The cold water coral IODP Expedition 307 Challenger Mound palaeoarchive:

Tackling the complexities of a trans-institutional collaborative approach to core analysis

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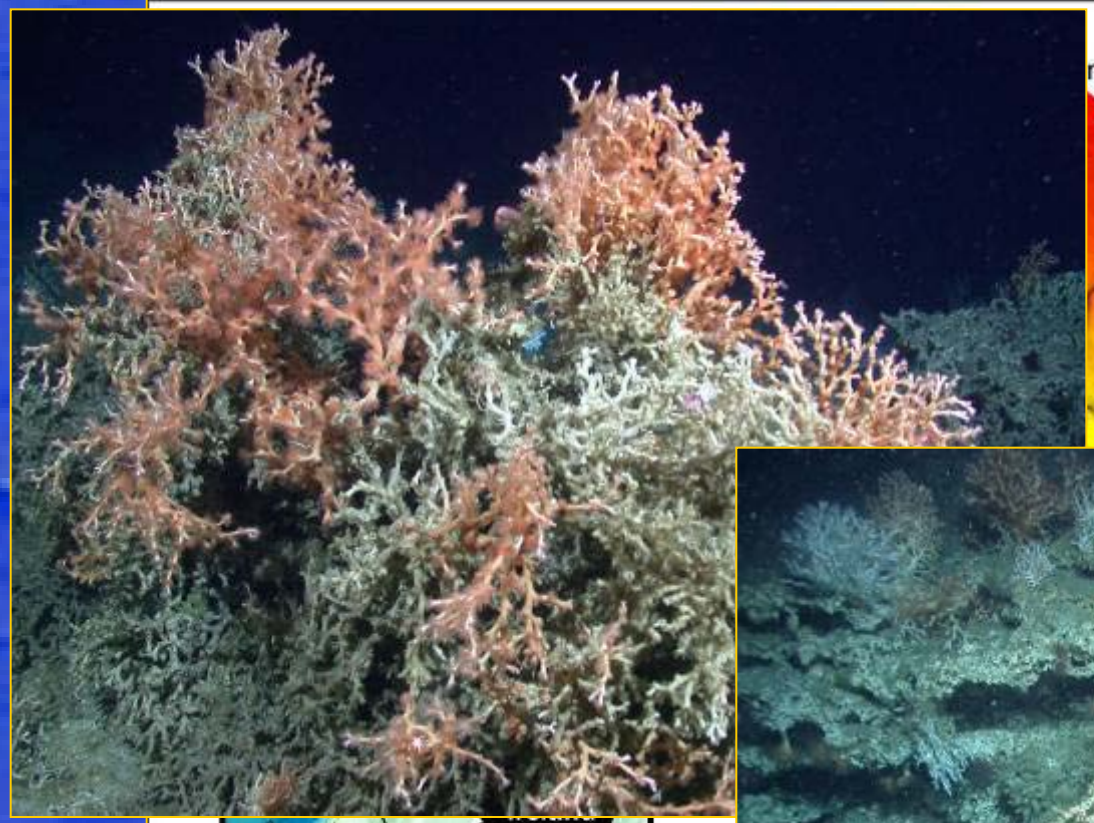
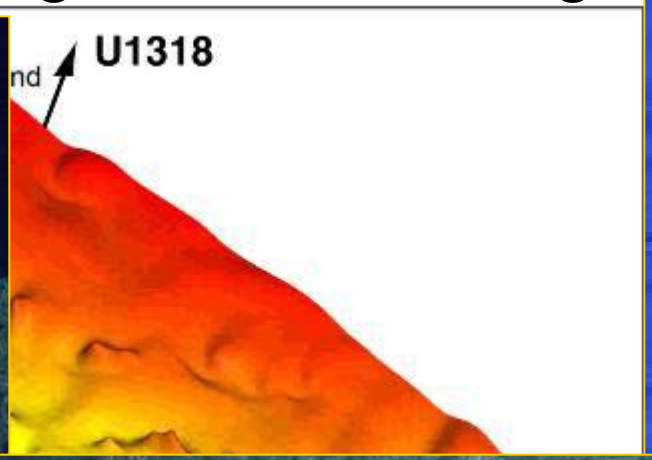
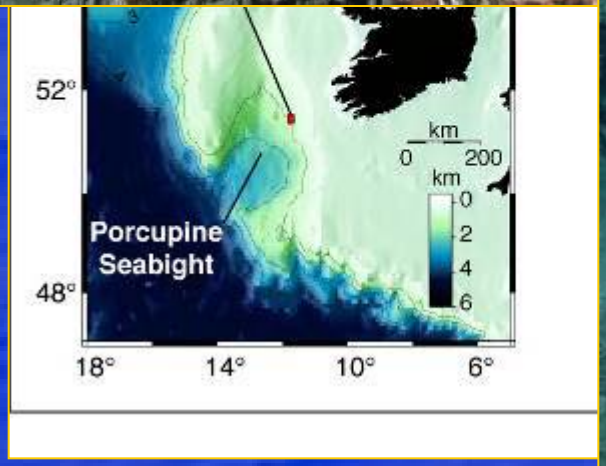
IODP

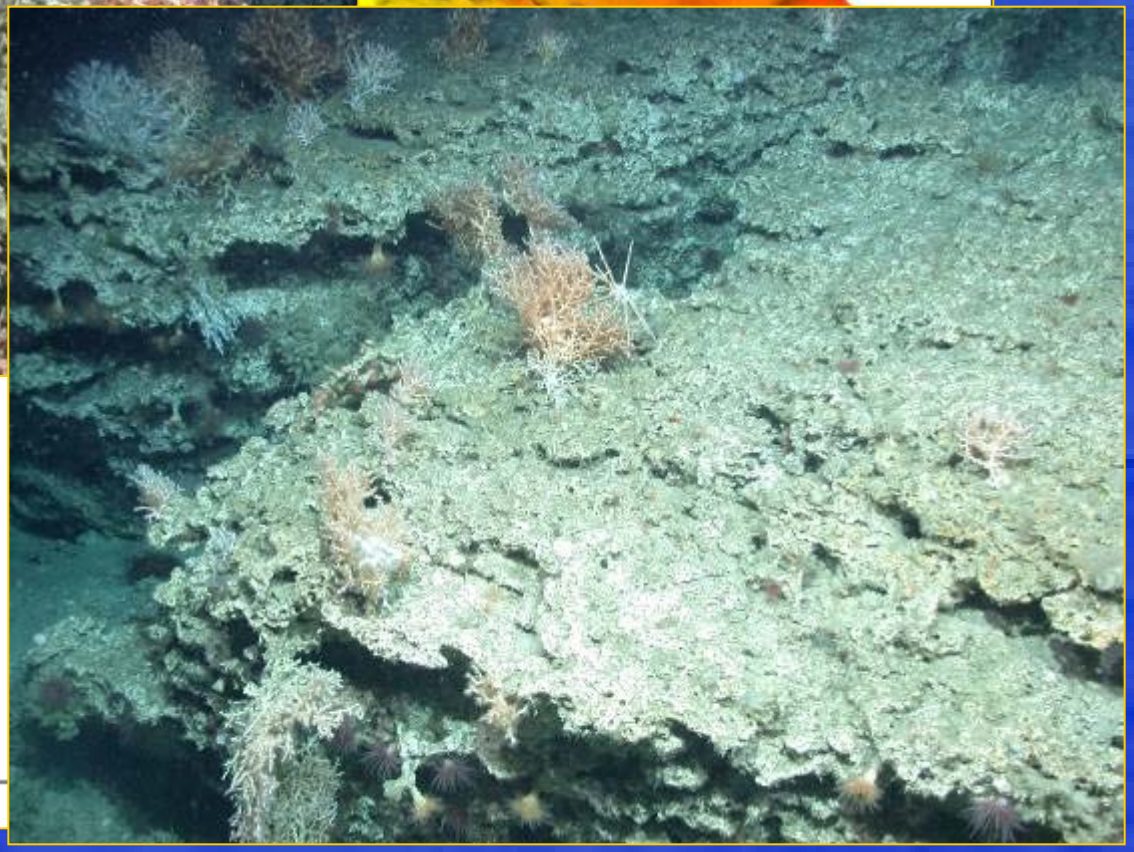
INTEGRATED OCEAN DRILLING PROGRAM

IODP Expedition 307 – Challenger Mound drilling

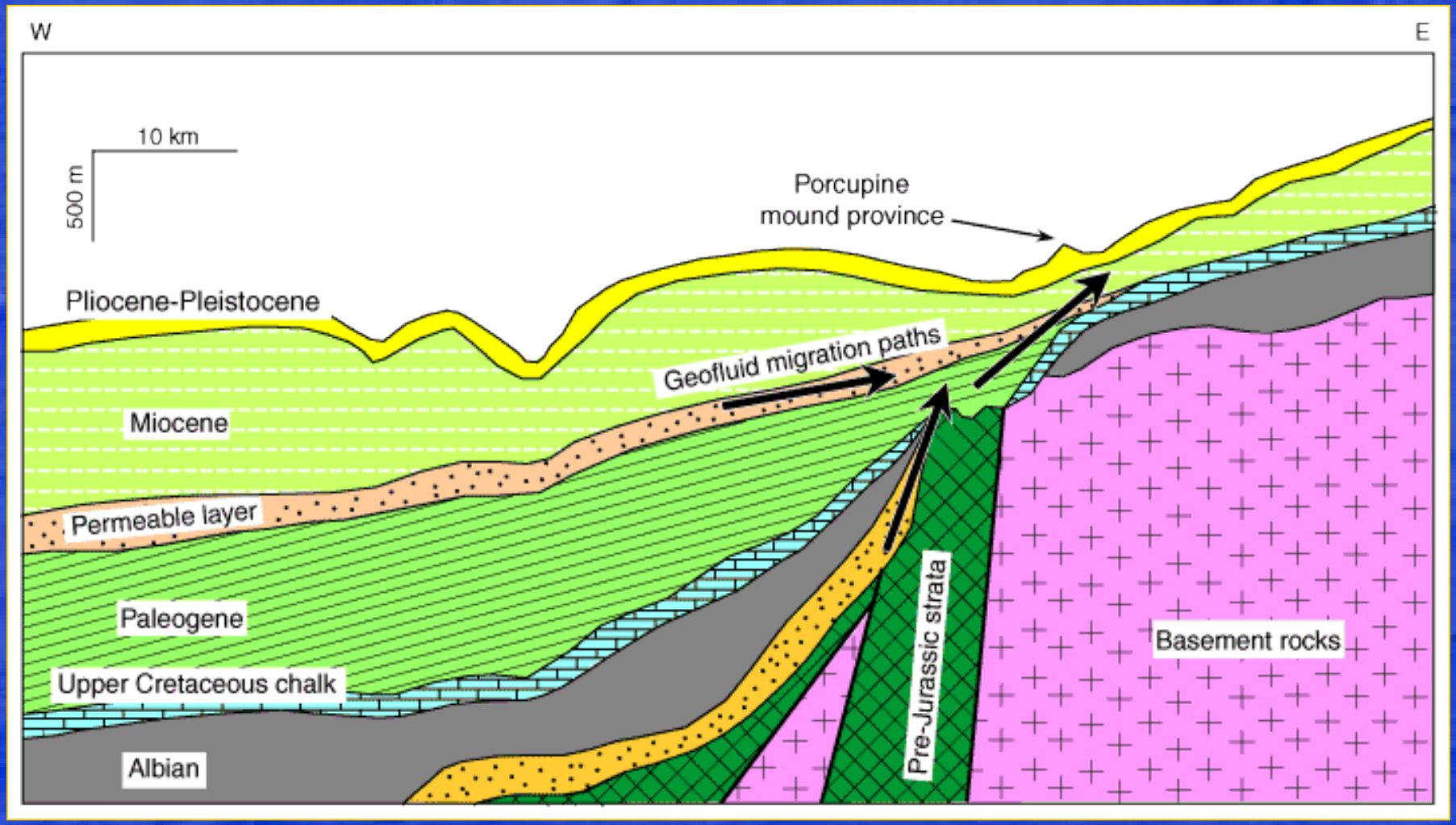


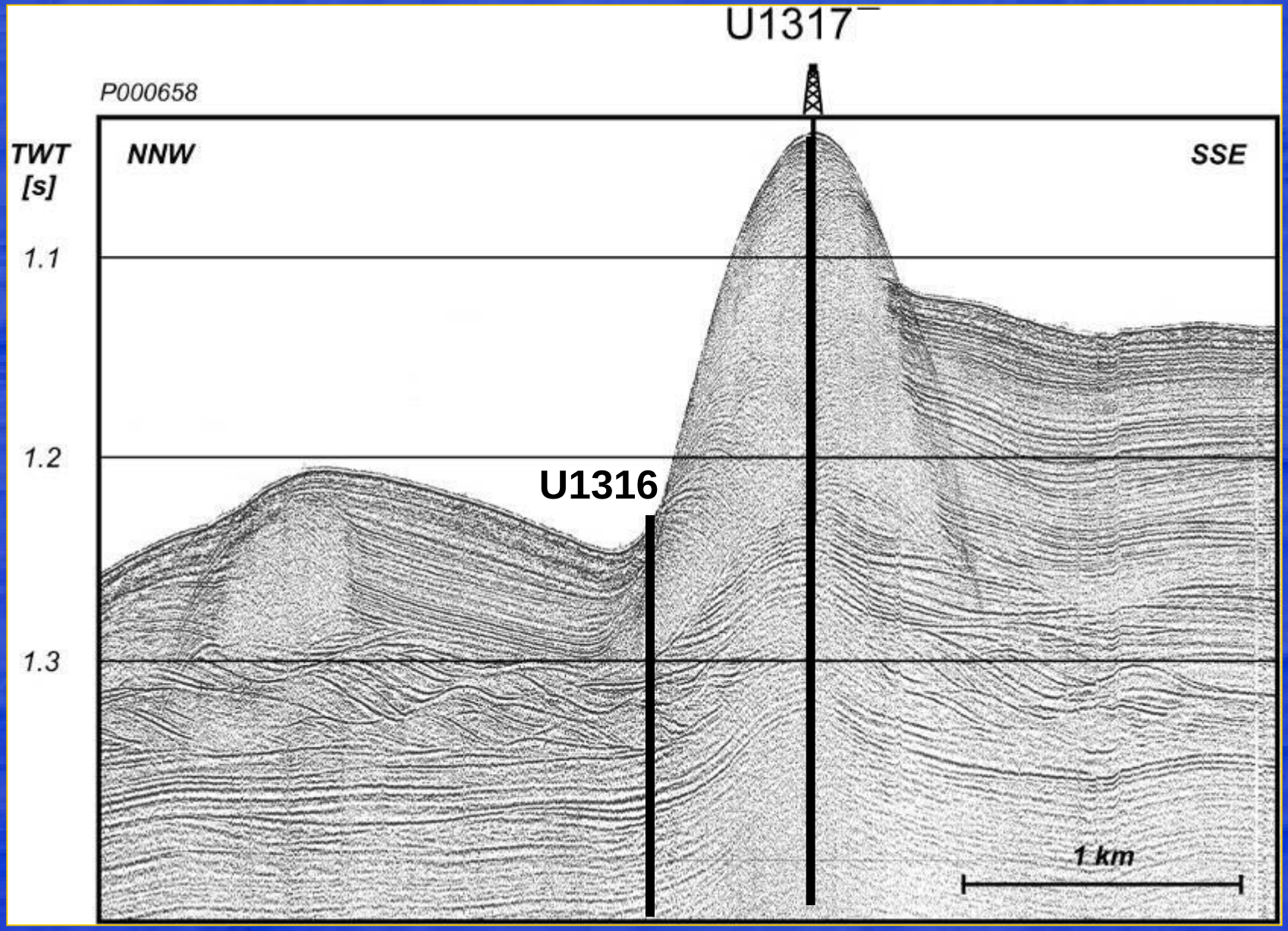




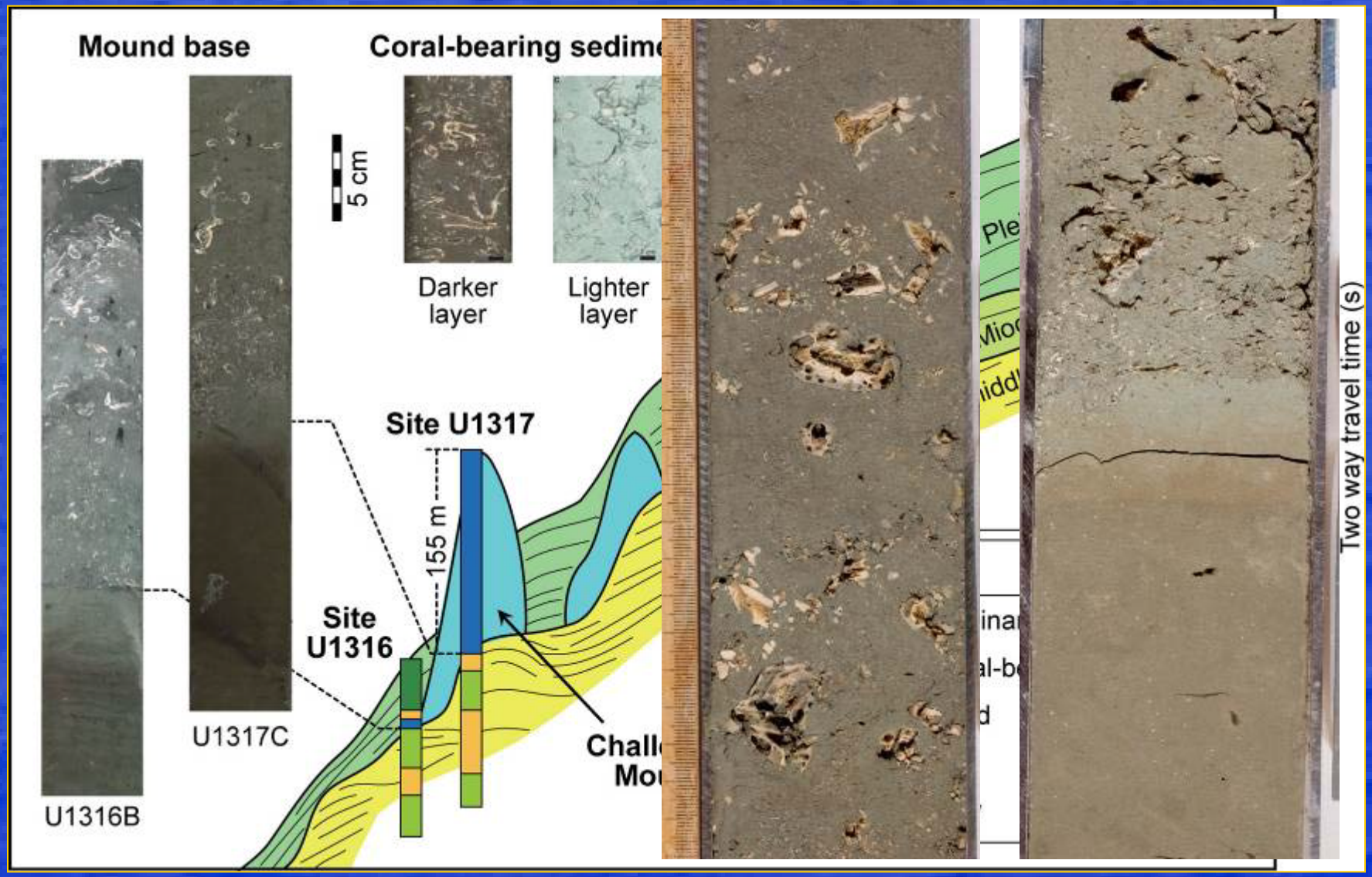


Gas seep hypothesis




U1317
P000658
TWT
[s]
NNW
SSE
1.1
1.2
1.3
U1316
1 km

IODP Expedition 307 – Challenger Mound drilling

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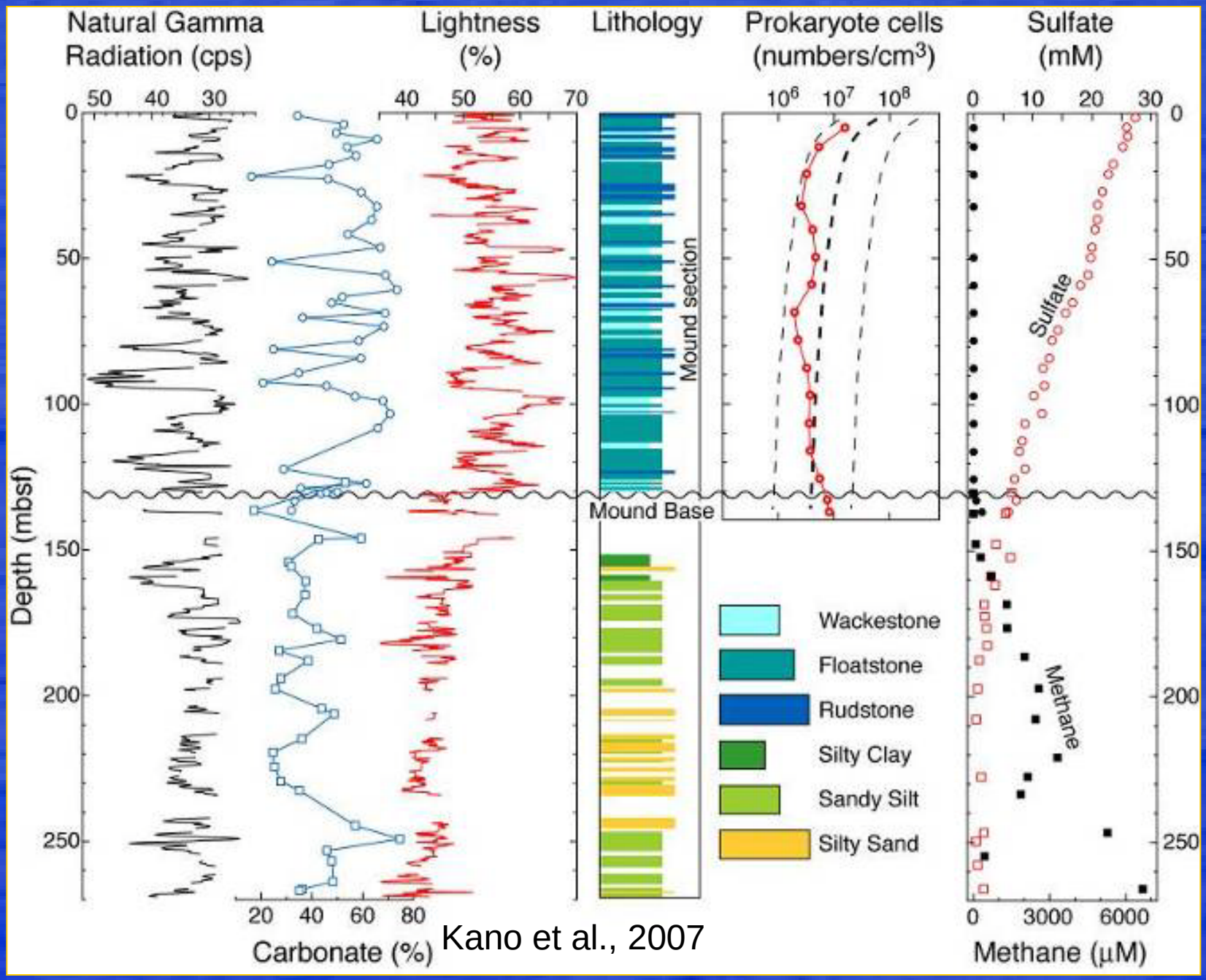
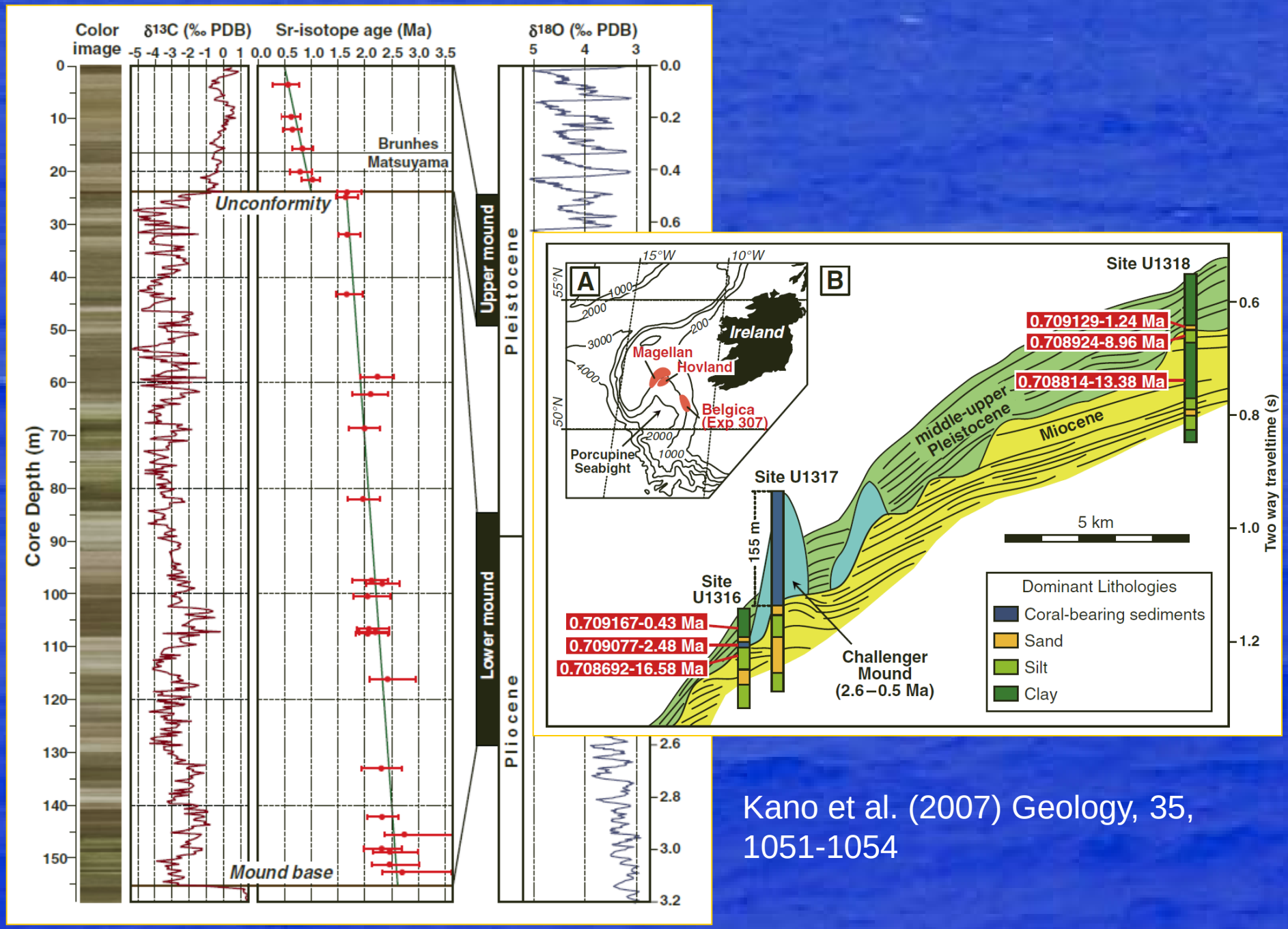


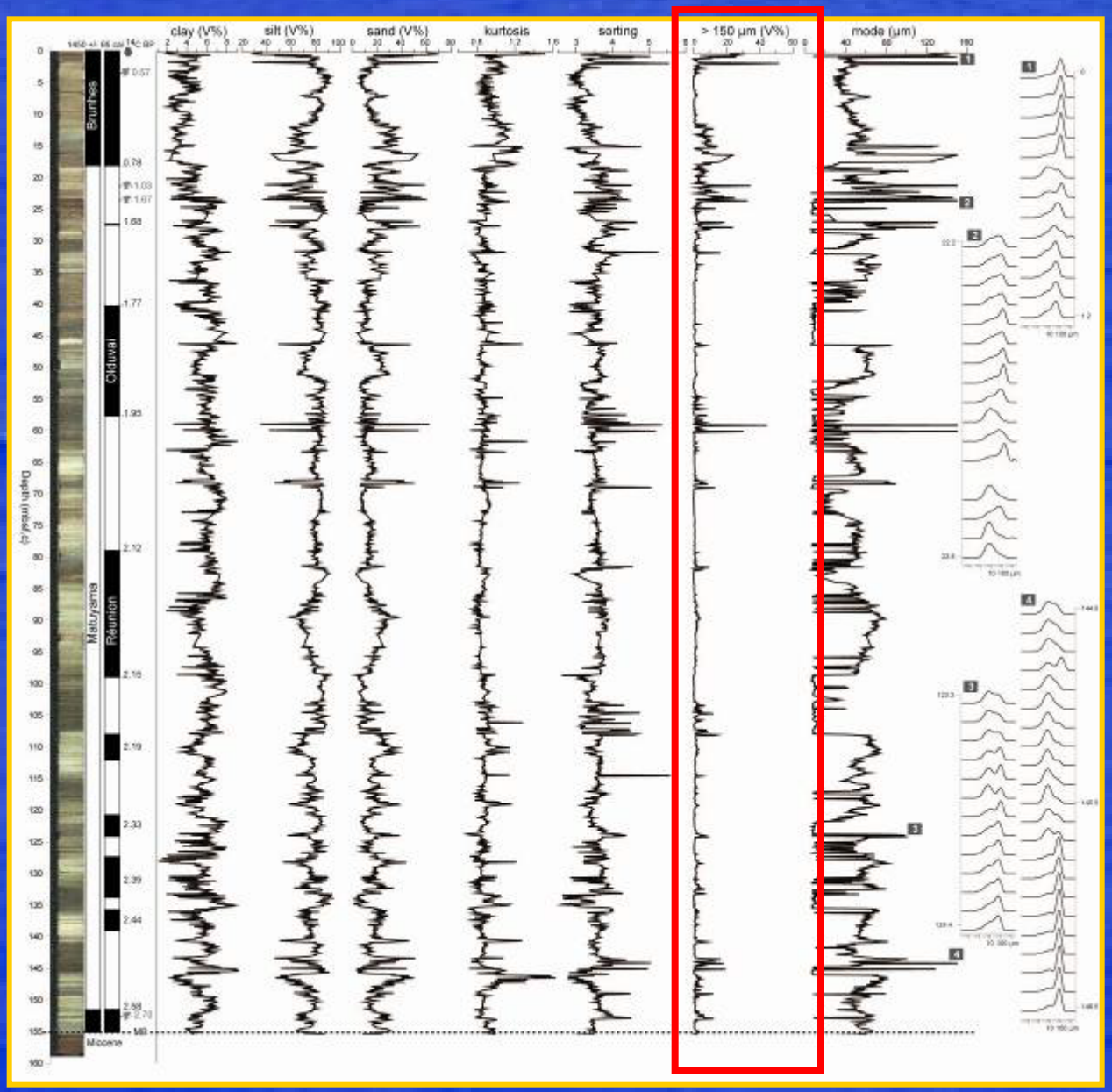
Kano et al., 2007



Kano et al. (2007) Geology, 35, 1051-1054

IRD %>150 µm

Thierens *et al*. (2010). Mar. Geol., 271, 260-277



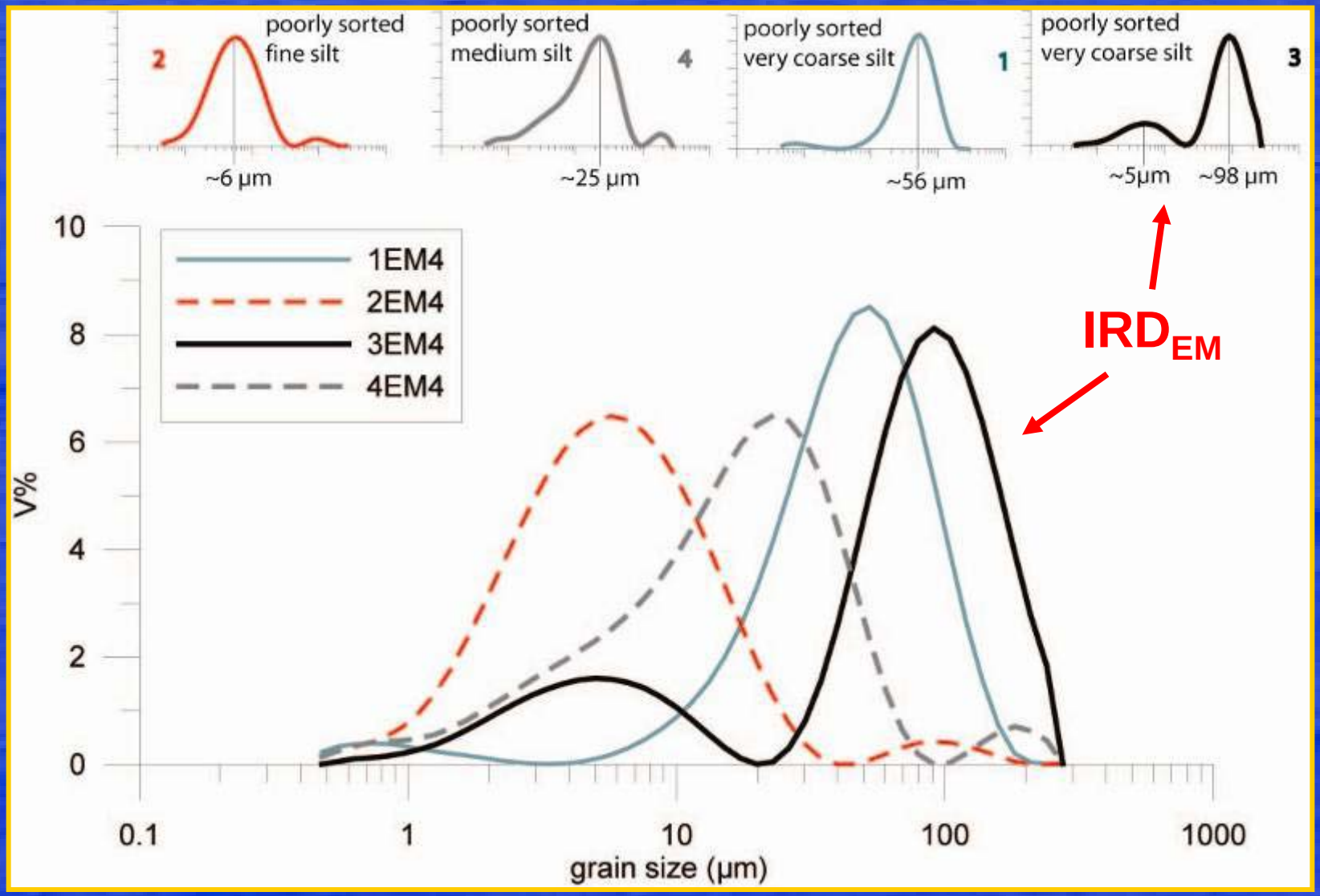
M1

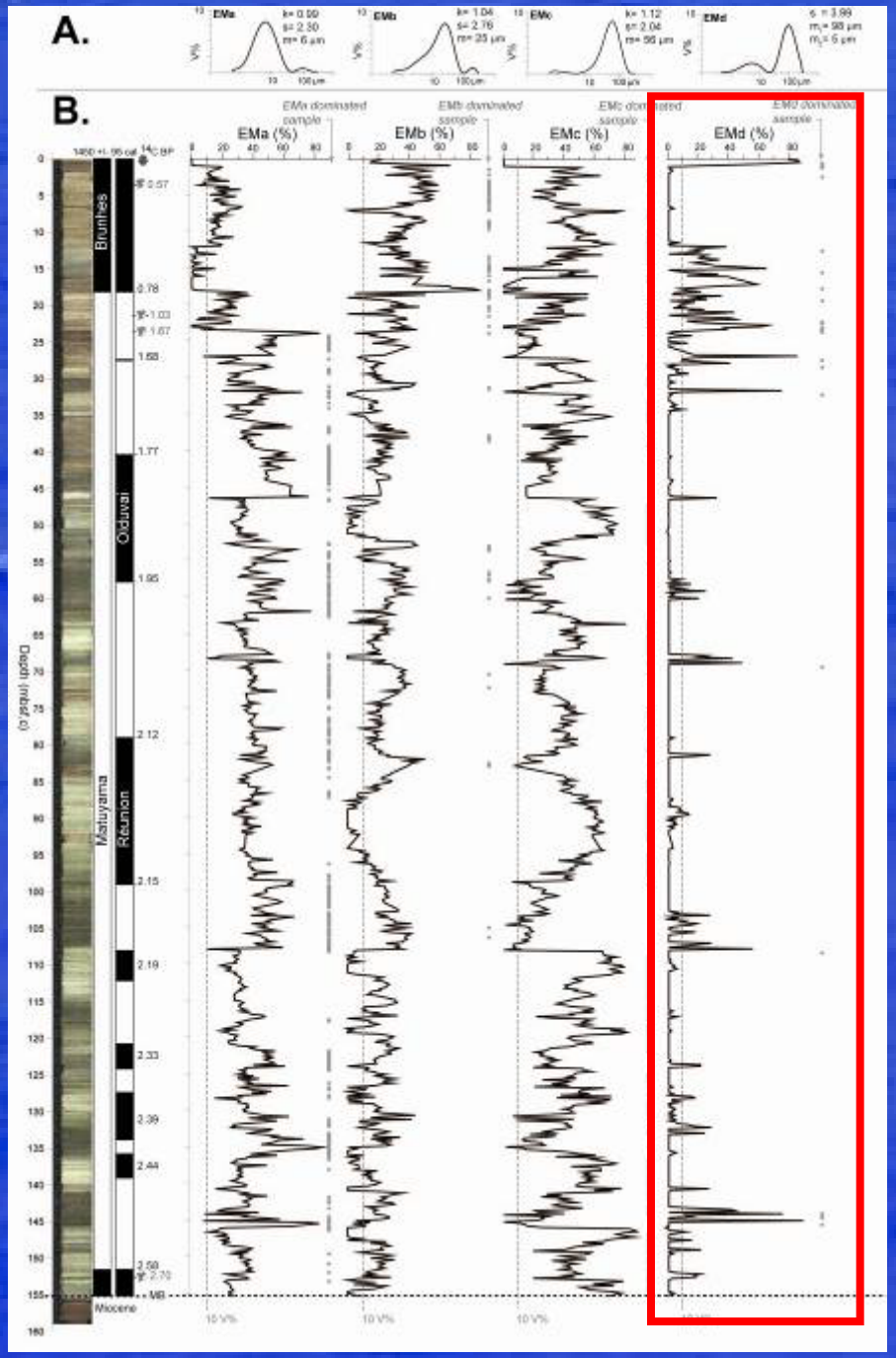
1.7 Ma

120m

2.6 Ma

End-member modelling of grain-size populations





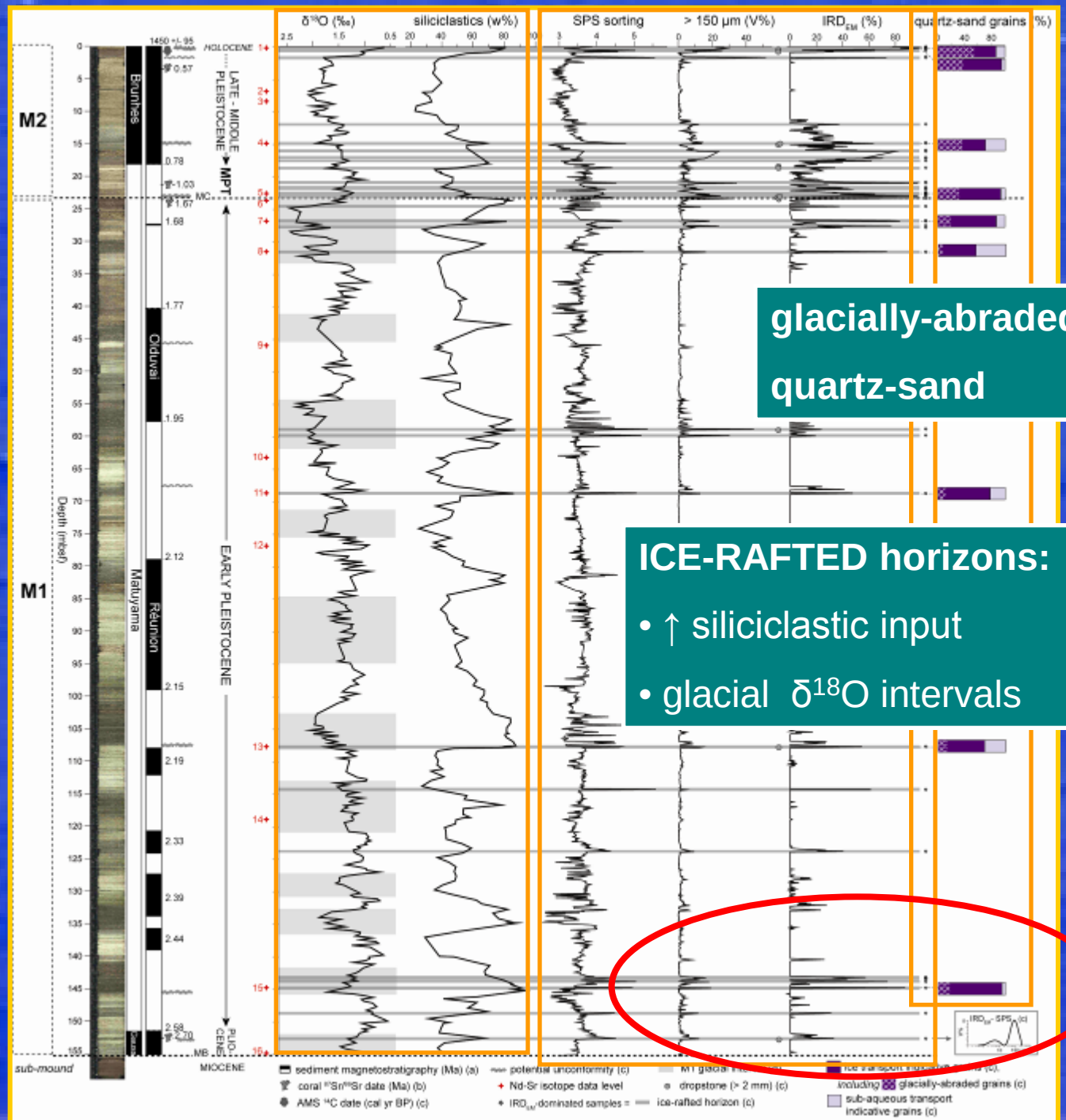
Thierens *et al*. (2010). Mar. Geol., 271, 260-277

1.7 Ma

M1

2.6 Ma

Groundtruthing IRD_{EM}



glacially-abraded quartz-sand

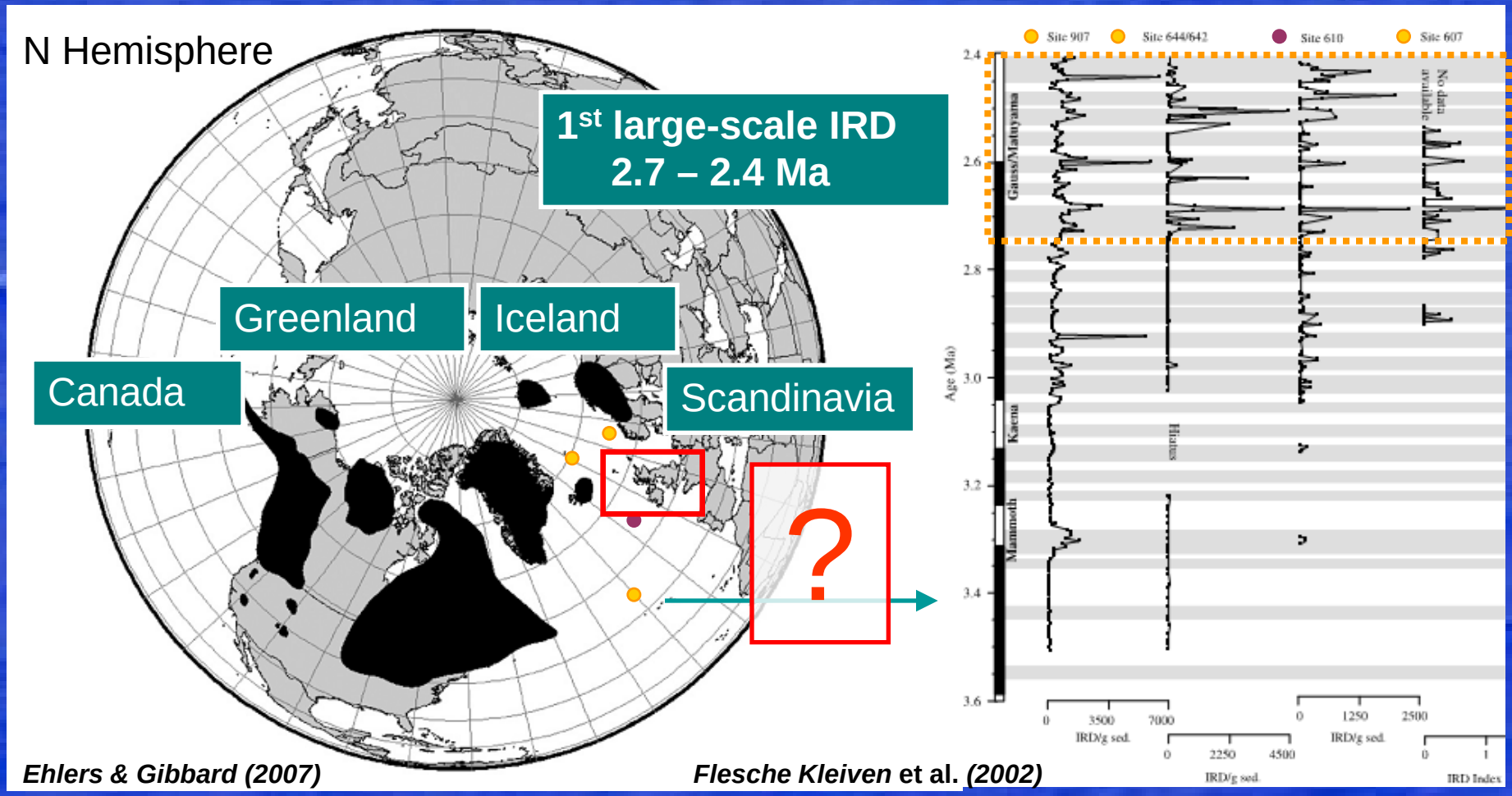
ICE-RAFTED horizons:

- ↑ siliciclastic input
- glacial $\delta^{18}O$ intervals

Thierens *et al.* (2011)

At the start of the Pleistocene, by 2.5 Ma, we have icebergs delivering IRD (glacially abraded grains) offshore of Ireland

Early Pleistocene ice



Ehlers & Gibbard (2007)

Flesche Kleiven et al. *(2002)*

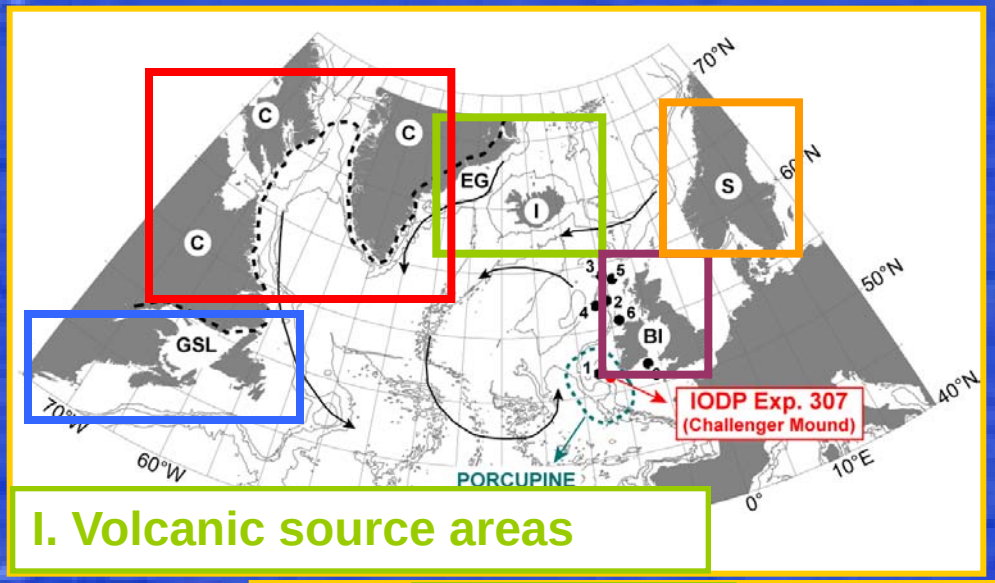
High latitude ice-sheets → *marine margin* → Ice-rafted detritus (IRD)

Provenance

- Nd-Sr isotopes source areas

Isotopic fingerprinting:

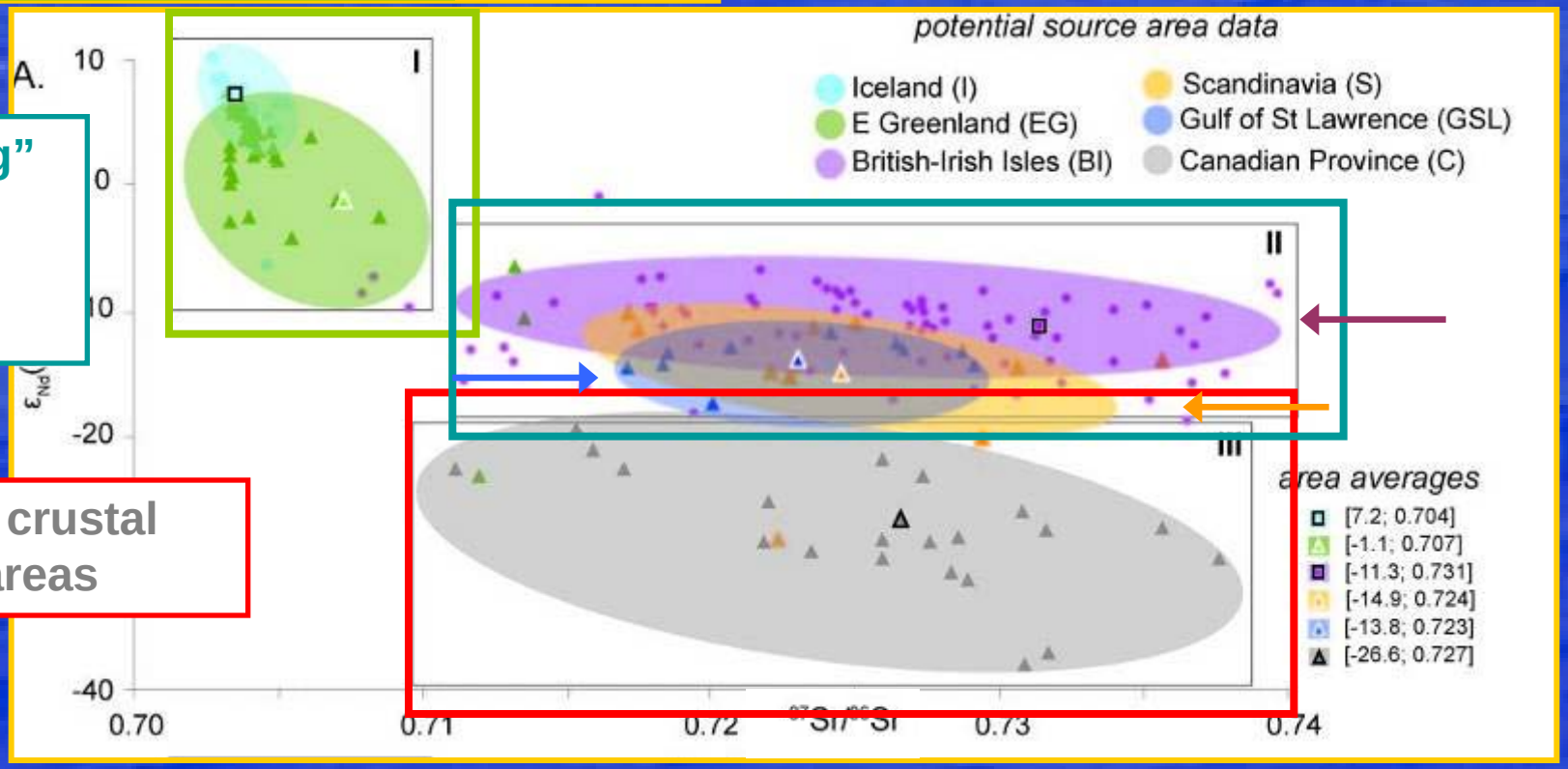
- $\varepsilon_{Nd}(0) \rightarrow {}^{143}Nd/{}^{144}Nd$
- ${}^{87}Sr/{}^{86}Sr$



I. Volcanic source areas

II. "young" crustal source areas

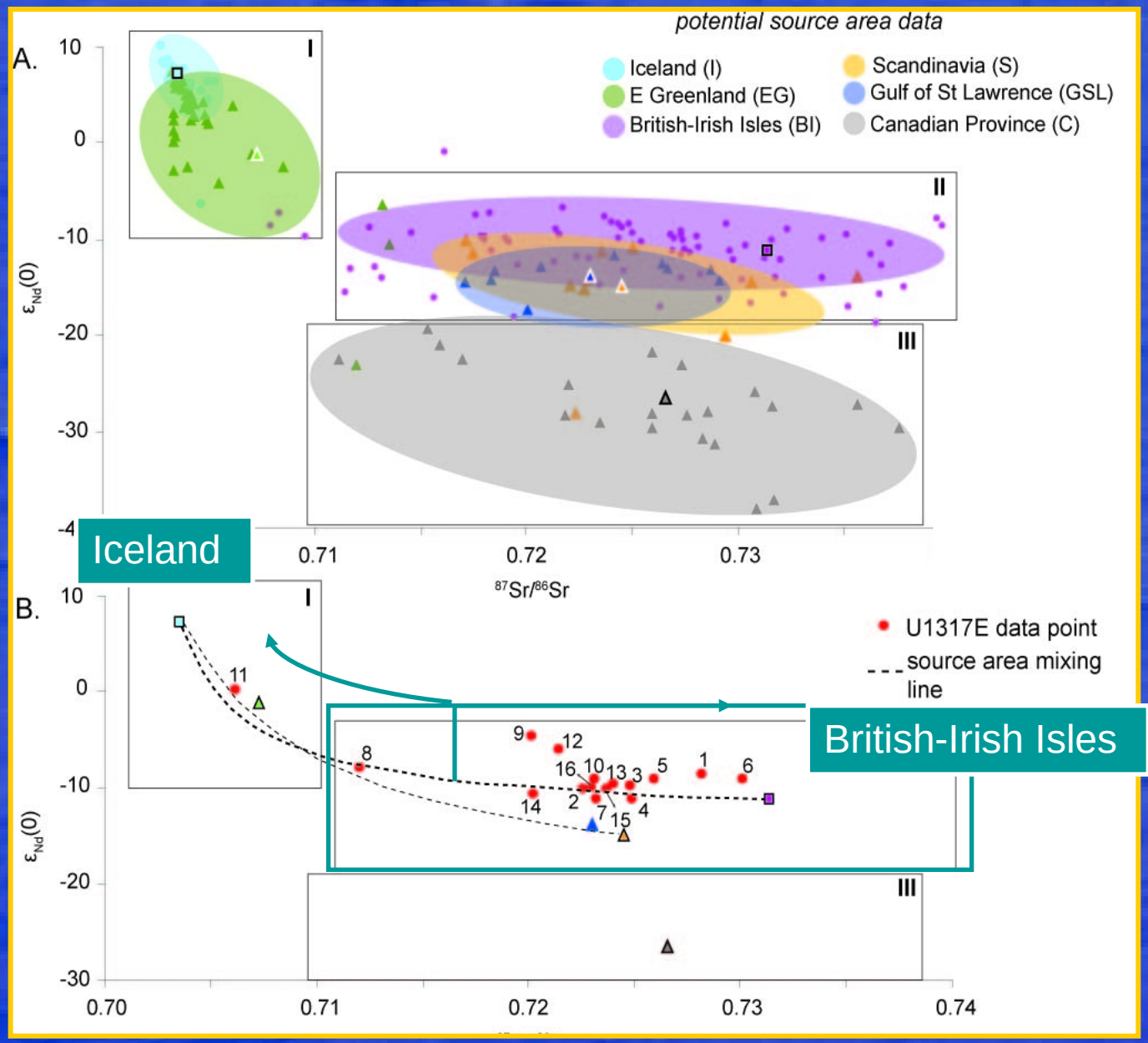
III. "old" crustal source areas



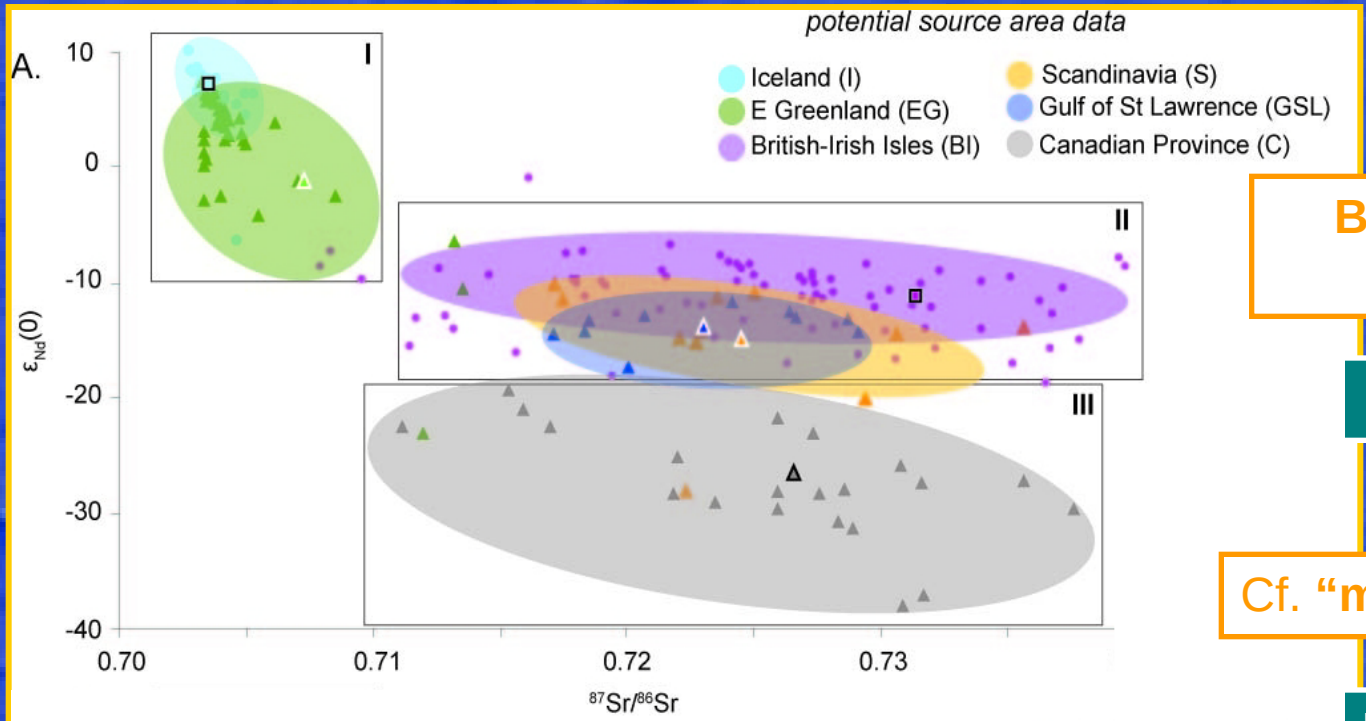
Thierens *et al.* (submitted)

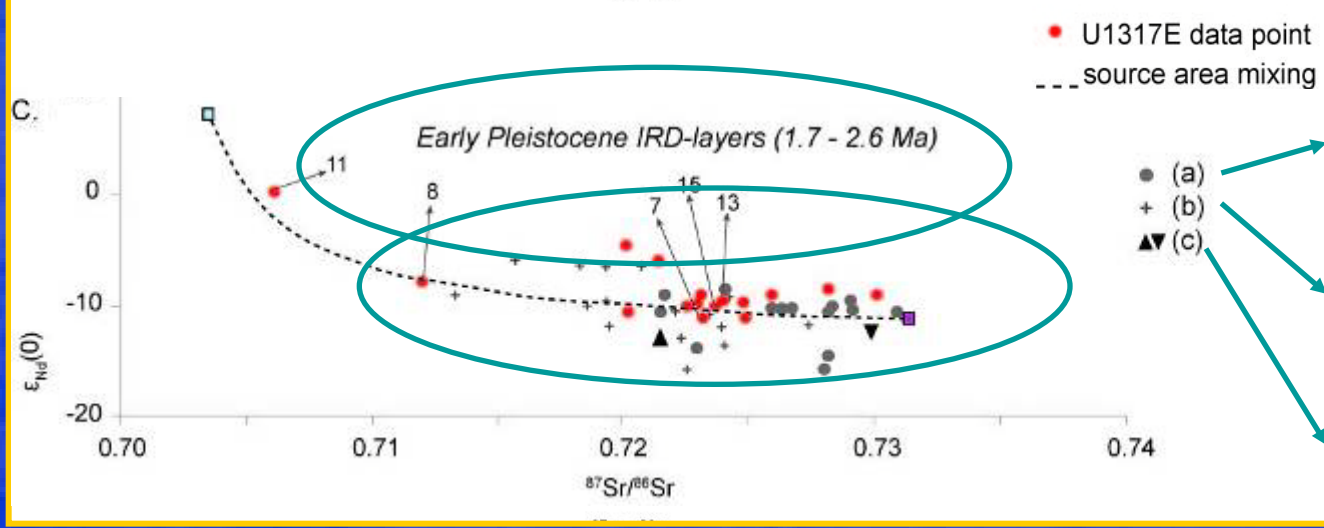
Nd-Sr isotopes

16 samples;
bulk, decarbonated sediment;
IRD & background sediment



Thierens *et al*. (submitted)





British-Irish source signature

"old" BI - ice

↓

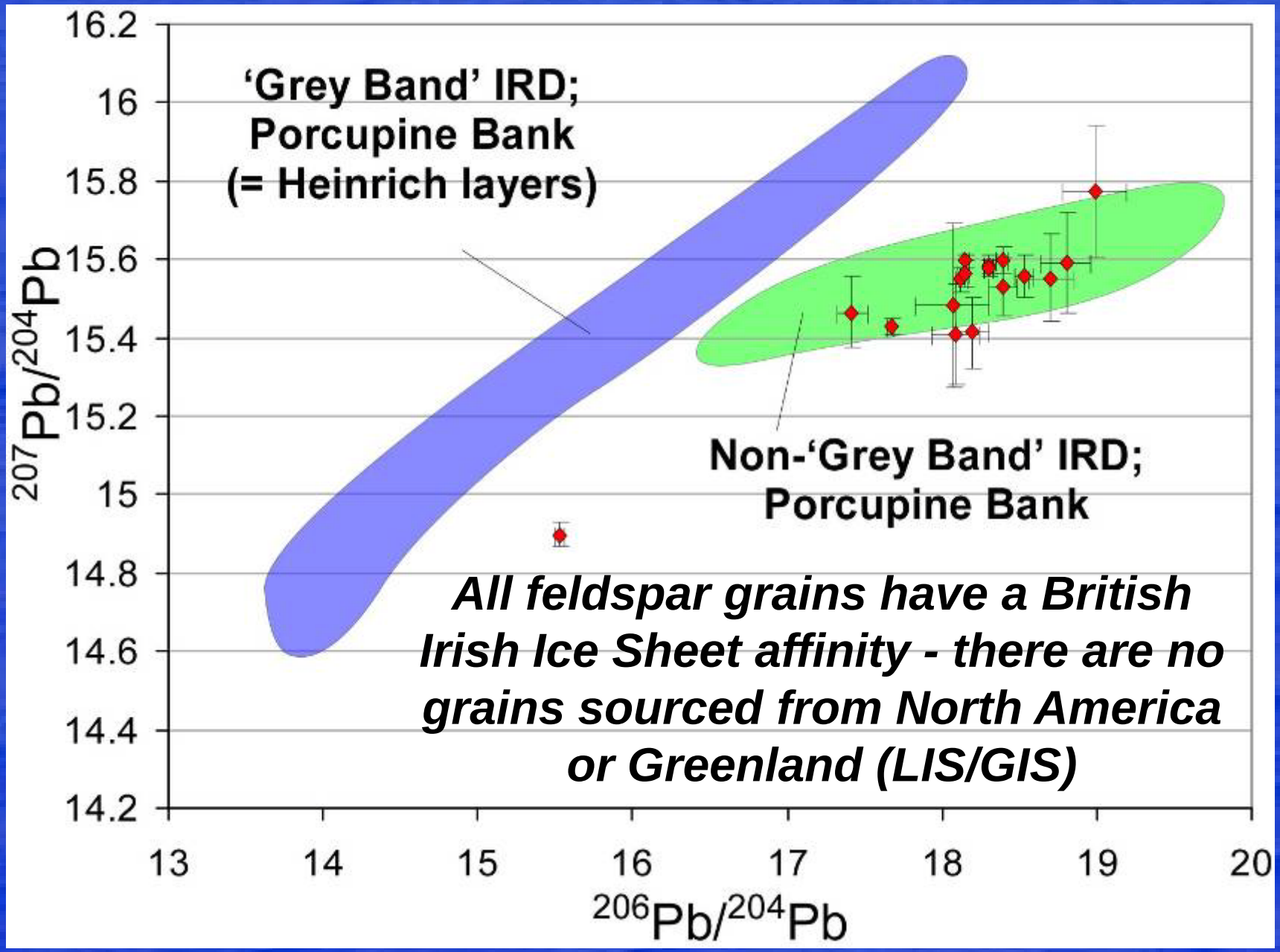
Cf. **"modern analogues"**

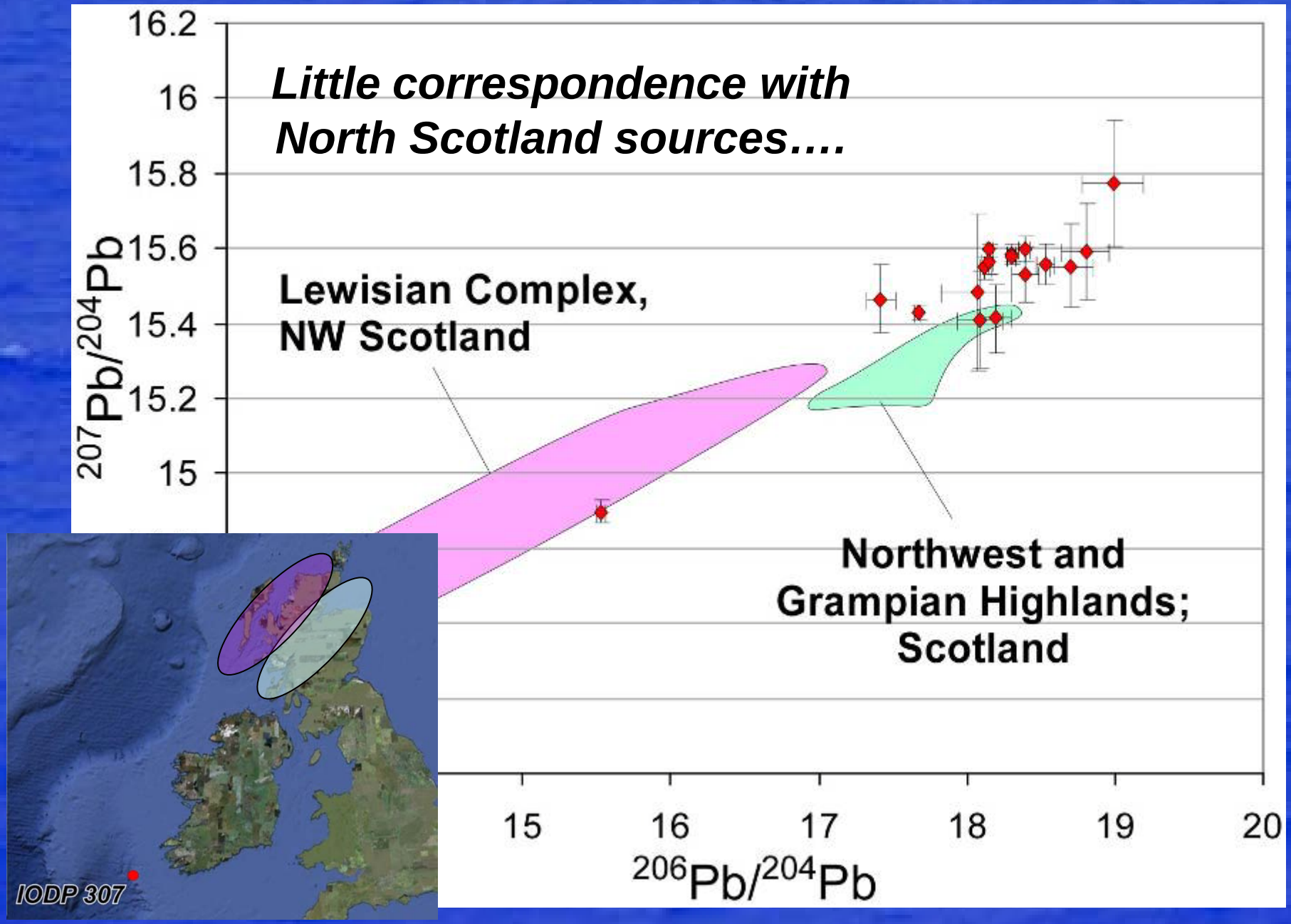
Late Pleistocene - Holocene Challenger Mound (Pirlet et al., 2010)

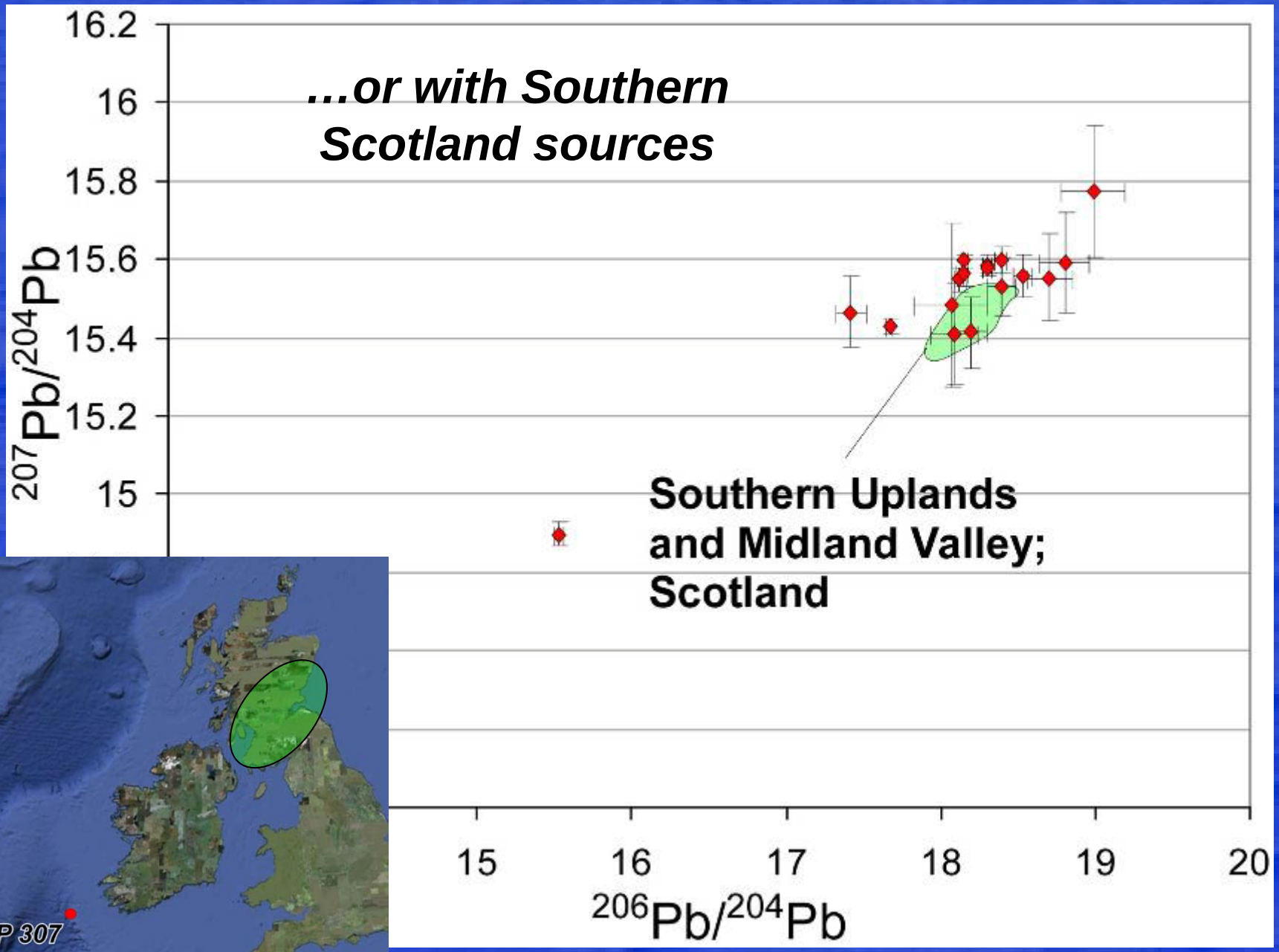
Late Pleistocene IRD (Peck et al., 2007)

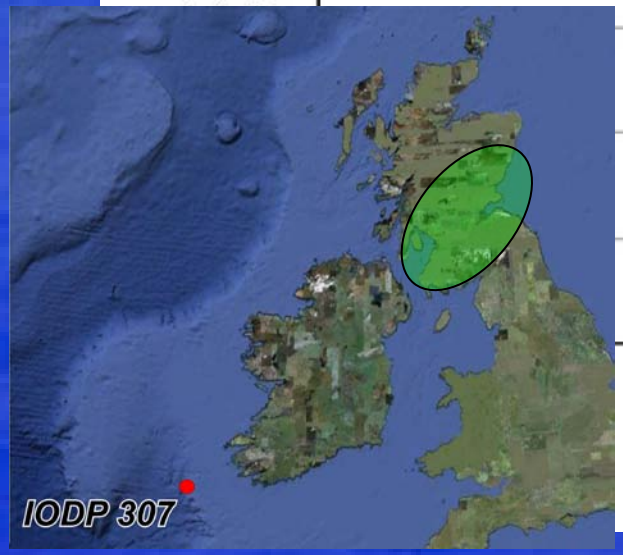
Modern Irish Shelf (Grousset et al., 2000)

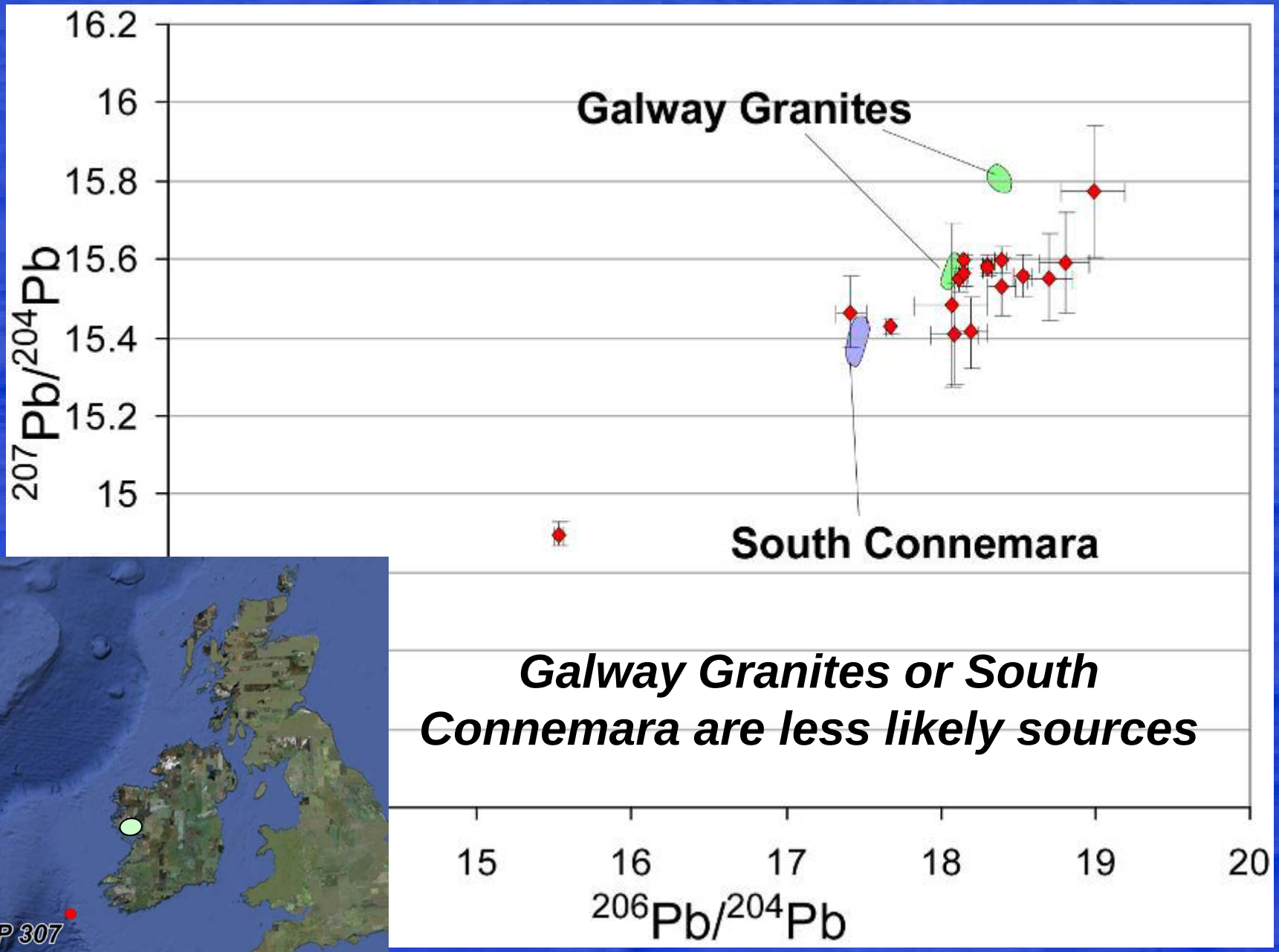
At the start of the Pleistocene, by 2.5 Ma, the BIIS was significantly developed to expand to sea-level and release icebergs


'Grey Band' IRD;
Porcupine Bank
(= Heinrich layers)
Non-'Grey Band' IRD;
Porcupine Bank
All feldspar grains have a British Irish Ice Sheet affinity - there are no grains sourced from North America or Greenland (LIS/GIS)
16.2
16
15.8
15.6
15.4
15.2
15
14.8
14.6
14.4
14.2
13
14
15
16
17
18
19
20
$^{207}Pb/^{204}Pb$
$^{206}Pb/^{204}Pb$

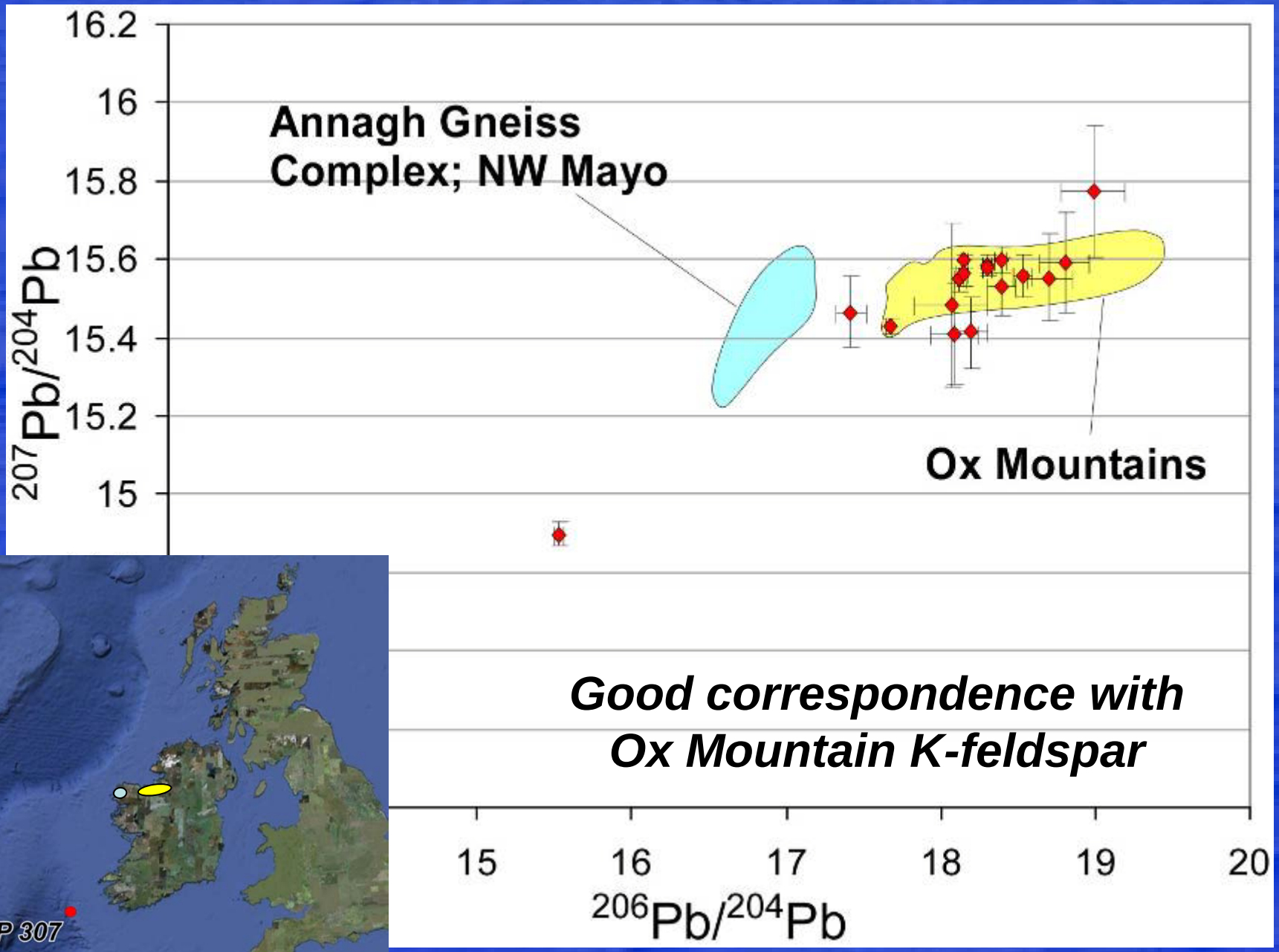

Little correspondence with North Scotland sources….
Lewisian Complex, NW Scotland
Northwest and Grampian Highlands; Scotland
16.2
16
15.8
15.6
15.4
15.2
15
$^{207}Pb/^{204}Pb$
15
16
17
18
19
20
$^{206}Pb/^{204}Pb$
IODP 307


…or with Southern Scotland sources
Southern Uplands and Midland Valley; Scotland
16.2
16
15.8
15.6
15.4
15.2
15
$^{207}Pb/^{204}Pb$
15
16
17
18
19
20
$^{206}Pb/^{204}Pb$


IODP 307

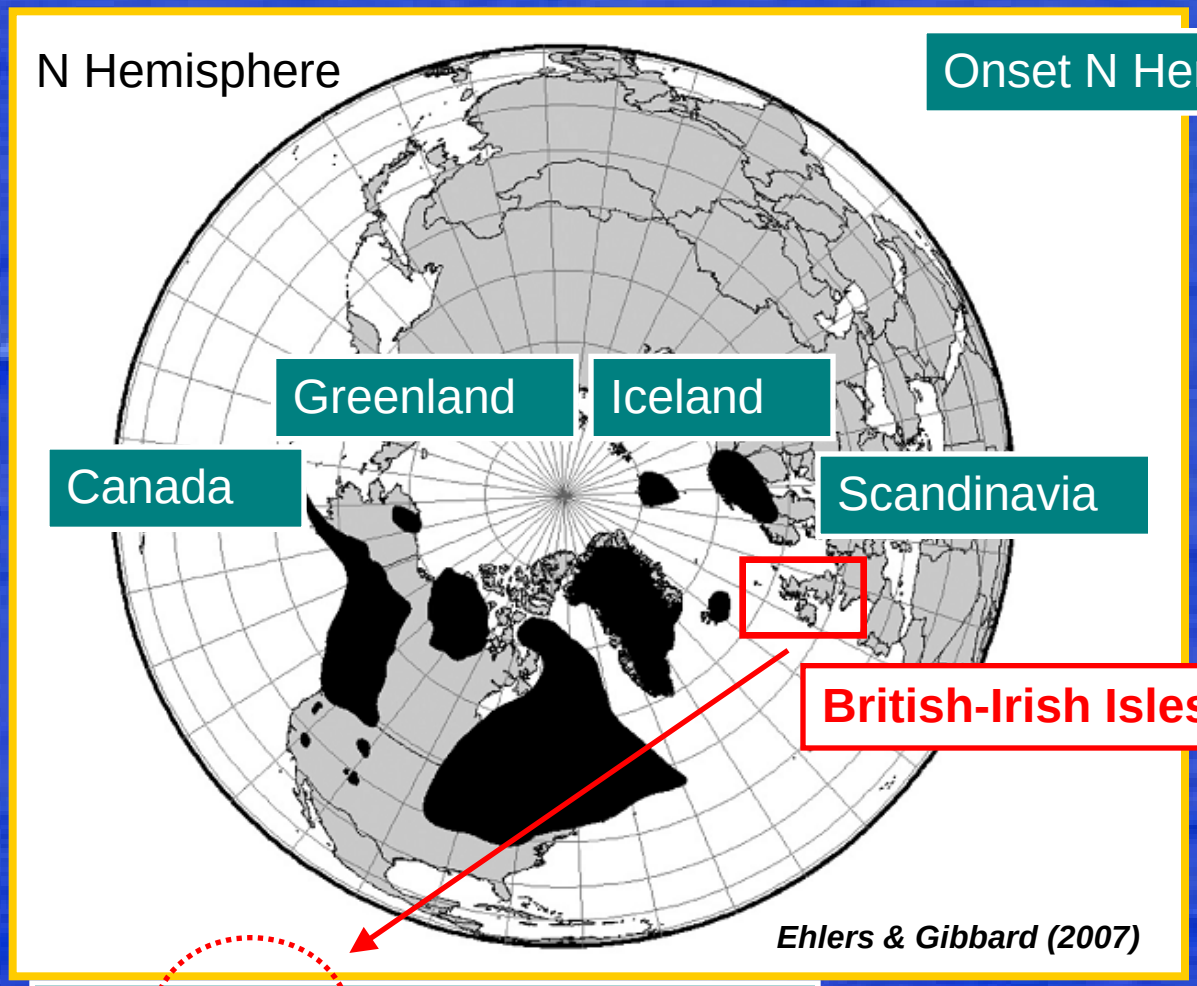


Galway Granites or South Connemara are less likely sources



Good correspondence with Ox Mountain K-feldspar

Implications



Onset N Hemisphere glacial expansion

"41-ka paced world"
– less glaciated

British-Irish ice sheet
→ sensitive reactor

- considerable ice accumulation on BI

- repeated ice

Ice-rafted detritus (IRD)

High + Mid latitude ice-sheets

marine margin

BIIS as a sensitive reactor at the start of the Pleistocene?

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Ice-rafting from the British–Irish ice sheet since the earliest Pleistocene (2.6 million years ago): implications for long-term mid-latitudinal ice-sheet growth in the North Atlantic region

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ABSTRACT

The Plio-Pleistocene intensification of Northern Hemisphere continental ice-sheet development is known to have profoundly affected the global climate system. Evidence for early continental glaciation is preserved in sediments throughout the North Atlantic Ocean, where ice-rafted detritus (IRD) layers attest to the calving of sediment-loaded icebergs from circum-Atlantic ice sheets. So far, Early-Pleistocene IRD deposition has been attributed to the presence of high-latitudinal ice sheets, whereas the existence and extent of ice accumulation in more temperate, mid-latitudinal regions remains enigmatic.

Here we present results from the multiproxy provenance analysis of a unique, Pleistocene-Holocene IRD sequence from the Irish NE Atlantic continental margin. There, the Challenger coral carbonate mound (IODP Expedition 307 site U1317) preserved an Early-Pleistocene record of 16 distinctive IRD events, deposited between ca 2.6 and 1.7 Ma. Strong and complex IRD signals are also identified during the mid-Pleistocene climate transition (ca 1.2 to 0.65 Ma) and throughout the Middle-Late Pleistocene interval. Radiogenic isotope source-fingerprinting, in combination with coarse lithic component analysis, indicates a dominant sediment source in the nearby British–Irish Isles, even for the oldest, Early-Pleistocene IRD deposits. Hence, our findings demonstrate, for the first time, repeated and substantial (i.e. marine-terminating) ice accumulation on the British–Irish Isles since the beginning of the Pleistocene. Contemporaneous expansion of both high- and mid-latitudinal ice sheets in the North Atlantic region is therefore implied at the onset of the Pleistocene. Moreover, it suggests the recurrent establishment of (climatically) favourable conditions for ice sheet inception, growth and instability in mid-latitudinal regions, even in the earliest stages of Northern Hemisphere glacial expansion and in an obliquity-driven climate system.