THERMAL HISTORY OF THE WESTERN IRISH ONSHORE

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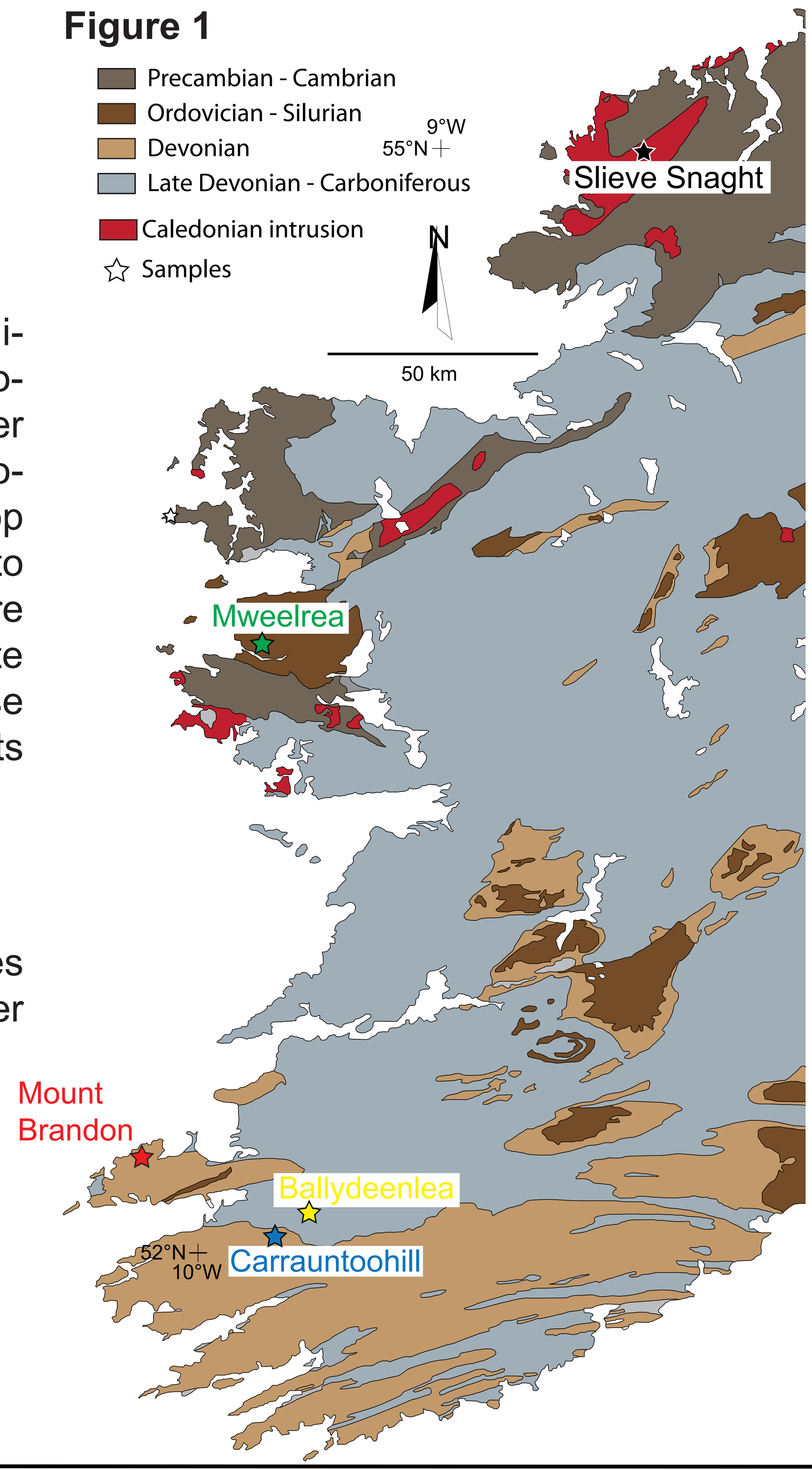
Introduction

The lack of post-Variscan sediments, outside of Northern Ireland, makes it difficult to assess the Mesozoic and Cenozoic geological evolution of onshore Ireland. Therefore offshore basins have been used to infer this evolution (e.g. Naylor, 1992). Thermal evolution of the landmass has also been deduced by extensive maturation studies of Carboniferous and Devonian rocks which cover a good part of the island (e.g. Clayton et al., 1989). These authors show that Paleozoic sediments have experienced several kilometres of post-deposition burial and, accordingly, have undergone kilometre-scale exhumation to reach their present day outcrop level. Combined with the filling of offshore basins, this results in the conventional view that the Irish landmass has been subject to erosion during the last 200 Ma or so. However, the precise dating of such exhumation cannot be inferred directly from the onshore part of the margin using these methods. In this passive margin context, low-temperature thermochronological techniques (apatite fission track [AFT] and apatite [U-Th]/He [AHe]) are useful to investigate periods of rapid cooling. Constraining the timing of these thermal pulses onshore improves our understanding of the evolution of the adjacent offshore basins. We present here the results of a thermochronological study on selected targets along the western coast of Ireland (Fig. 1).

Figure 1



Results

AHe and AFT ages range mostly from the Early Cretaceous to the Jurassic (Fig. 2 and 3). There is no correlation between ages and elevation (see Fig. 2 for AHe vs elevation). However, a plot of mean track length (MTL) vs the fission track ages (e.g. Gallagher and Brown, 1997) implies an important cooling event around 150 Ma (Fig. 3).

Figure 2

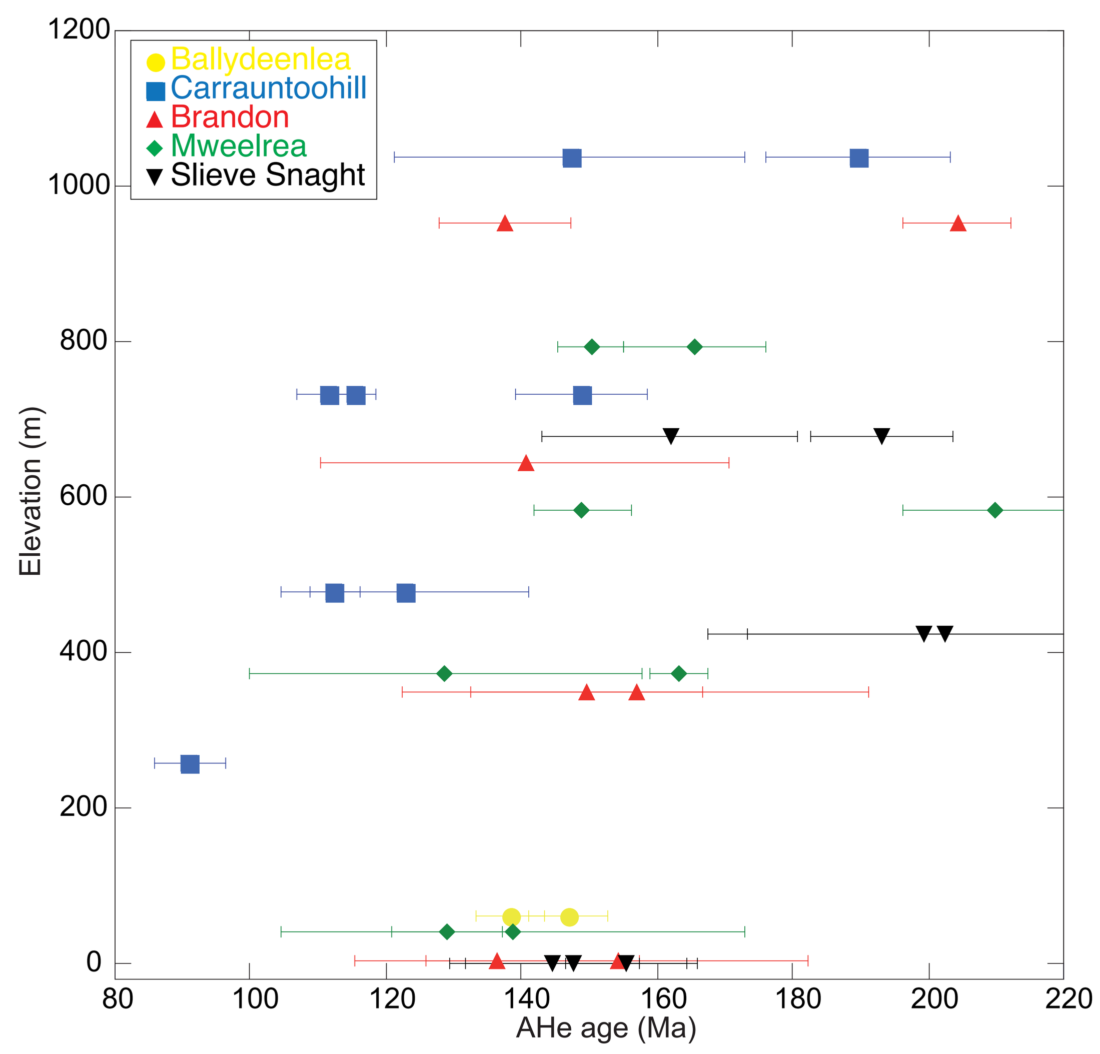
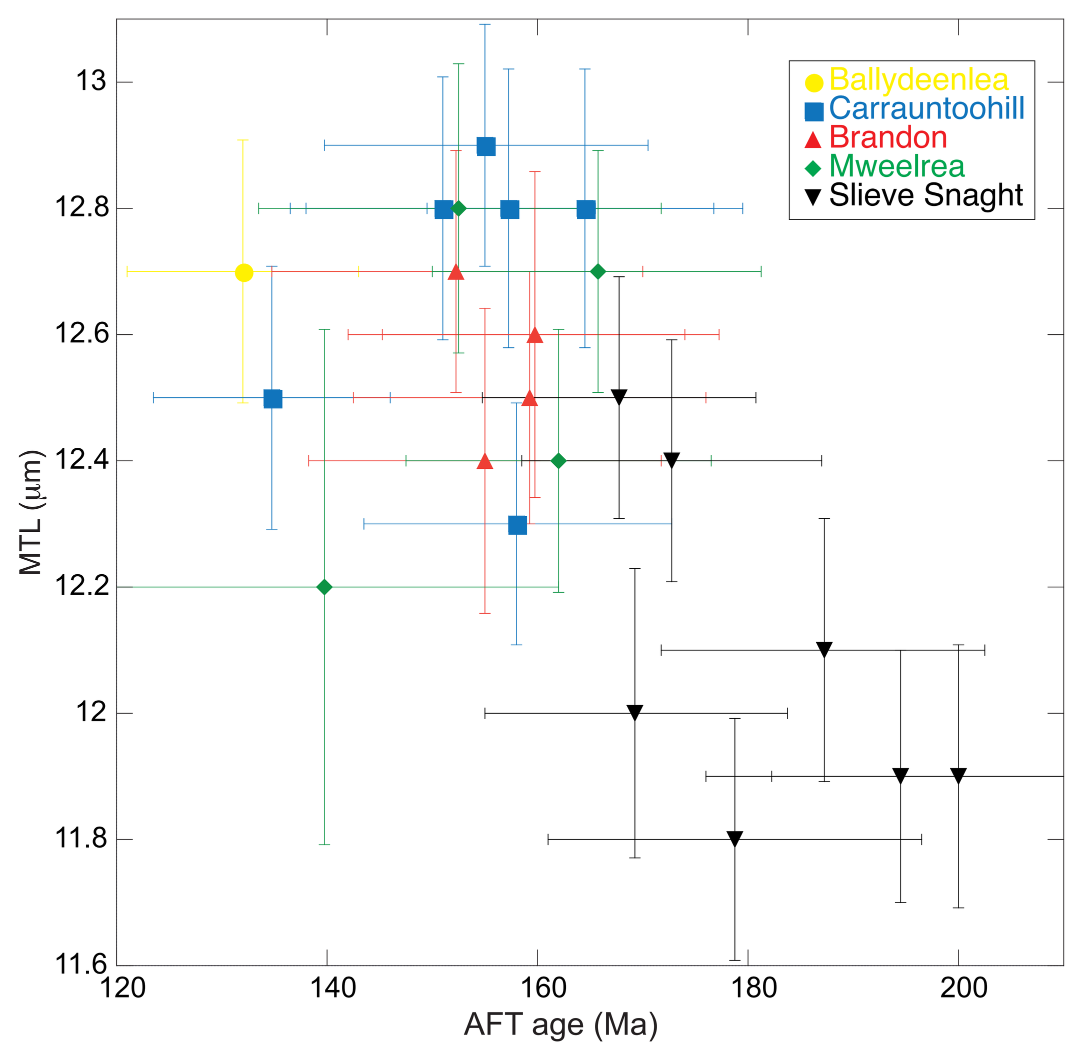


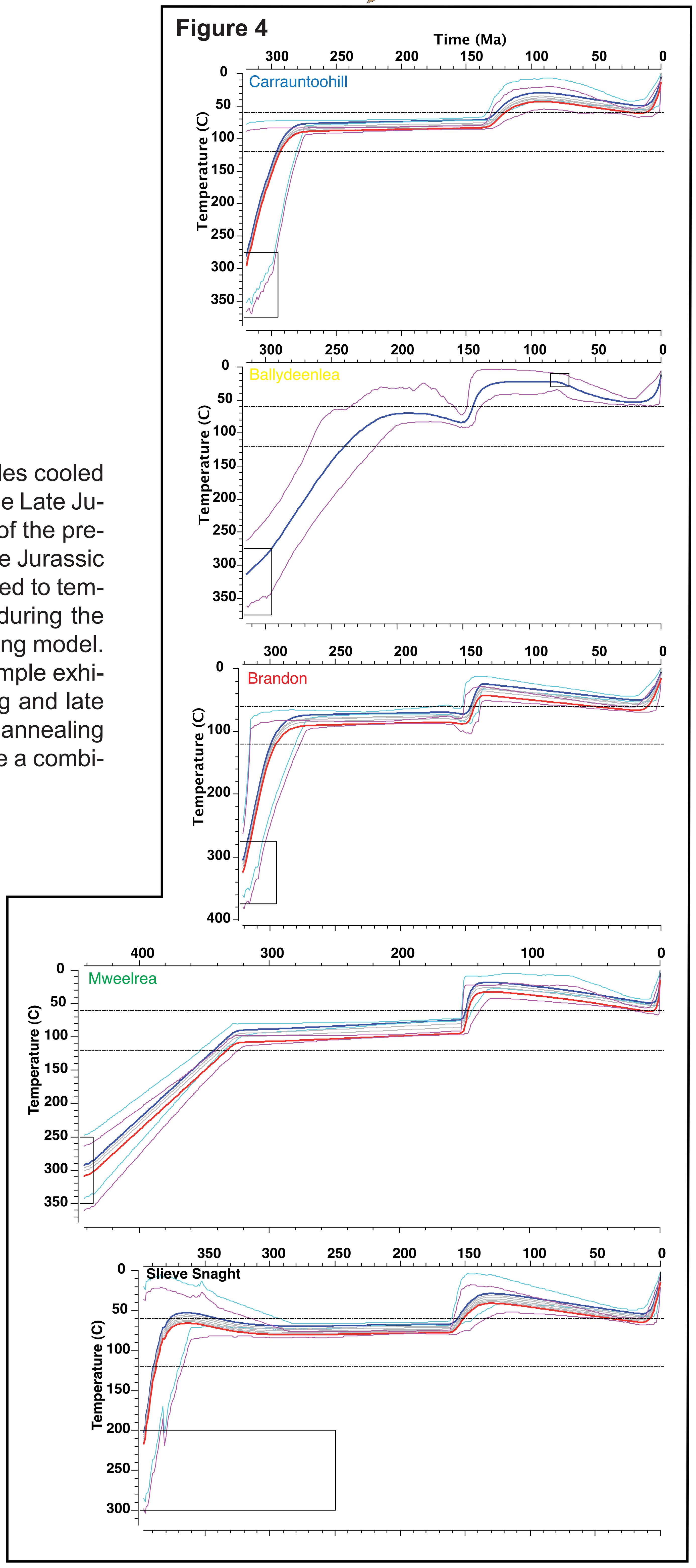
Figure 3



Interpretation

Inverse modelling of all the data for each profile is shown in Fig. 4. During post-Variscan exhumation the samples cooled to temperatures of around 80°C. A rapid cooling event (down to temperatures as low as 20°C) occurred during the Late Jurassic to Early Cretaceous and this event is attributed to rift-related exhumation. This demonstrates that much of the present-day topography in Western Ireland developed due to rift-shoulder uplift linked to the main phase of Mid-Late Jurassic extension in the Western Irish offshore basins. During the Cretaceous and Early Tertiary slow reheating is inferred to temperatures of about 50-60°C, and is probably linked to sedimentation onshore. Finally, a rapid cooling event during the Neogene is observed. This late stage of cooling is well known to be a typical artefact of the fission track annealing model. Therefore it is hard to decipher if this cooling is a true feature of the Irish margin. However, the Ballydeenlea sample exhibits vitrinite reflectance of 0.5% (Evans and Clayton, 1998) which is in agreement with our modelled reheating and late cooling. Forward modelling tests without such reheating/cooling episode have been undertaken, but as the annealing model used is still the same, these tests remain inconclusive. This late cooling starts around 20 Ma and could be a combination of inversion under compressive stress (e.g. Hillis et al., 2008) and glacial erosion.

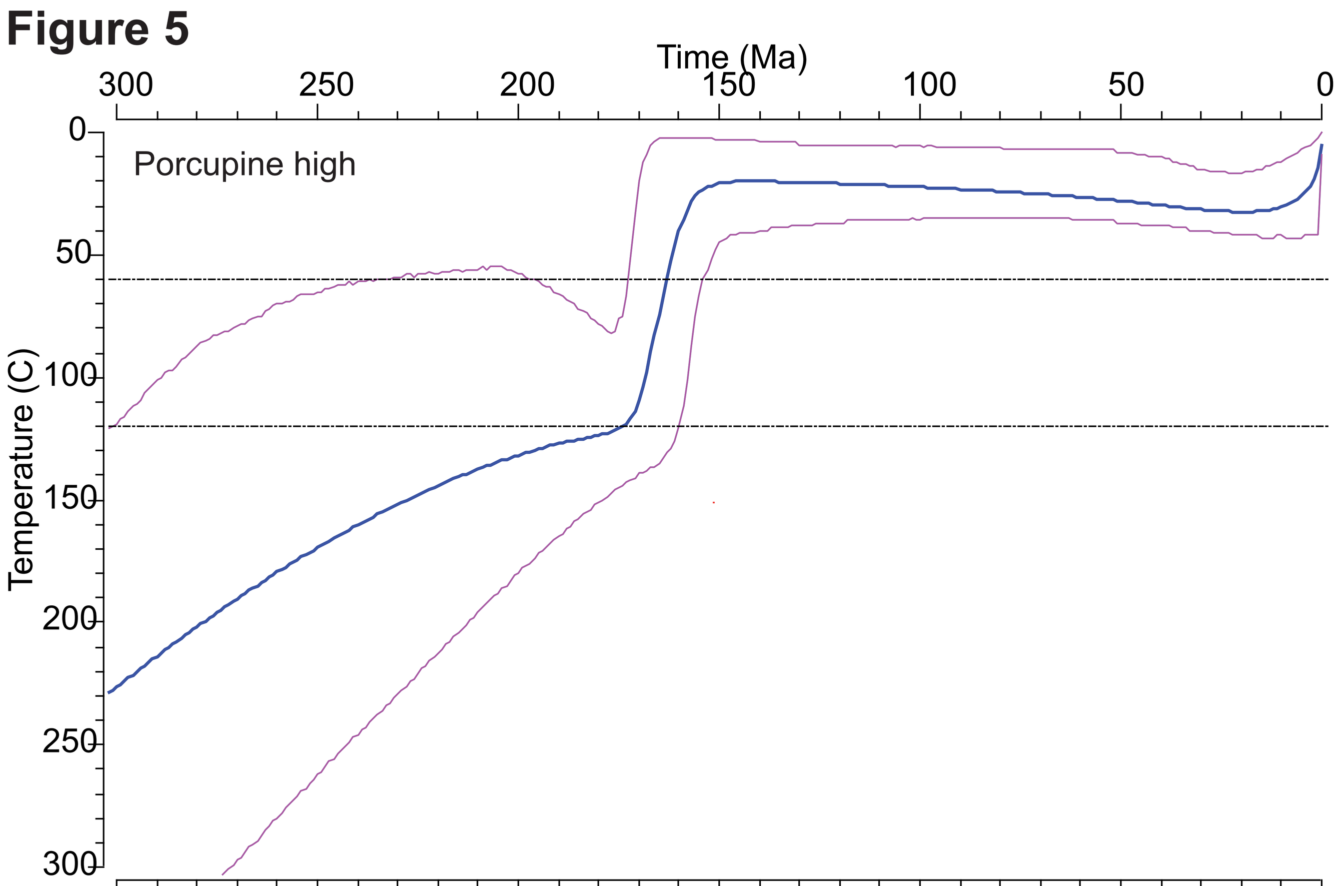
Figure 4



Conclusion

After the Variscan exhumation, the main cooling episode is related to the rifting of the Atlantic Ocean. We do not infer any important vertical movement during Late Cretaceous and Paleogene, excluding therefore important reactivation phases onshore. The only possible important reactivation could be during the Neogene, linked to the main building phase of the Alpine compression and also to Quaternary glaciation.

Figure 5



Future work

This onshore study is now being augmented by a new thermochronological study on the Porcupine High and on the wells of the western offshore basins. The first results from the Porcupine High show a remarkable similarity with the onshore part of the margin (Fig. 5).

Acknowledgements

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