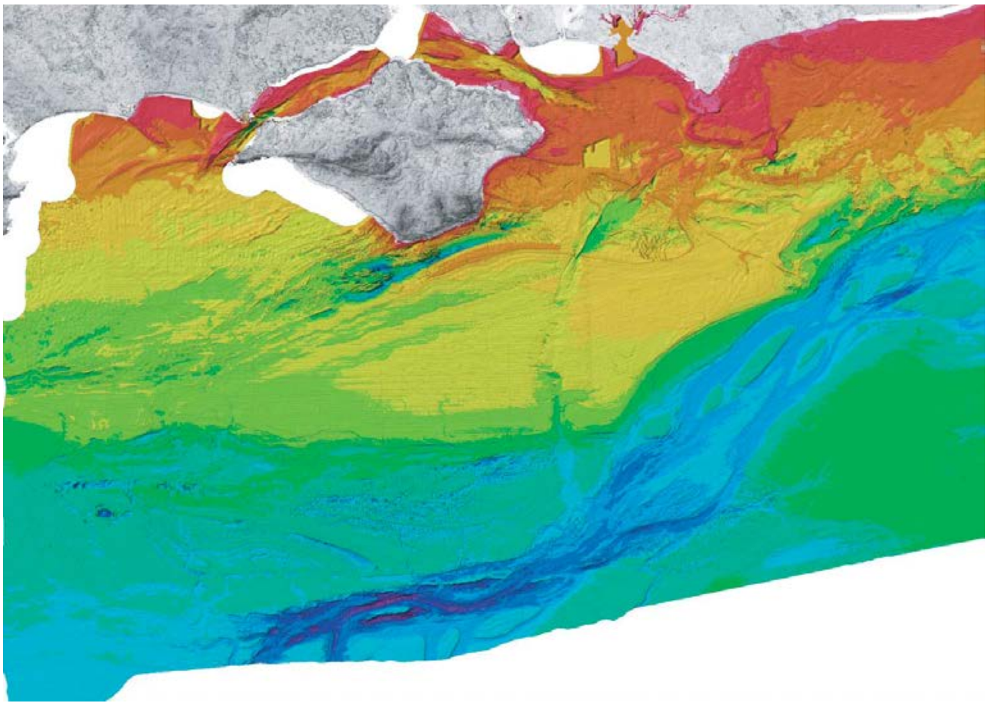
Geomorphology

When Britain first left Europe (*September 2007*)

The British Isles, in particular the east and southeast of England, are integral parts of Europe from a geologists standpoint. No major faults separate Suffolk, Essex and Kent from parts of the Netherlands, Belgium and France to the east, across the North Sea and the Channel. Indeed, it was possible to build the Channel Tunnel entirely through Chalk beneath the Channel with barely a change in stratigraphic level. So how did the British Isles come to be an Atlantic archipelago? For decades Pleistocene specialists have suspected that, during lowstands of sea level, the Rivers Thames, Rhine and Seine formed the headwaters of a huge river system that flowed down the axis of the Channel to the longitude of Land's End. That formed a broad valley, but one unlikely to have created the definitive breach now followed through one of the world's busiest shipping lanes. That would be because appropriately huge amounts of sediment would continually have filled floodplains developed at different sea levels. Indeed, offshore geophysical surveys have mapped out a complex braided pattern of large, sediment-filled channels. Somehow the sea's power had to become directed at the valley sides to increase the efficiency of both erosion and marine sediment transport. That it happened is witnessed by the towering Chalk cliffs that are a leitmotif of both sides of the Channel. Some significant flood event was proposed as an agent of rapid geomorphological change that allowed marine erosion to get a grip. Now there is strong evidence for such a catastrophic event, and how it might have occurred (Gupta, S. *et al*. 2007. Catastrophic flooding origin of shelf valley systems in the English Channel. *Nature*, v. **448**, p. 342-345; DOI: 10.1038/nature06018).



Bathymetry of English Channel south of the Isle of Wight: increasing depth shown by red to blue rainbow scale. Note clear evidence for massive scouring shown by braided channels on the seabed of the deepest part. (Credit: Gupta *et al 2007*; Fig. 2)

The deciding evidence emerged from detailed bathymetric maps produced from 1979 to 2003 by the UK Maritime and Coastguard Agency using precise sonar sounding. The paper's authors from Imperial College, London and the UK Hydrographic Office focussed on data south of the Isle of Wight that show exquisite detail of the sea floor topography. This includes clear palaeovalleys extending from modern river systems in southern England towards an axial valley system. It is in the second that the defining features of catastrophic floods appear. These are streamlined bedrock mesas on a kilometric scale, linear megascours and huge terraces, reminiscent of the Channelled Scablands of Washington State, USA, but on a larger scale. (The Scablands formed when a major lake dammed against the Laurentian ice sheet burst from its confines.) The lesser valleys entering the axial region from the north end hanging above the main channel. A variety of more 'conventional' riverine features are etched onto this extraordinary terrain. There is evidence for more than one ex-plosive flooding event, each of which seems to have emanated from the vicinity of the present Dover Strait (Pas de Calais). North of that a large lake might have formed by damming caused by combined Scandinavian and British ice and the resistant anticlinal ridge that once extended from the Weald to the Artois in Belgium and northern France. Once the ridge was breached by break-out of the lake's waters, later sea level rise would have connected the northern North Sea to the axial lowlands of the Channel. Then, both tidal scour and storm waves could further enhance the topographic gap to create a permanent seaway, dry only during glacial periods. The events probably took place between 450 and 180 ka, eventually to be expressed by the curious cultural differences between Europe and its new offshore islands.

See also: Gibbard, P. 2007. Europe cut adrift. *Nature*, v. **448**, p.259-260; DOI: 10.1038/448259a.

Deltas of the Arctic Ocean (*September 2007*)

From space river deltas present the most fascinating views of Earth. For the largest delta systems, on the scale of the Amazon and Ganges-Brahmaputra deltas, only a satellite view permits their analysis and understanding. No two large deltas are alike, and there must be physical reasons for this universal dissimilarity. A group from the University of Durham, UK (Whitehouse, P.L. *et al*. 2007. Glacial isostatic adjustment as a control on coastal processes: an example from the Siberian Arctic. *Geology*, v. **35**, p. 747-750; DOI: 10.1130/G23437A.1) have used mosaics of Landsat-7 images to make sense of delta development on the northern shores of Russian Federation.

Globally, the sea-level rises following the last glacial maximum have had a marked effect on the form of major deltas, together with increased weathering erosion and sediment transport as the world became wetter. Those at low latitudes have built on pre-existing deltas formed as the ocean surface stood some 130 m lower than it does today. Large rivers flowing to high northern latitudes have had a different history of delta formation, and this comes out in their forms. Whitehouse and colleagues focus on the very marked differences between the deltas of the largest Siberian rivers: the Ob', Yenisei and Lena. All three rival the flow of the Mississippi River but transport considerably lower volumes of sediment. While the Ob' and Yenesei have far smaller deltas at the heads of deep gulfs of the Arctic Ocean than they might seem to deserve, the Lena has a spectacular delta. Overall, the deltas of eastern Siberia, including that of the Lena, are proportionately bigger than those of western Siberia (the Ob' and Yenesei). The likely cause of the difference is variation in relative sea-level rise, according to the way the continental surface responded to melting of ice sheets following the last glacial maximum. While areas covered by thick ice are depressed during glaciation and rise isostatically following melting, areas just beyond the ice cover were bulged up by displaced asthenosphere, and tend to sink as the load disappears. The net result of sea-level rise and subsidence of peripheral bulges is that relative sea-level rise is greater over the bulges than elsewhere, but differs according to the loading and the distance of the coast from the ice cap. Western Siberia experienced a rise of 14 m more than in unglaciated regions and eastern Siberia had a rise of 6 m. The result is that the greater sea-level rise at the Ob' and Yenesei outflows has more than compensated for the supply of sediment, giving diminutive deltas. In the area of the Lena outflow sediment has been able to build up above stabilised sea level to give its spectacular delta. In detail, the crucial period for shaping these coastal features was from about 7 ka, when melting slowed appreciably. By 3 ka the Lena area ceased to have rising relative sea level, whereas it continued in western Siberia.