The thermal history of Western Ireland

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1. Introduction

Low-temperature thermochronological techniques have the advantage of yielding temporally controlled thermal history information. Despite past studies (e.g. Green et al., 2000; Allen et al., 2002) the post-Variscan exhumation history of the Irish onshore remains controversial. Consequently we present here a low-temperature thermochronological study that combines the apatite fission track (AFT) and (U+Th)/He dating (AHe) methods with a pseudo-vertical sampling (i.e. summit-to-valley sample transects) on selected targets along the western Irish coast (**Fig. 1**). One sample was also selected from the Ballydeenlea Late Cretaceous Chalk near Killarney (County Kerry) because of its key geological history. We are currently extending the study to the Porcupine High, a basement block offshore western Ireland.

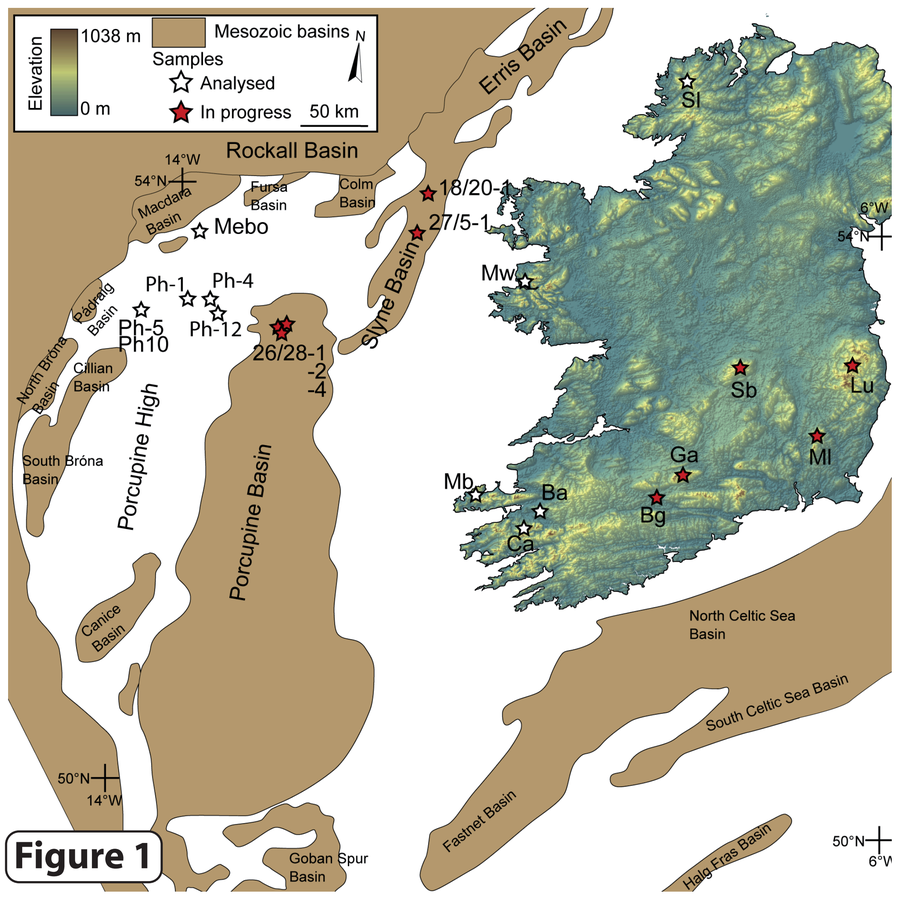


Figure 1

2. Thermochronological results

The AFT ages range from 131.8 ± 11.0 Ma to 200.1 ± 17.8 Ma (2σ). The mean track length (MTL) is similar in all profiles, ranging from 11.8 ± 0.19 µm to 12.9 ± 0.19 µm (1 SE) with a standard deviation of between 1.87 µm and 2.33 µm. A plot of AFT age vs MTL shows a slight decrease in MTL with increasing age, although this correlation is mainly due to the Slieve Snaght profile that yields older ages and lower MTLs compared to the other profiles (**Fig 2a**). Overall our data are in accordance with previously published results.
AHe ages range from 78.2 ± 7.8 Ma to 216.5 ± 21.6 Ma (1σ, uncorrected) and from 96.4 ± 9.6 Ma to 267.9 ± 26.8 Ma (1σ, FT-corrected). The AHe ages tend to be younger towards the bottom of each profile, but there is not a clear correlation between AHe age and elevation. As observed in the AFT ages, AHe ages are slightly younger in the south than in the north (**Fig. 2b**).
On the six offshore samples analysed so far, only 3 yielded enough good apatites to perform (U+Th)/He analysis. Both AFT and (U+Th)/He data are similar to the onshore ones with the exception of Mebo sample that exhibits a rather long MTL (**Fig. 2a**)

Figure 2a

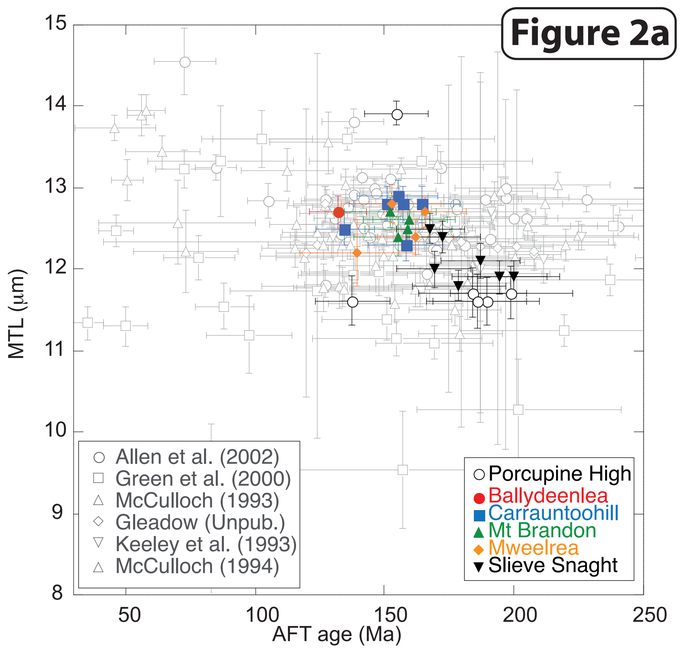
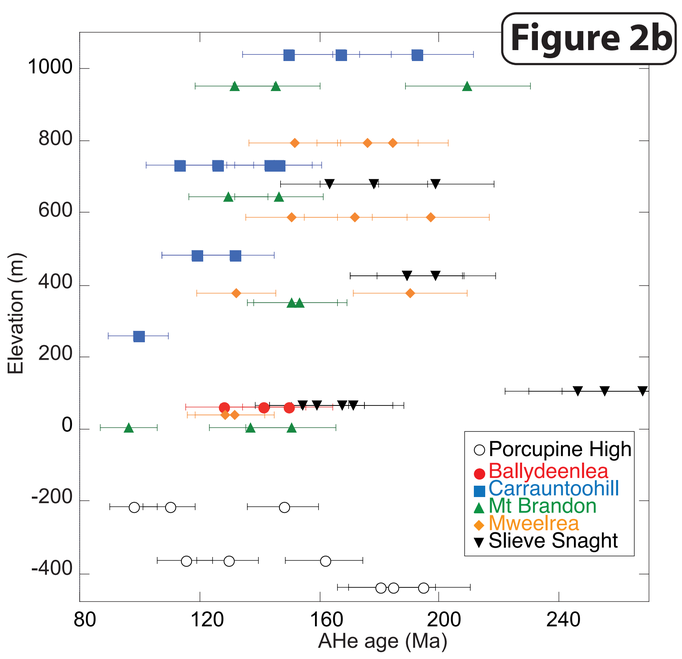


Figure 2b

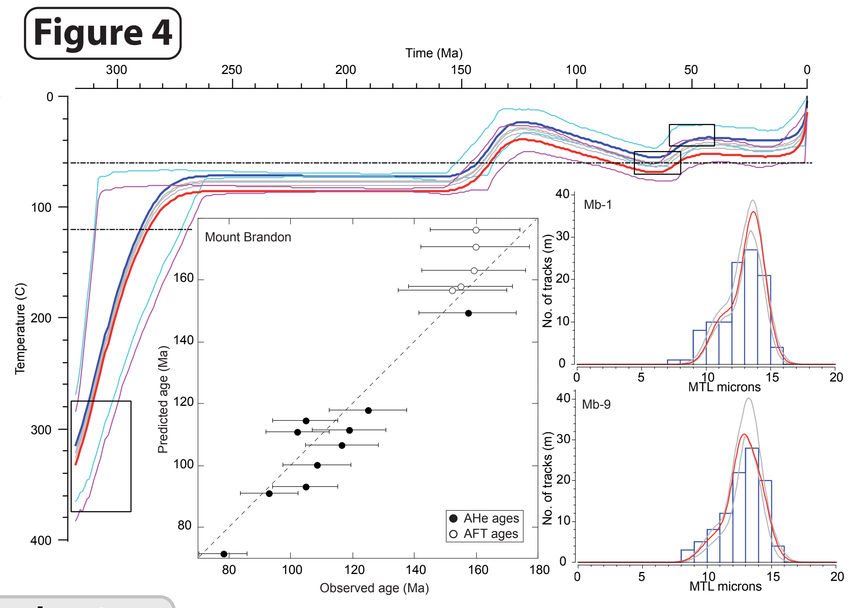


3. Interpretation

Inverse modelling of the AHe and AFT data from the pseudo-vertical profiles has been undertaken to extract thermal history information using the QTQt software (Gallagher, 2012). The expected model for each profile and samples are depicted in **Fig. 3**.
- Samples cooled rapidly into the PAZ following the early high temperature constraint, indicating rapid post-orogenic (Caledonian or Varican) exhumation.
- The most important post-Variscan phase of cooling occurred during the Mesozoic.
- It is diachronous along western Ireland.
- This cooling episode typically lasts for 25 to 30 Ma and the total amount of cooling is ~50°C.
- Because both the age and diachroneity of this cooling episode are very consistent with the rifting of the Atlantic margin of Ireland, we argue that the cooling is due to the uplift and subsequent erosion of the rift shoulder(s).
- The Late Cretaceous and Cenozoic evolution remains more uncertain as the thermochronological techniques are not sensitive at temperatures < 40°C.
- Sample profiles underwent reheating during the Late Cretaceous to Early Cenozoic, related to burial beneath ca. 1.5 km of sedimentary rocks. This is in agreement with vitrinite reflectance data from the Campanian Ballydeenlea Chalk. This cover was removed during the Cenozoic.
- Our dataset points to a final pulse of exhumation in Neogene times, probably related to compression of the margin and possibly enhanced by Pleistocene glacial erosion.
- It is possible that an Early Cenozoic exhumation event, compatible with our data (as infered with constrained tests, **Fig. 4**) but not seen in our thermal histories derived from the inverse models, accounts for part of the Cenozoic exhumation.

- Offshore (**Fig. 5**) samples with both AFT and (U+Th)/He data exhibit similar thermal histories than onshore.
- On a smaller geographical scale the same diachroneity for the Mesozoic cooling is observed.
- The Porcupine High did not seem to behave as a single continental block.
- The Post-Mesozoic cooling part of the model is underconstrained

Figure 4



4. Conclusion

Both the Western Irish onshore and Porcupine High show a similar evolution with a phase of important cooling during Mesozoic.
This cooling phase is probably related to uplift and erosion of rift shoulders.
The subsequent part of the history remains uncertain but importantly the present-day landscape of western Ireland is relatively recent and is not inherited from the Varsican orogenic belt or from Mesozoic rift-related topography.

5. Future work

This onshore study is now being complimented with samples from central Ireland to test the hypothesis of cooling related to rift flank uplift. Offshore, more samples from Porcupine High will be collected to better constrain the evolution of this basement block. Analyses from offshore boreholes in the Porcupine and Slyne basins are also underway.

6. Acknowledgements

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7. References

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Figure 3

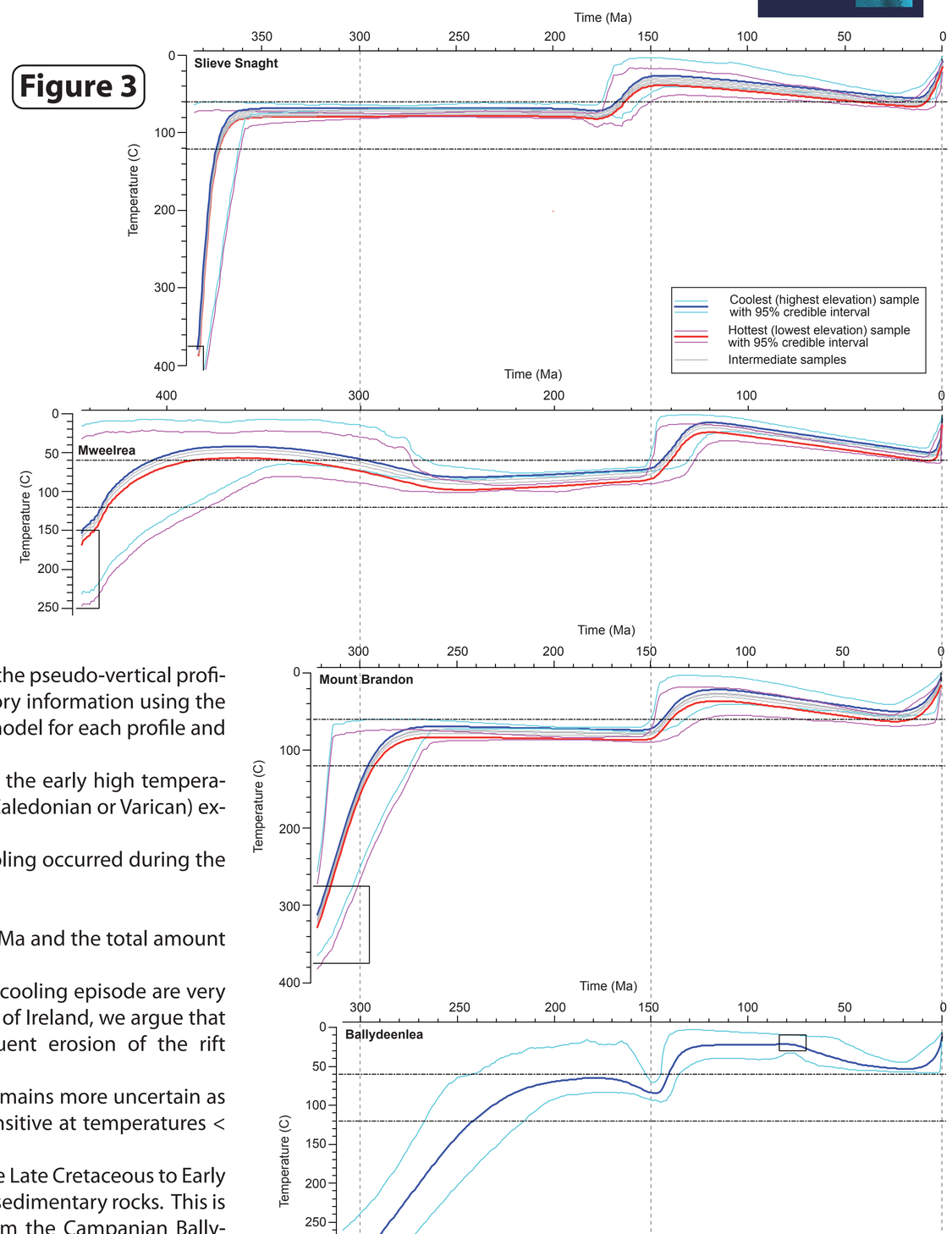

Figure 5