New insights into the timing and driving mechanisms of exhumation in the western UK basin system

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Elucidating the timing and driving mechanisms of exhumation episodes has fundamental implications for the understanding of the relationships between intra-plate deformation and events at plate margins. The western UK basin system consists of a number of structurally compartmentalized rift basins and half-graben which contain up to 12 km of Permo-Triassic, Jurassic, Cretaceous and Tertiary sediments deposited following alternating pulses of active extension and thermal subsidence. Although it is clear that these basins have experienced significant amounts of exhumation, most recent studies have focused solely on constraining the magnitude of section removed, rather than investigating the timing at which the exhumation occurred. It has generally been assumed that the exhumation occurred during the Late Cretaceous to Early Tertiary, as this coincides with both the development of the Icelandic mantle plume and the main phase of Alpine compressional deformation. However, interpretation of an extensive apatite fission track (AFT) and vitrinite reflectance (VR) dataset from across these basins has identified a number of spatially and temporally distinct palaeo-thermal episodes which reflect the contribution of both regional and localised uplift events during the Early Jurassic, Early Cretaceous and Late Tertiary, to the progressive exhumation of the western UK basin system.

The importance of Early Cretaceous exhumation across these basins is highlighted by AFT and VR data from wells across the East Irish Sea Basin (EISB), and from the Mochras borehole in the Cardigan Bay Basin. Integration of AFT and VR data from wells located near the western and southern margins of the EISB have allowed the definition of Early Cretaceous (~140 to 120 Ma) geothermal gradients, which appear to be related to heating following burial, with temperatures approximately 60ºC higher than present-day temperatures across the basin. This suggests that around 2 km of section may have been removed from parts of the EISB during the Early Cretaceous, although thermal history data from wells in the central and northern parts of this basin suggest that in these areas, Early Tertiary exhumation may have been equally important. New AFT and VR data from the Mochras borehole define a geothermal gradient of ~38ºC prior to exhumation in the Early Cretaceous which removed around 1 km of Jurassic section. As the effects of Early Cretaceous exhumation have also been recognised from across the Central Irish Sea Basin and southern England, it is clear that this represents a regional exhumation episode, and the driving mechanisms behind this event are probably related to Atlantic rifting. A futher pulse of regional exhumation occurred following Miocene basin inversion, although the magnitude of section removed during this event is harder to constrain. Meanwhile, analysis of a suite of apatite samples collected from outcrops across Snowdonia and the Harlech Dome, North Wales has identified a previously unreported Triassic-Early Jurassic cooling episode. Samples began to cool from palaeotemperatures >110ºC between 230 to 185 Ma, and as this cooling is coeval with fault-controlled subsidence in the adjacent Cardigan Bay Basin, it is interpreted as representing localised exhumation resulting from footwall uplift.