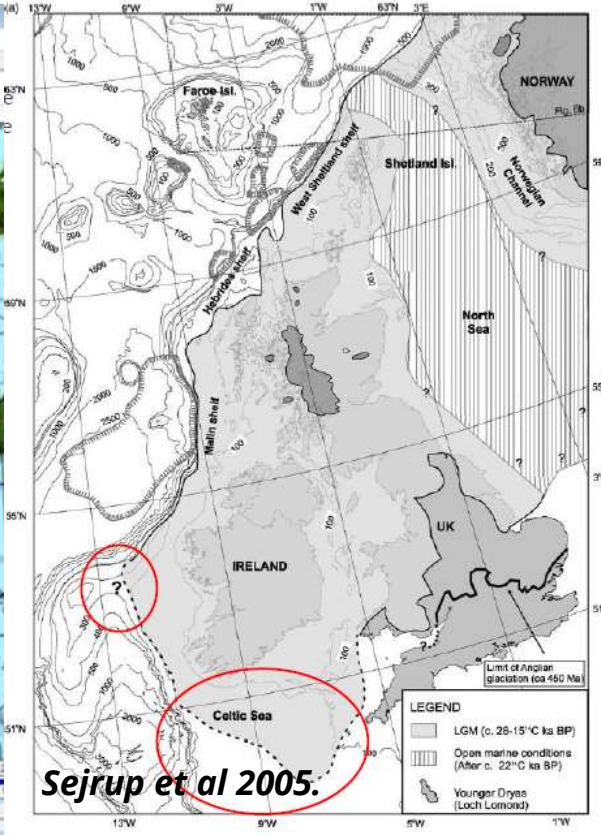
McCarron et al 2018

Pleistocene – Fastnet / Celtic Sea

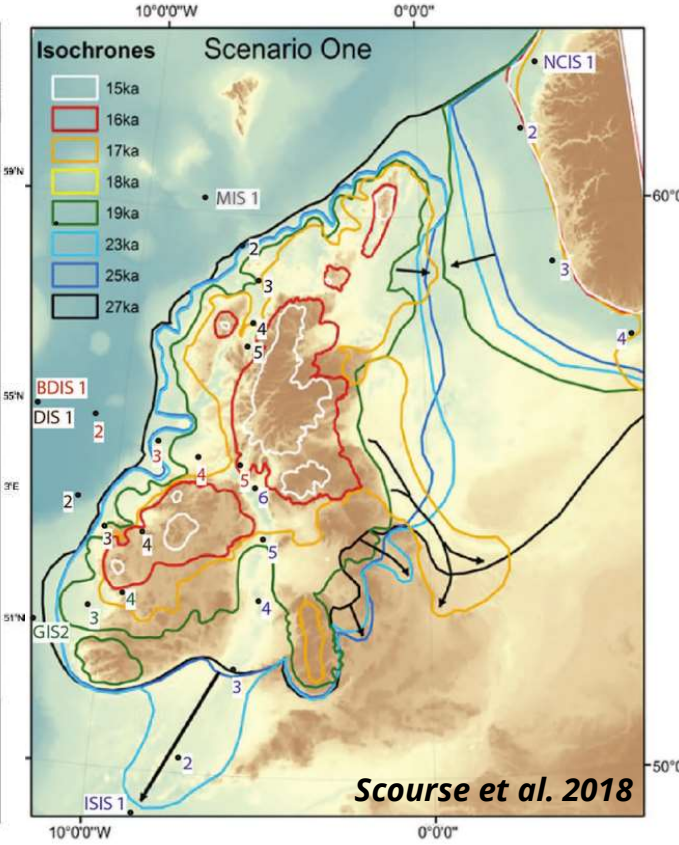
- Published ice sheet limits used to incorporate extent
  - *E.g. Scourse et al 1990; Sejrup et al., 2005; Clarke et al, 2012; Praeg et al., 2015; Scourse et al 2018*

Approximate LGM with support from vibrocores

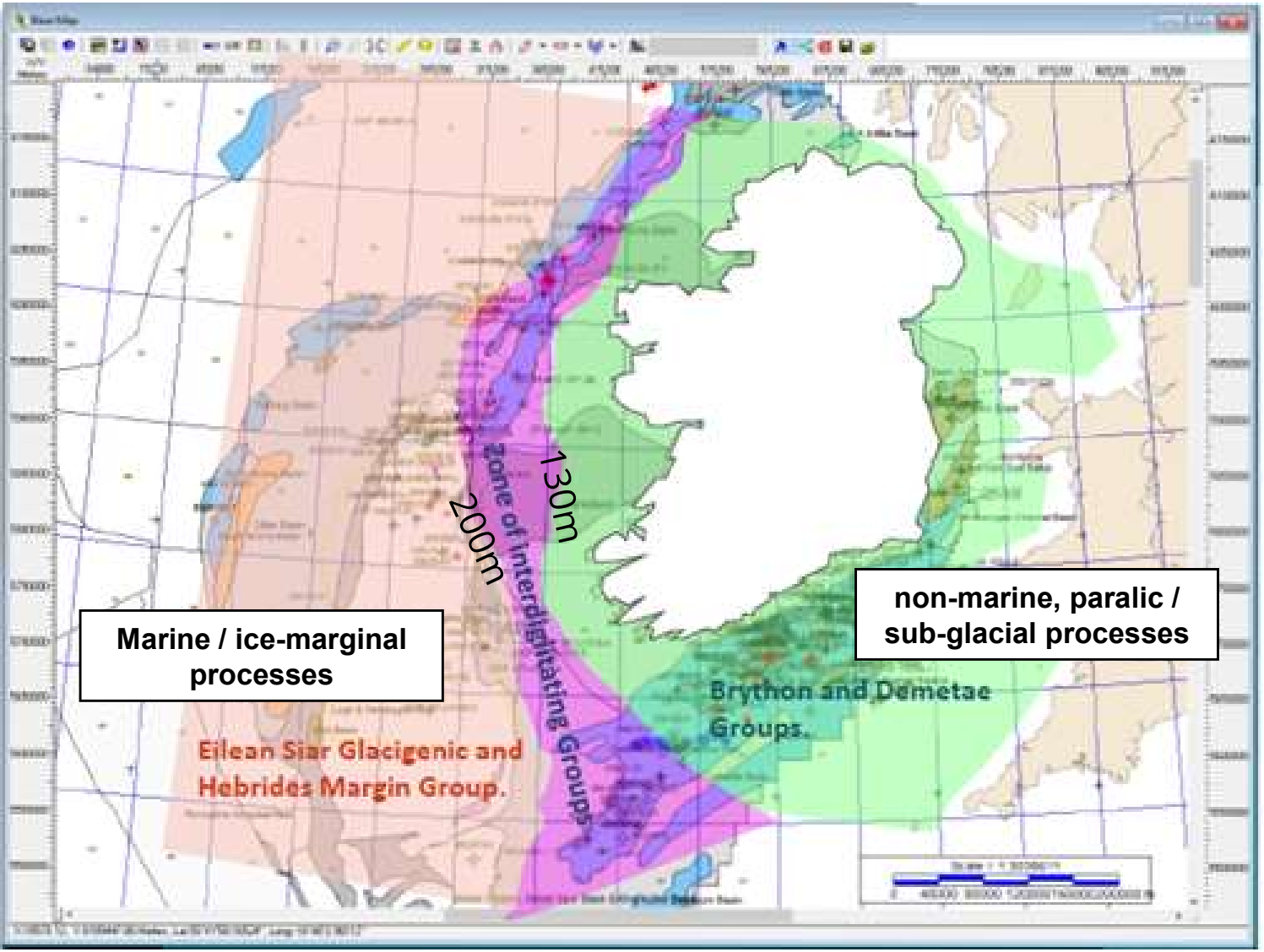




Limit of the last ice sheets



Pleistocene & Pliocene Groups



- Marine; ice-marginal sediments follow approx. present day 200m bathymetric contour
- Non-marine sediments occur inboard of present day 130m bathymetric contour
- The zone between the present day 130m and 200m bathymetric contours (i.e. outer part of the shelf) represents areas where ‘open marine’ and ‘non marine’ sediments (groups) interdigitate
  - 27/24 boreholes on shelf NW of Ireland
  - Vibrocore data SW of Ireland
- **Provenance not used as a criteria but rather process**

Existing UK Framework

- BGS (Stoker *et al* 2011); 4 Groups defined:

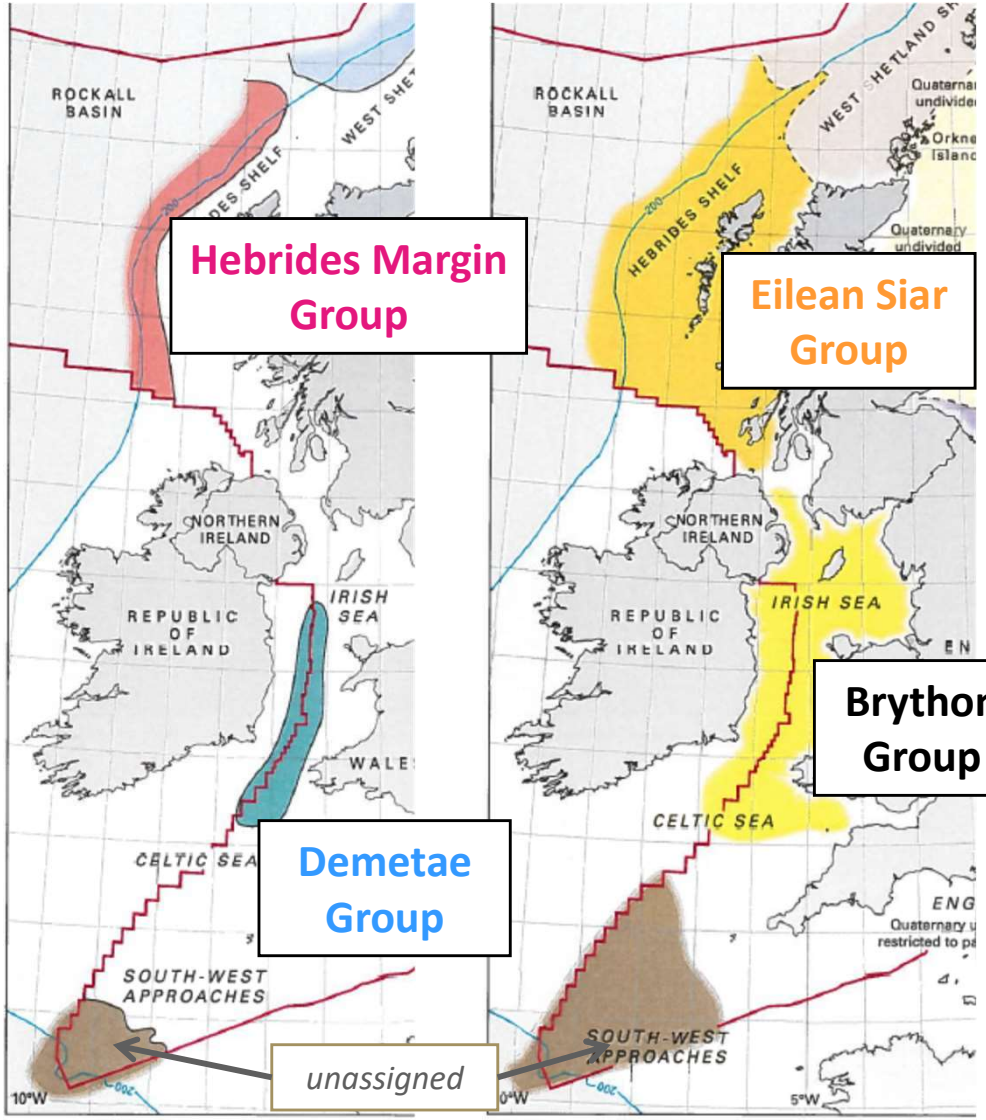
		Atlantic Margin	East Irish Sea
		Eilean Siar Glacigenic Group	**Brython Glacigenic Group**
Quaternary	**Pleistocene**	ice-marginal, marine, ice-contact processes	subglacial and proglacial deposits, e.g. Irish Sea ice stream
	C5	**Regional U/C ("Mid-Pleistocene Glacial Unconformity")**	
		Hebrides Margin Group	**Demetae Group**
Neogene	**Pliocene**	shelf-margin to deep-water deposits, pre-glacial	terrestrial and shallow marine sediments, pre-glacial
	C10	**Early Pliocene C10 regional U/C**	

- It was determined these published groups accurately extended to Irish Groups based on lithotypes, facies, biostrat, seismic, ice processes

- Project will **publish updated definitions** incorporating Irish stratigraphy

Pliocene – Pleistocene (non-glacial)

Pleistocene (glacial)



Future work

- Integration of offshore and onshore frameworks, use of biostratigraphic data, seismic interpretation and established biozones in this project

- Celtic Sea – detailed integration with BGS boreholes in SW Approaches

- Further subdivisions and units to be defined:
  - *Provenance from Irish landmass not used in Group definitions, maybe later incorporated at Formation level*
  - *E.g. Integrating provenance of ISIS into Irish Brython Group*
  - *E.g. Seismic facies within Pliocene in Hebrides Margin Group; parallel bedded seismic in deeper locations (open marine) to prograding features in structurally higher, open marine shelfal settings may represent a different depositional environments.*

- Future offshore name proposals to go through the PAD and Stratigraphic Committee