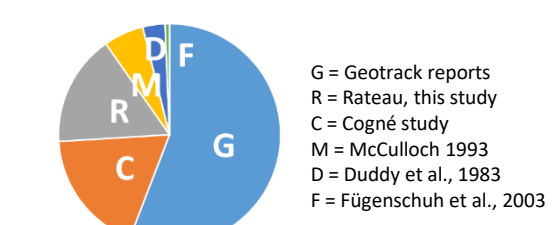


Irish-British Isles Database of Apatite Thermochronology (IBIDAT) – 1977-2021

New insights from a synthesis of old and new apatite fission track and (U-Th-Sm)/He (AFT) data

IBIDAT so far:

- All onshore/offshore, surface and borehole AFT data for Ireland
 - Only onshore surface data for Northern England, Wales and Scotland
- Onshore**
- 478 AFT ages
 - 120 AHe ages
- Offshore**
- 62 locations
 - 264 attempted samples
 - 229 AFT ages
 - 154 ages suitable for modelling
 - Source of suitable samples:



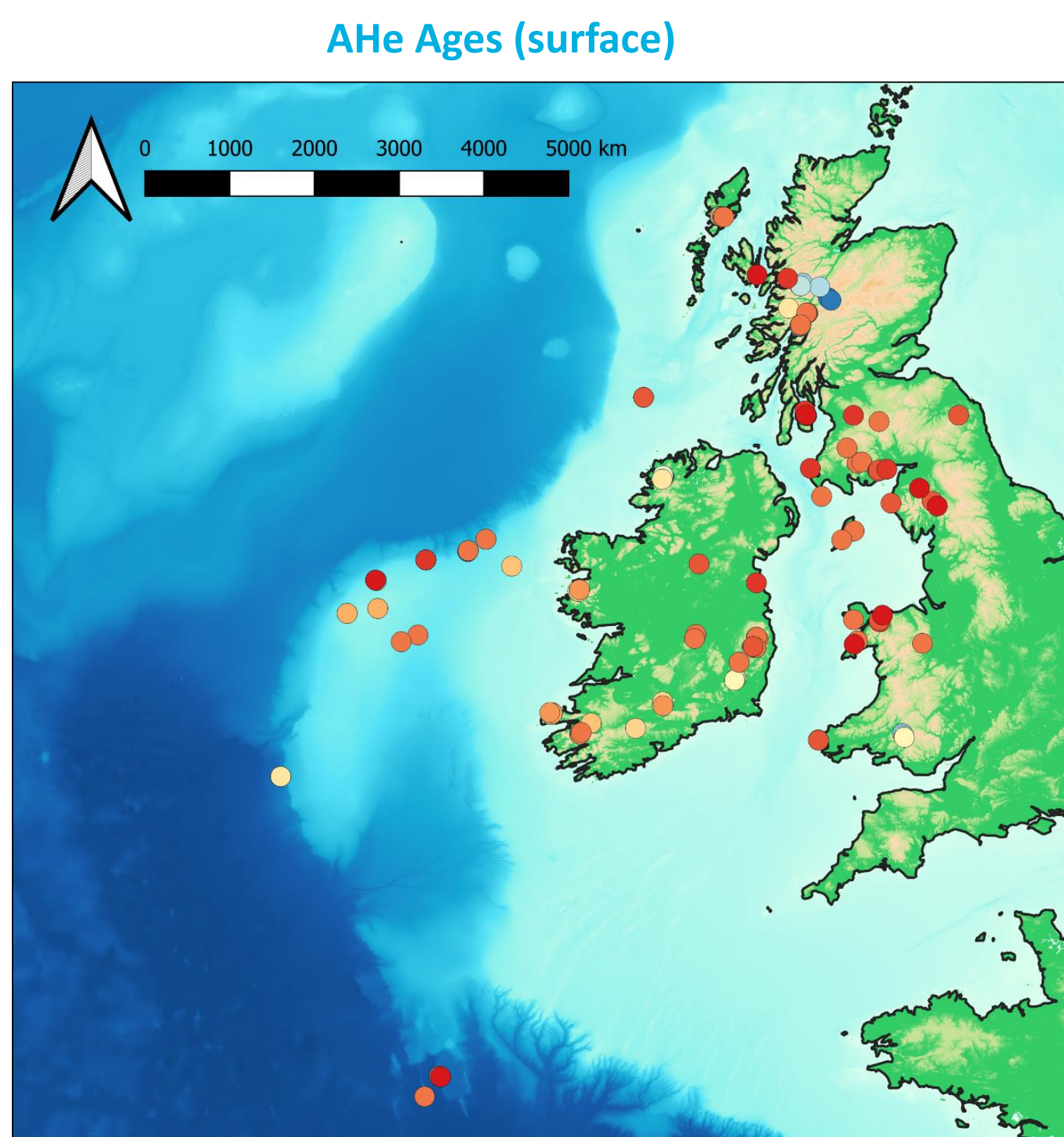
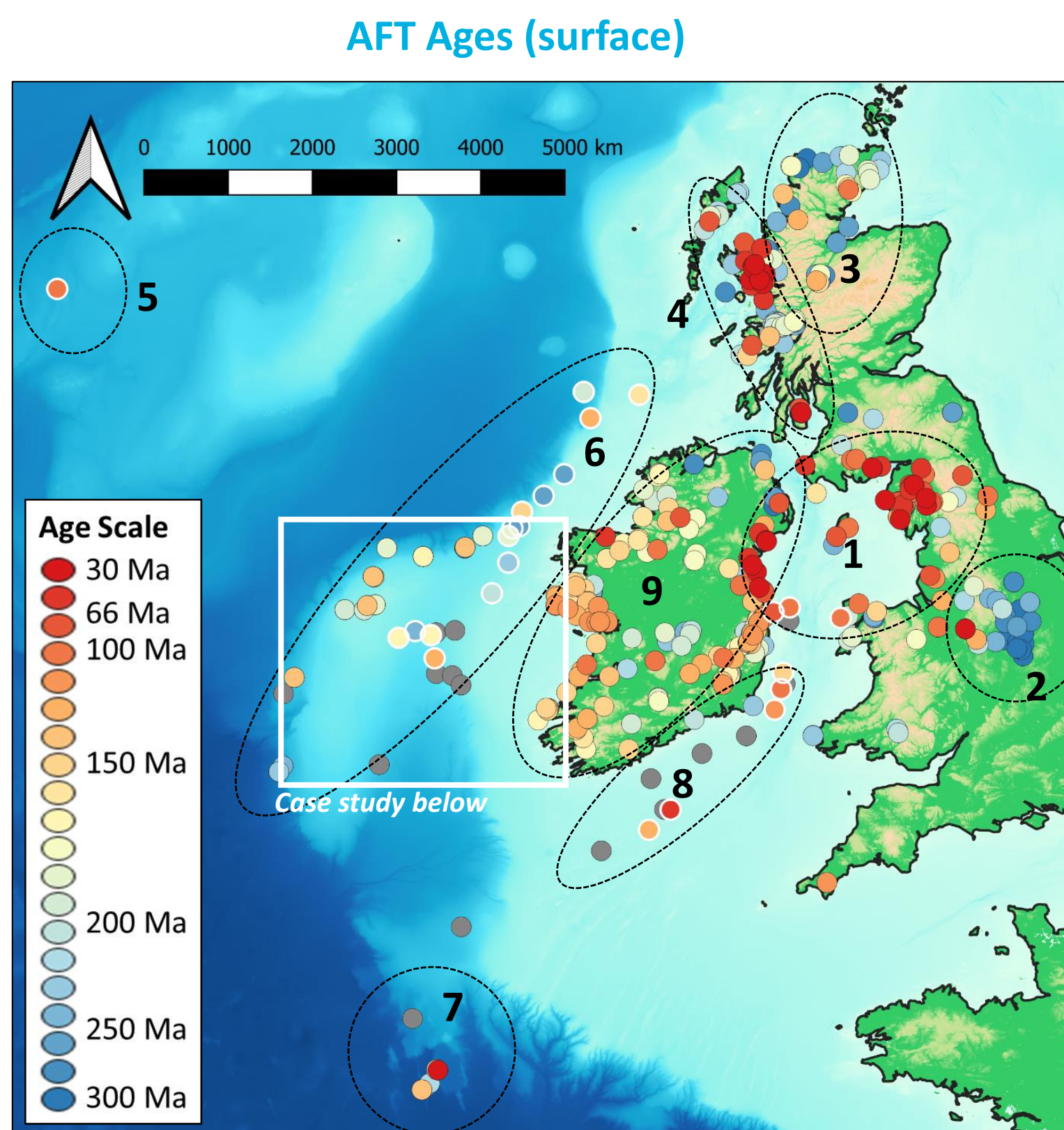
- 26 AHe ages

AFT age range (surface only):

- 28 Ma to 546 Ma

AHe age range (surface only):

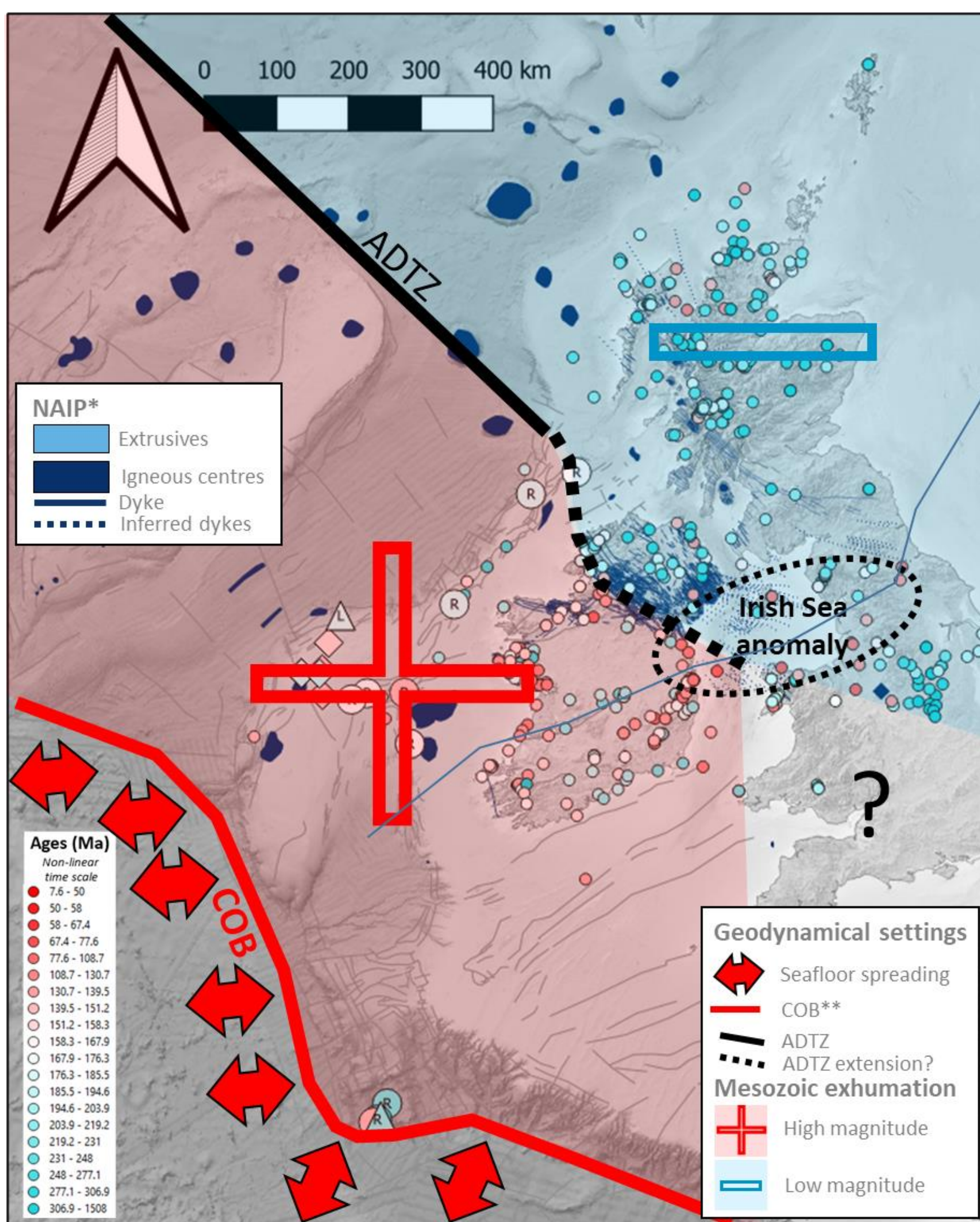
- 14.6 Ma to 459 Ma



- 1 **Irish Sea and bordering highs** (Lake District and eastern Ireland): Long-debated and still mysterious Irish Sea thermal anomaly. Small-scale variability showing that the cause of the thermal anomaly had complex short-wavelength thermal effects
- 2 **English Midlands**: stable craton with old AFT ages (young age is from an intrusion from the Lower Tertiary dyke swarm)
- 3 **Scottish Highlands**: First AFT ages published in the Irish British Isles (Hurford, 1977). Mixed ages showing a complex pattern of denudation. Old helium ages demonstrating limited amount of burial of summits and highs.
- 4 **Hebrides Tertiary Igneous Province**: all young AFT and AHe ages are related to the emplacement of the igneous centres rather than burial. Some old FT ages spread around the igneous centres (so the Irish Sea anomalous area does not extend to the Hebrides region)
- 5 **Hatton Basin**: Oldest AFT study offshore West of Ireland (1983 DSDP borehole). Upper Cretaceous ages from some Eocene sands.
- 6 **Porcupine High, Basin and offshore NW Ireland**: Main focus of this project. Mixed age signal showing a yet poorly constrained denudation history.
- 7 **Goban Spur**: AFT and AHe data from dredge and dive samples showing Mesozoic exhumation. Presence of an anomalous basement sample with Eocene AFT and AHe ages (probably ice-rafted from the Hebrides?)
- 8 **Celtic Sea**: AFT showing important Paleocene erosion linked to compressional structures
- 9 **Onshore Ireland**: Dominated by Mesozoic ages, complex denudational fingerprint. Older ages in Antrim.

1) Decoupling at a transfer zone

Large-scale – 1,000s km

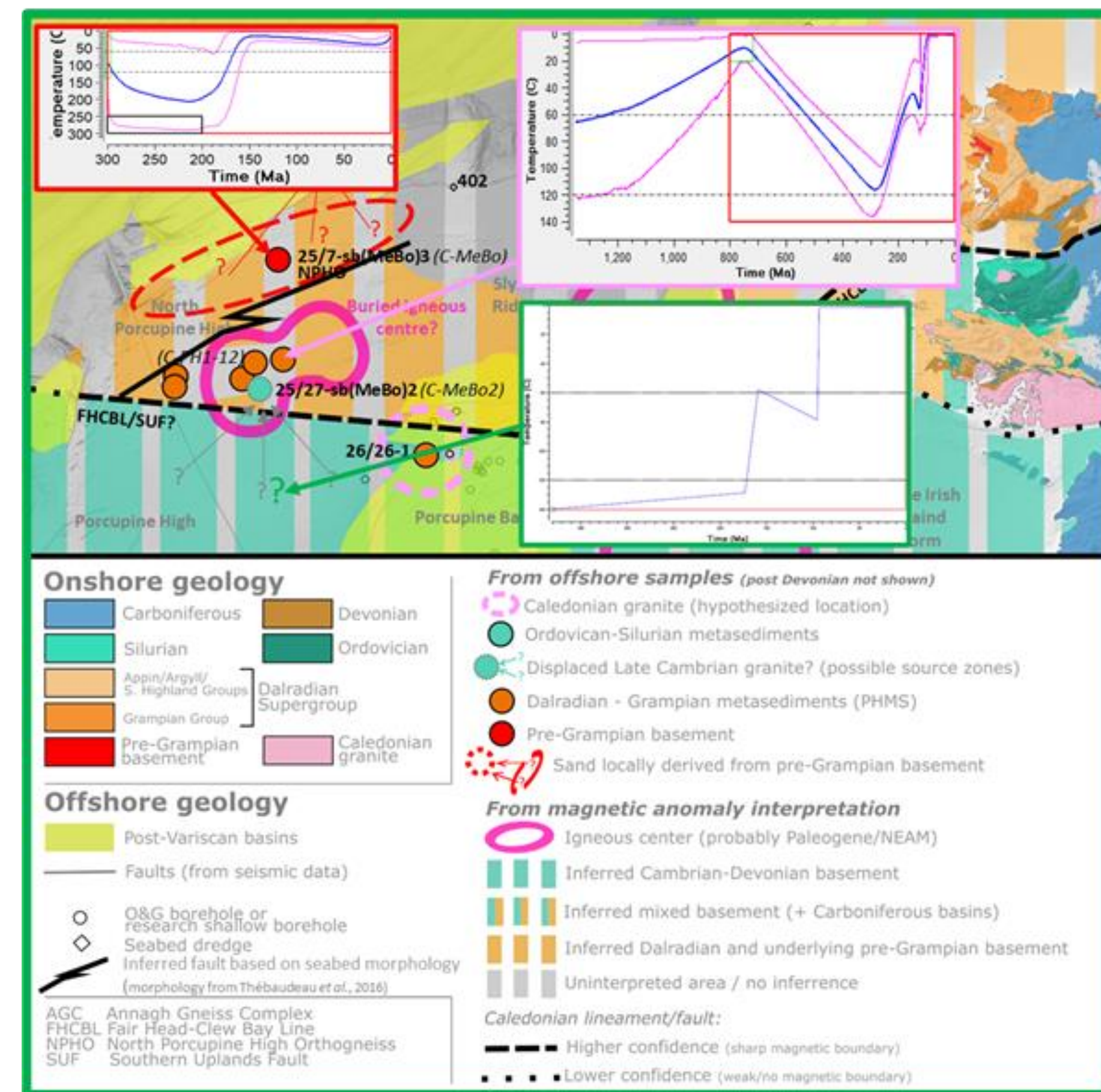
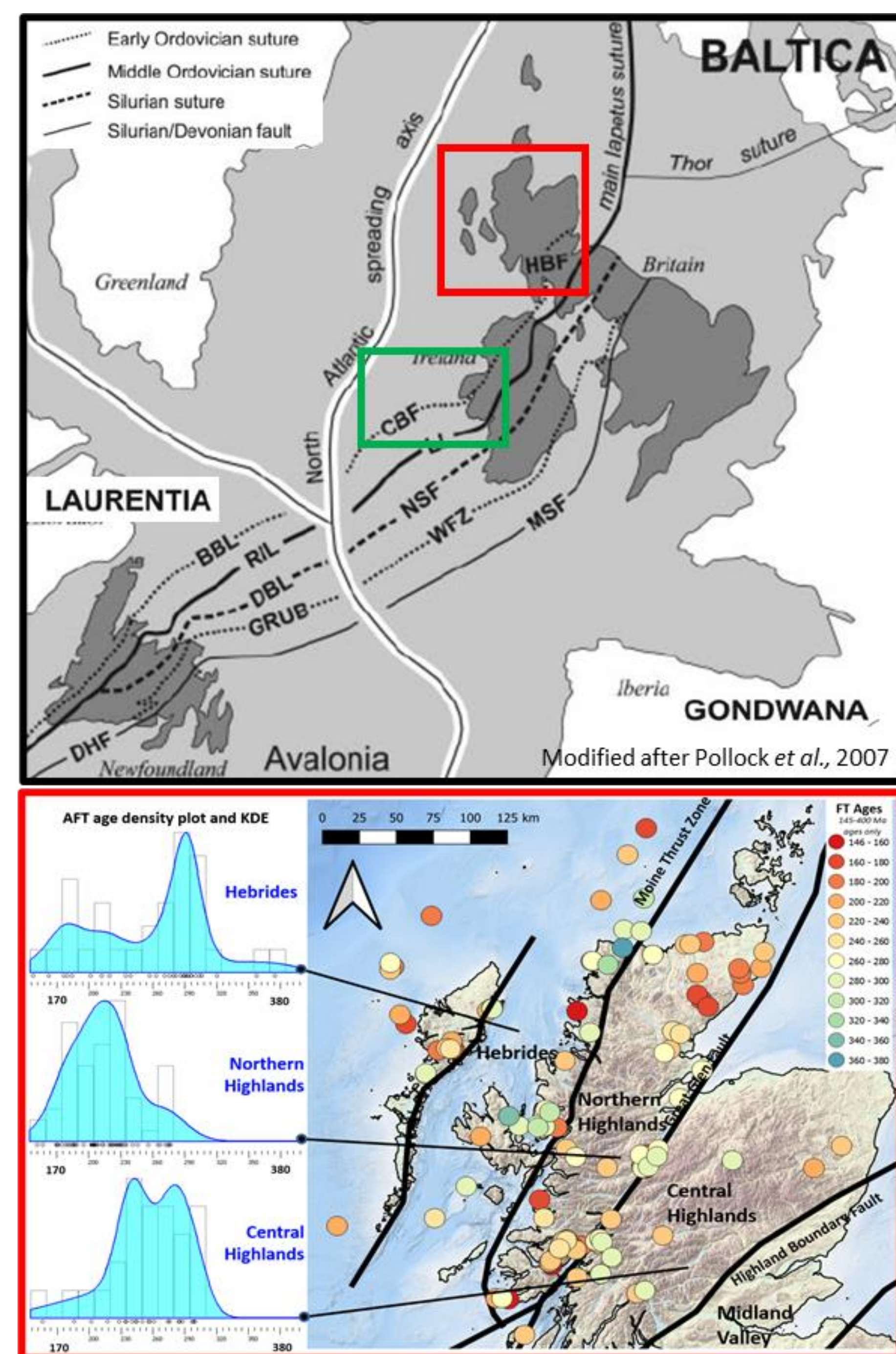


- After data filtering: older AFT ages in Scotland and Northern Ireland in comparison to Ireland.
- **Discrete** rather than gradual boundary. Spatial correlation with 1) a possible extension of the offshore **Anton Dohrn Transfer Zone (ADTZ)** to the NW; 2) the southern edge of the locus of the **Paleogene igneous dyke swarm**.
- **Hypothesis**: The Anton Dohrn transfer zone extends onshore to the SE and acted as a zone of weakness during Mesozoic rifting = greater amount of exhumation to the SW than to the NE.

- **Caledonian faults** = orogenic regional-scale faults, correlated to faults in NE Canada.
- Caledonian faults delineate **tectonic blocks** and **basement terranes**.
- **Younger** AFT ages in the **Northern Highlands** terrane vs **older** ages in the surrounding **Central Highlands** and **Hebrides** terranes.
- **Hypothesis**: Difference in ages = Differential response to Mesozoic exhumation controlled by Caledonian faults
- Offshore Ireland, on the **North Porcupine High**, dredge and cored basement samples revealed thermal histories with significantly different timings of the main Mesozoic exhumation event.
- **Major Caledonian faults** in the area based on magnetic anomaly and basement samples
- **Hypothesis**: Discrepancies in age of main phase of exhumation due to differential exhumation across inferred Caledonian faults (similar to Northern Scotland example).

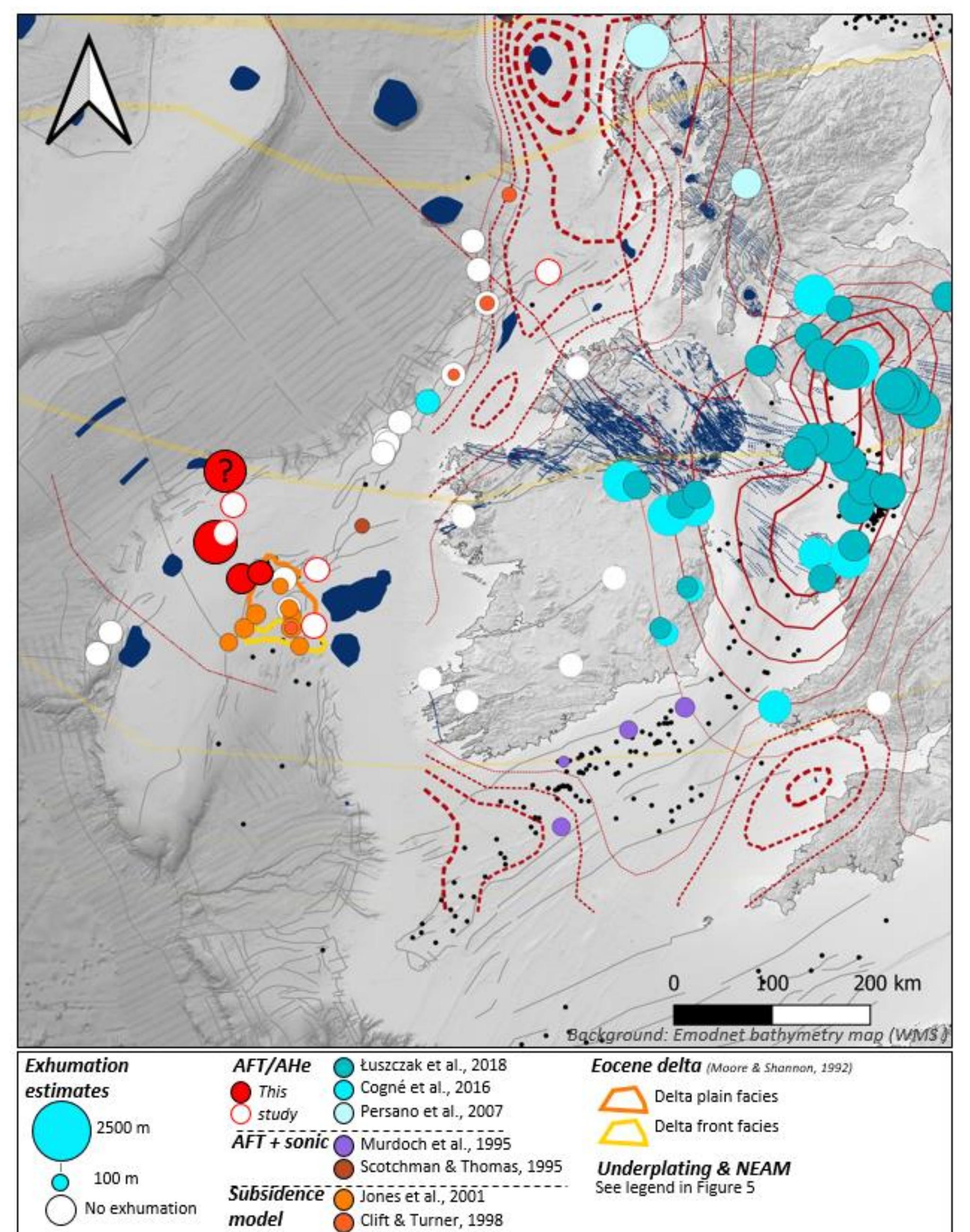
2) Decoupling at orogenic lineaments

Medium-scale – 100s km



3) Igneous underplating

Medium-scale – 100s kmv



- **Greater Irish Sea Anomaly**, GISA = Anomalously young (Paleogene) AFT ages in and around the central Irish Sea. Main focus of thermochronological studies in the British-Irish Isles over the last few decades.
- Recent studies: correlated exhumation to the presence of a high velocity body at the base of the crust, interpreted as **igneous underplating** (emplaced during the Paleogene and derived from the Icelandic plume).
- Igneous underplating can lead to significant localized exhumation due to isostatic compensation and subsequent erosion-led isostatic compensation.
- **New studies offshore Ireland: No Paleogene exhumation** despite the presence of a thick high-velocity body at the base of the crust such as in the **Donegal Basin** and further north in the **Outer Hebrides**.
- The absence of significant exhumation despite the presence of these bodies reveal the **non-systematic exhumation response to igneous underplating** and therefore the large uncertainty present when using them as a prediction tool for exhumation.

Conclusions

- Compilation of a large AFT/AHe database for the British-Irish Isles and offshore shelves + new offshore AFT/AHe ages.
- The database reveal for the first time the control of certain crustal structures (transfer zone and orogenic faults) on the Mesozoic exhumation of the area.
- The Anton Dohrn Transfer Zone might extends onshore to the SE and might have acted as a zone of decoupling during Mesozoic exhumation, with the zone to the SW being more uplifted than the zone to the NE.
- Caledonian faults delineate tectonic blocks that seem to have responded differently to Mesozoic exhumation.
- The previously discovered mechanism of igneous underplating is shown to be ambiguous as it does explain the Greater Irish Sea Anomaly but is in contradiction with the old AFT ages found in the Donegal Basin and Outer Hebrides.
- Th

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- PAD for the use of the seismic and well data