TRINITY COLLEGE DUBLIN

Modelling the thermal structure of Ireland, its offshore basins and Britain

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1 Aim of the study

Our knowledge of the thermal structure of Ireland is still very little understood. The Cenozoic exhumation is important for understanding the geological outcrop pattern, has implications for intra-plate exhumation studies and the distribution of hydrocarbon resources.

Therefore, the aim of this study is to:

- Investigate the timing and causes of Cenozoic exhumation in Ireland and Britain by using low temperature thermochronology.
- Investigate the timing of basins inversion (offshore) with implications for petroleum companies.
- Produce a regional 3D model of the thermal structure of Ireland, Britain and its offshore basins.

2 State of the art

Recent studies have suggested two competing hypothesis for exhumation in Ireland and Britain:

1. Palaeocene (65.5 - 55.8 Ma) exhumation due to crustal magmatic underplating associated with the proto-Iceland mantle plume (White and Lovell, 1997; Persano et al., 2007).
2. Far-field plate boundary stresses produced by Alpine collision and the opening of the North Atlantic Ocean during late Palaeogene - Neogene (33.9 - 2.4 Ma) (Hillis et al, 2008).

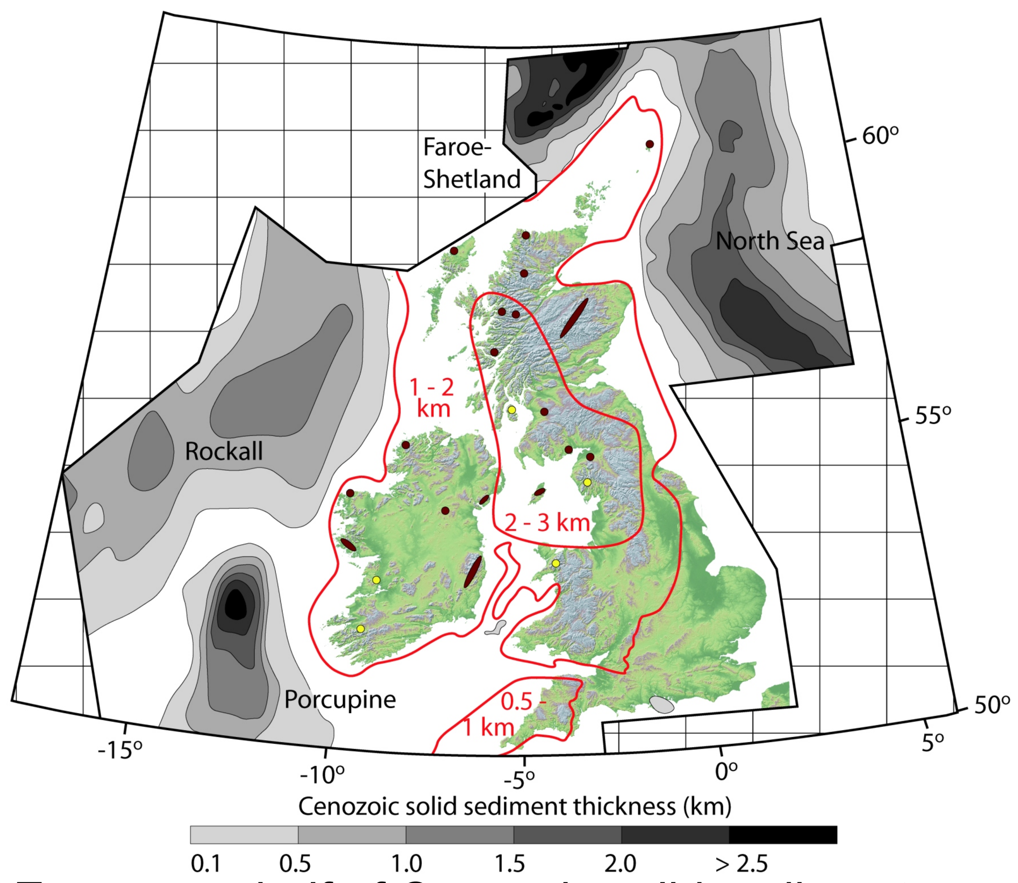


Figure 1. NW European shelf of Cenozoic solid sediment (adapted from Jones et al., 2002) and estimates of onshore Cenozoic denudation (adapted from White and Lovell, 1997). Red dots: existing samples Yellow dots: planned sampling areas.

3 Strategy

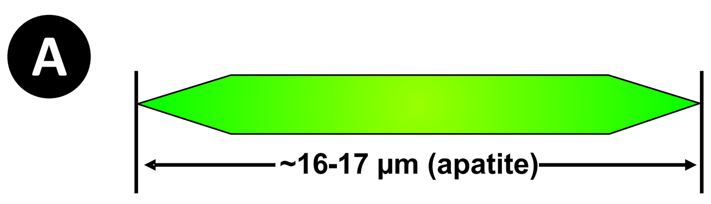
- Collecting suitable rocks for low temperature thermochronology (e.g. Granites) around Ireland and Britain (Scotland, Isle of Man and North England).
- Sampling vertical profiles and boreholes available for a as large as possible difference in elevation from the top sample to the bottom sample.
- Using low temperature thermochronology methods such as apatite fission track (AFT) and (U-Th-Sm)/He dating on apatite (AHe).
- AHe will be the first regional study in Ireland and will be undertaken in collaboration with Dr. Finaly Stuart (SUERC).

4 Low temperature thermochronology

In general thermochronology is a radiometric dating method which is dependent on temperature and time.

The annealing behavior of fission tracks in low chlorine apatite is dependent mainly on temperature (Fig. 2):

- Over 120°C: total annealing
- Zone between 60 - 120°C: partial annealing of tracks (PAZ). Tracks shrink in length (Fig. 2B).
- Under 60°C: tracks lenghts are not affected



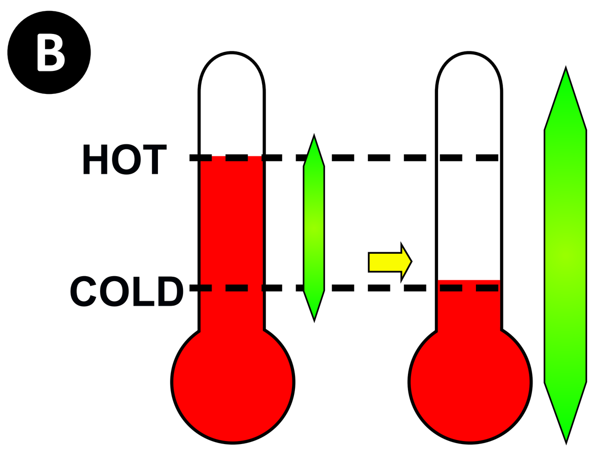


Figure 2. A: Initial length of a fission track in an apatite. B: Dependency of fission track length on temperature.

5 Track length distribution

AFT and AHe are useful for determining the cooling path of a sample due to their overlapping temperature zones. The track length distribution of AFT is particularly useful for modelling the cooling path (Fig. 3).

AFT has a temperature range between 60 - 120°C and AHe between 40 - 85°C (Helium partial retention zone: HePRZ).

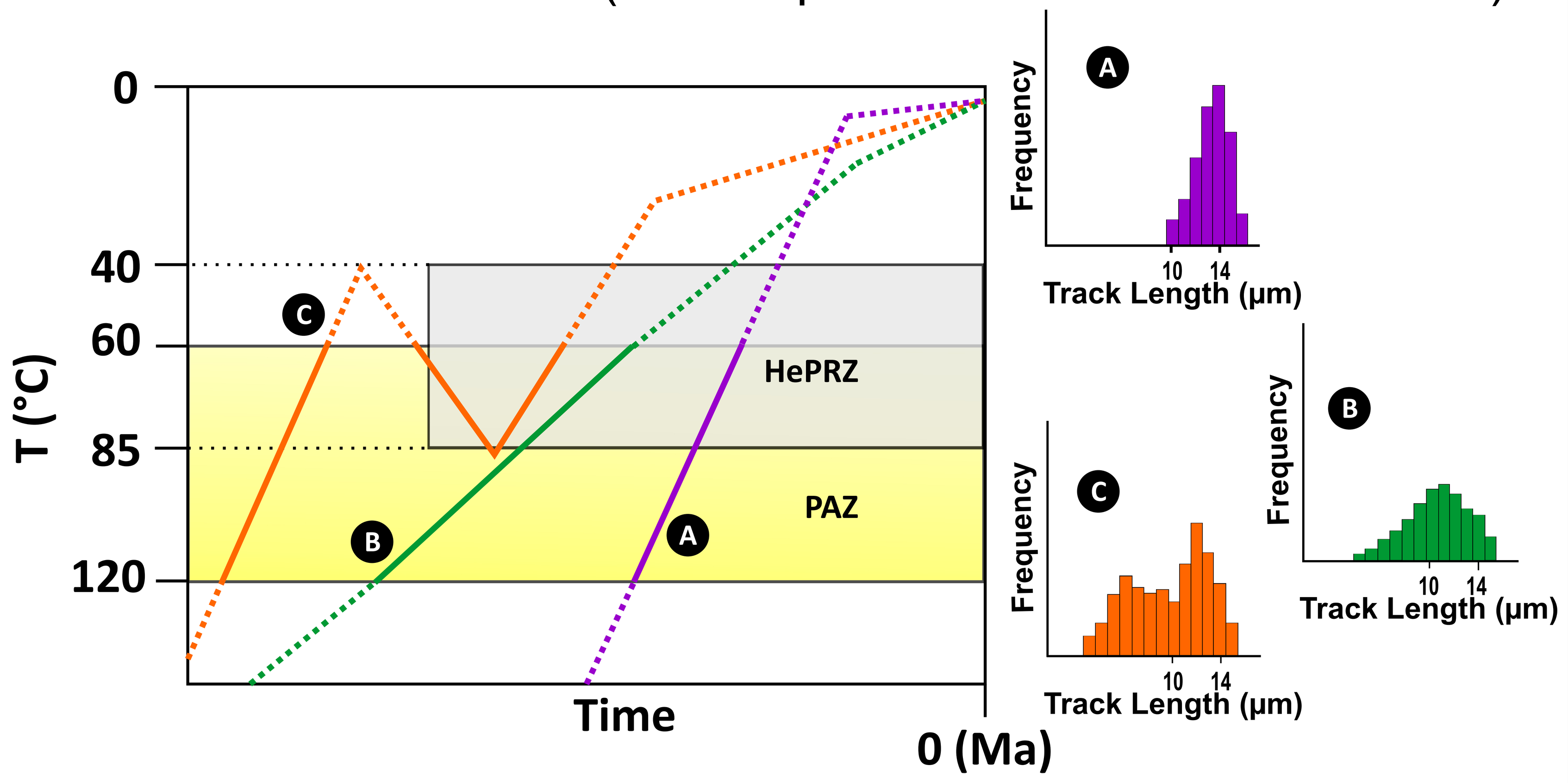


Figure 3. Track length distributions for three different cooling paths.
A: Long and narrow track length distribution indicating fast cooling. B: Wide distribution indicating slow cooling. C: Bimodal distribution indicating reheating.

6 Conclusion

- The aim is to determine the timing and causes of Cenozoic exhumation in Ireland and Britain by using low temperature thermochronology and producing a 3D model of the thermal structure.
- These data will be used to determine if uplift is related the development of the proto-Iceland mantle plume or with intra-plate compressional forces?

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