LECTURE

A new look at the geological map of southern Britain

Summary of lecture presented to the Society on Saturday 12th April 2003 by Dr John CW Cope of Cardiff University.

Post-Cretaceous movements that affected the British Isles are generally summarised as the Alpine folding that produced E-W trending folds in southern England. However, perusal of the '10 mile' Geological Survey map of southern Britain shows that there is a preponderance of older rocks in the north and west and younger ones in the south and east. A line drawn from Anglesey to London crosses formations of every geological system from the late Precambrian through to the Palaeogene, in close order of succession and only lacking the Permian. This means that effectively there is a south-easterly regional dip for southern Britain.

Studies of the rocks of northern and western parts of southern Britain, using techniques such as apatite fission track analysis, have indicated various thicknesses of lost cover, but the more recent figures suggest that the most deeply eroded areas have lost in excess of 2000 m of cover since the Late Cretaceous. By taking an area that has purportedly lost such a cover thickness (such as the Cheshire Basin) it is possible to reconstruct a stratigraphy that can explain this lost thickness. As the Cheshire Basin was a major Triassic depositional centre, it is likely that, in the context of British regional geology, it also once had a thick Jurassic cover. The Prees outlier, in the southern part of the basin, preserves a thick basinal facies of the lower and middle parts of the Lias Group, so it is not too difficult to imagine an original succession there comprising perhaps 1600 m of Jurassic rocks and 400 m of Cretaceous rocks.

If areas in the north-west have lost up to 2000 m of cover, what about areas farther south and east? The Rugby area lies on the Triassic-Jurassic boundary and must have lost the thickness of Jurassic and Cretaceous rocks that lie to its south-east. Simple extrapolation reveals that this amounts to some 800-900 m, whereas the Chiltern Hills that have outliers of Palaeocene rocks on them, can hardly have lost any cover (Cope 1994). It is thus possible to build up a 'contour' picture of southern Britain by comparing amounts of cover lost; these contours parallel in a remarkable way the outcrop patterns of the Mesozoic formations in southern and eastern England (Figure 1). The area with the greatest loss is in the Irish Sea and may be locally over 2500 m. The uplift was caused by igneous activity that can be dated to the earliest part of the Palaeogene and may well be related to an early phase of dyke activity, dated in the East Irish Sea Basin to 65·5-63.0 Ma. It is likely that such activity caused underplating of the crust and initiated a series of episodes of uplift and erosion that lasted perhaps

30 Ma. If the uplift totalled some 2000 m in the Cheshire Basin fading to zero on the Chiltern Hills, a simple trigonometrical calculation shows that the regional south-easterly dip imparted by such an event is of the order of 50 minutes of a degree. This is too small a figure to feature on a geological map, but enough to produce the result we see.

Other evidence for this uplift and erosion in the north-west is provided by a study of the gravity map of the area, which shows a positive Bouguer anomaly over northern and western Britain, with its contours curved in a similar manner to those of the Mesozoic formations of south-eastern Britain. Over the eroded area Caledonian granites are well exposed and virtually all the outcrops of the Precambrian and Lower Palaeozoic rocks of England and Wales lie within this area too (Fig. 1). This significant period of uplift and erosion explains many of the geological anomalies of western Britain such as the almost total absence of the Chalk. Despite some of the highest sea-levels in the Phanerozoic there is no preserved Chalk in the whole of the Irish Sea, although there are considerable thicknesses of Jurassic rocks in the Cardigan Bay and Kish Bank basins. It now appears clear that the Chalk was once deposited over the whole of this area and has since been removed by erosion. It also explains why mature hydrocarbons occur at relatively shallow depth in the Eastern Irish Sea Basin; the area has lost some 2000 m of Jurassic and Cretaceous rocks (Cope 1998).

The material eroded from the uplifted area, amounting to some 200,000 km^3, would have been rapidly removed under the tropical regime of Palaeogene Britain. Erosional products were transported to the North Sea in the east, and across Ireland to the Porcupine Basin and other areas on the Atlantic margin of Ireland. Sediment would have been transported along major river systems that would have flowed radially outwards from a centre now in the Irish Sea, to the north of Anglesey. These would be the forerunners of today's drainage and it is remarkable that all the long rivers of southern Britain rise in the west and flow eastwards, while those of Ireland rise in the east and flow westwards; this is a direct result of their post-Cretaceous origins. The margins of the Irish Sea, including Cardigan Bay, and northwards to the Solway Firth have undergone later down-faulting that has produced short rivers that flow into the Irish Sea on both the Anglo-Welsh and Irish sides; these have captured some of the flow from the principal drainage. Although the drainage has been modified by glaciation, its origins remain remarkably clear.

References

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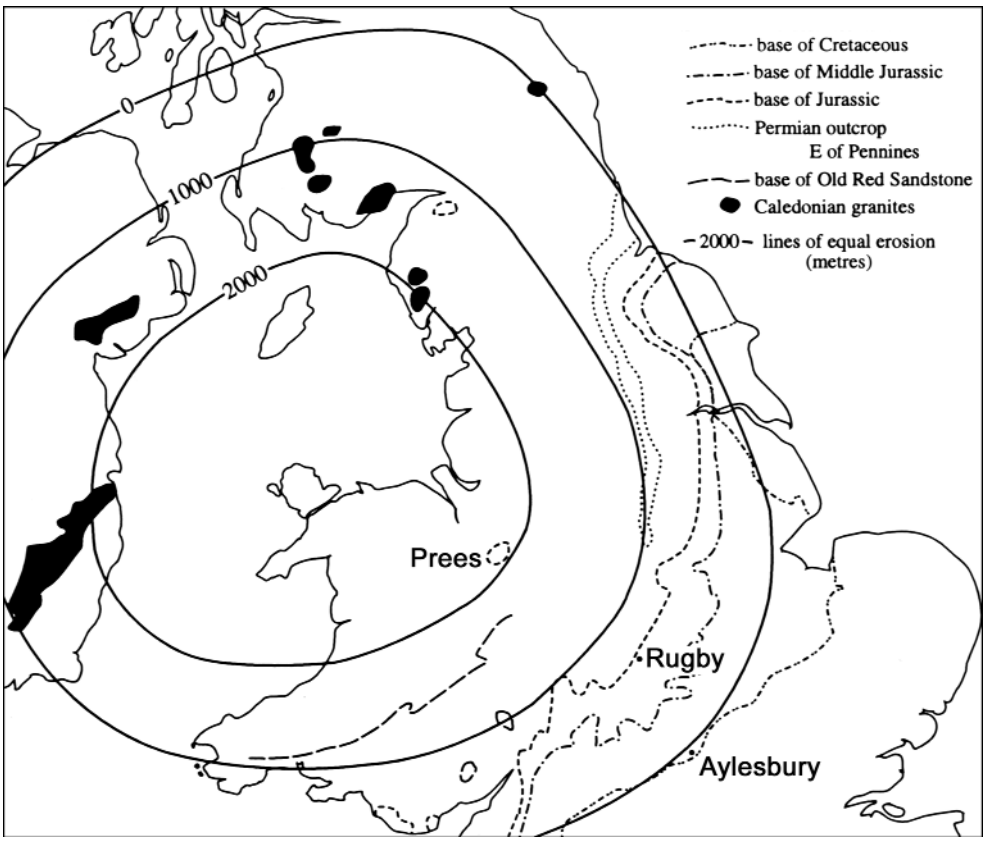

Figure 1. Possible extent and amount of the net erosion of the Irish Sea and surrounding areas. Note the marked parallelism with the formation boundaries, except in north Yorkshire where they curve around the pre-existing Cleveland Basin. All outcrops of Precambrian and Lower Palaeozoic rocks of England, Wales and eastern Ireland lie within the eroded area. Position of the contours over southern Scotland more conjectural since they have been affected by the later uplift of western Scotland. Reproduced by permission of the Geological Society of London.