

# Basement structure and the terrane model of Northern Ireland

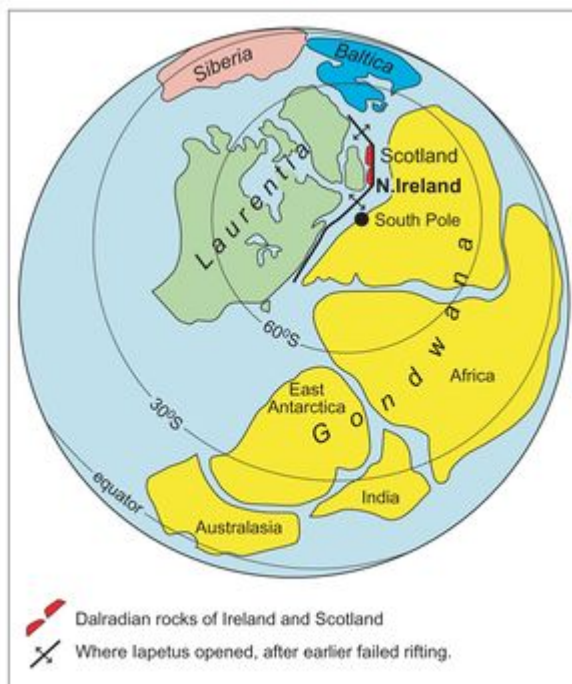
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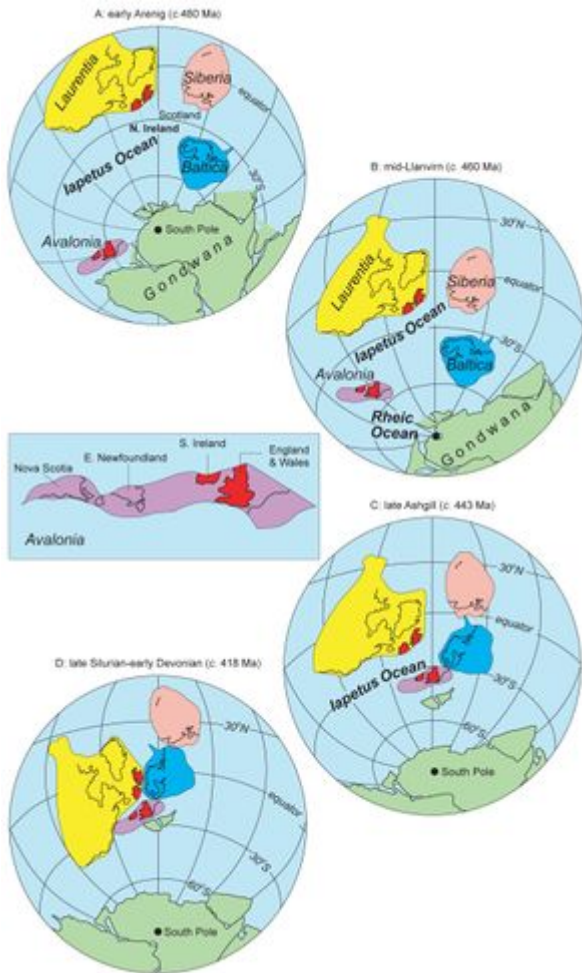
Mitchell, W I (ed.). 2004. [The geology of Northern Ireland-our natural foundation](#). Geological Survey of Northern Ireland, Belfast.

T B Anderson, T P Johnston and W I Mitchell

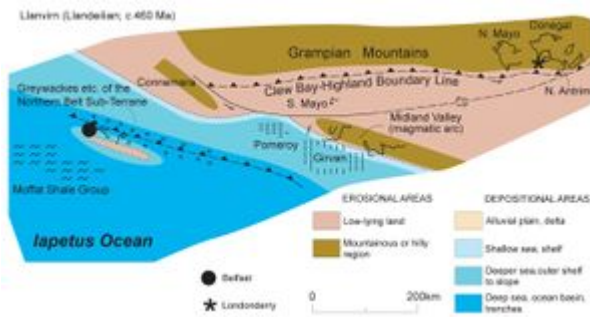
## Introduction



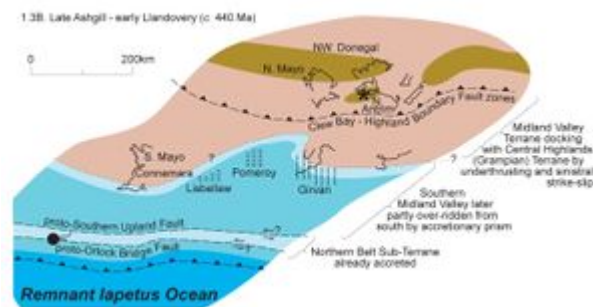
Distribution of the continents in Neoproterozoic times. (c. 600Ma). (P947783)



Distribution of the continents and terranes in Palaeozoic times (5). (Relative size of Ireland and Britain exaggerated). (P947784)

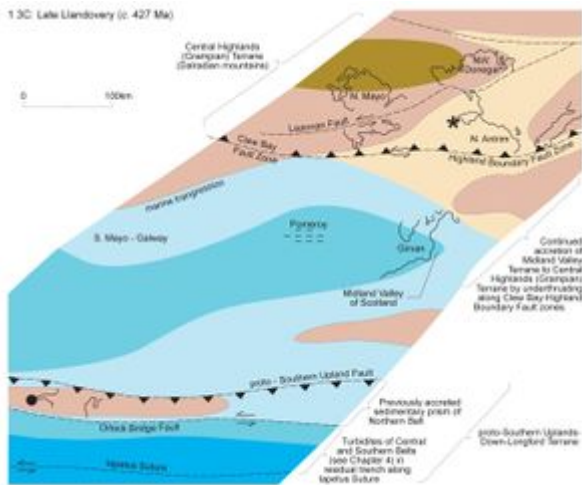


Palaeozoic palaeogeographical reconstruction of northern Ireland and Britain (15). Llanvirn (Llandeilian: c.460Ma) (P947785)

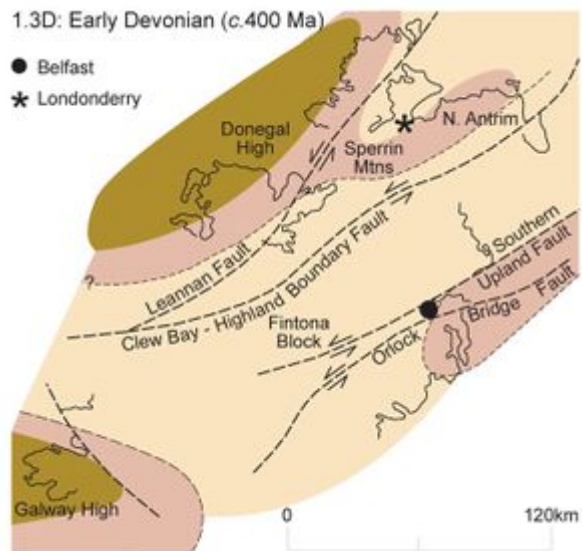


Palaeozoic palaeogeographical reconstruction of northern Ireland and

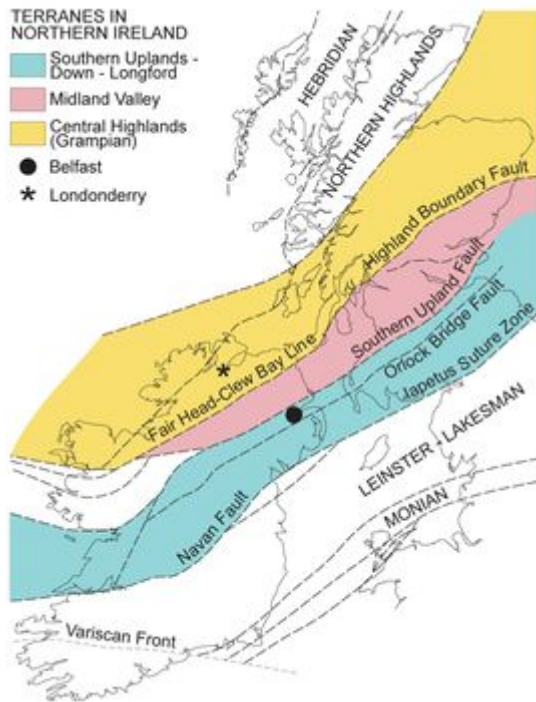
Britain (15). Late Ashgill - early Llandovery (c. 440Ma) (P947786)



Palaeozoic palaeogeographical reconstruction of northern Ireland and Britain (15). Late Llandovery (c. 427Ma) (P947787)



D Palaeozoic palaeogeographical reconstruction of northern Ireland and Britain (15). Early Devonian (c. 400Ma) (P947788)



Configuration of terranes in the northern parts of Ireland and Britain (15). (P947789)

"The Precambrian and Lower Palaeozoic foundations of the British Isles may be viewed as a series of suspect terranes whose exposed boundaries are prominent fault systems of various kinds, each with an unproven amount of displacement." <sup>[1]</sup>

The geological foundations of Ireland and Britain, known as the Caledonides, were assembled in the Caledonian Orogeny. Like most orogenic belts, the Caledonides consist of a collage of suspect terranes, each with a distinctive stratigraphy and structural, metamorphic and igneous history <sup>[2][3][4][5]</sup>. A suspect terrane may be defined as an area characterised by an internal continuity of geology (including petrology, metallogeny, geophysical properties and palaeomagnetic record) that is bounded either by faults, or mélangé representing a trench complex, or cryptic suture zones. Terranes now juxtaposed across such boundaries commonly display geological structures and histories so strikingly different it implies that they were once very widely separated. Although movements on the bounding faults and suture zones are commonly estimated in hundreds of kilometres they can rarely be determined with precision. Many of the suspect terranes are best envisaged as buoyant fragments of crust which were accreted to the adjacent continents when the surrounding oceanic crust was returned to the mantle by oceanic closure and subduction.

## Rise and fall of the Iapetus Ocean

The Iapetus Ocean <sup>(P947783)</sup> probably first opened in late Neoproterozoic (Vendian) time as a consequence of rifting caused by the separation of Baltica (North European Plate) and Siberia from Laurentia (North American Plate) <sup>[6]</sup>. Evidence for the existence of the Iapetus Ocean and for the continental plate closures come from studies of faunal provincialism and palaeomagnetism. The reconstruction of events starts in early Arenig time <sup>(P947784) A</sup> with Avalonia in its original position as a marginal sliver of the continent of Gondwana and the Iapetus Ocean attaining its maximum width of about 5000 km. However, this changed through mid-Ordovician time as Avalonia drifted northwards <sup>(P947784) B</sup> and palaeomagnetic data locate the southern margin of Laurentia, including the northern part of Ireland and Scotland at latitude 15–20°S, with eastern Avalonia including southern Ireland, England and Wales, in latitudes of 60°S <sup>[7]</sup>. By late Ordovician-early

Silurian time ([P947784](#) C) the Iapetus Ocean had narrowed significantly resulting in a breakdown of faunal provinces with the spread of a cosmopolitan benthic community to the shores of all the major continents <sup>[8]</sup>.

However, it was not until latest Silurian time that the Iapetus Ocean finally closed. Thus, by the Early Devonian, the Caledonian suspect terranes that had been brought together from opposite sides of that ocean by strike-slip shuffling had come together and the geological framework of Ireland and Britain was completed ([P947784](#) D). Much of the early Caledonian deformation recorded in the rocks of Ireland and northern Britain is attributed to across-strike compression, probably induced by the collision and accretion of offshore terranes or arcs with the Laurentian margin <sup>[9]</sup>. In contrast, deformation of the marine sediments composing the Southern Uplands-Down-Longford Terrane appears to be related almost entirely to their diachronous incorporation into an accretionary prism on that same continental margin, but with little if any evidence of collision tectonics <sup>[10]</sup>.

## Terrane assembly in Ireland

Assembly and docking of the terranes that form the basement in Northern Ireland commenced in mid-Ordovician time and continued for 80Ma through the Silurian and finished in the Early Devonian, about 380Ma ago ([P947785](#)), ([P947786](#)), ([P947787](#)), ([P947788](#)). Closure of the Iapetus Ocean was effected, at least in part, by large sinistral strike-slip movement <sup>[11]</sup> on the terrane-bounding faults and along internal faults <sup>[12][13]</sup>. The composite continental crust that resulted from those movements formed a basement for subsequent erosion and deposition during the remainder of Ireland's geological history.

Northern Ireland straddles three of the seven suspect terranes <sup>[14]</sup> that together constitute the Caledonian Orogen in Ireland ([P947789](#)). From north to south these are referred to as the Central Highlands (Grampian) Terrane, Midland Valley Terrane and the Southern Uplands-Down-Longford Terrane ([P947790](#)).

### Central Highlands (Grampian) Terrane

The Central Highlands or Grampian Terrane consists of Moinian (Mesoproterozoic) and Dalradian (Neoproterozoic-Cambrian) rocks ([see Central Highlands \(Grampian\) Terrane - metamorphic basement article](#)) and Caledonian igneous intrusions. The southern margin of the terrane is marked by the concealed Fair Head-Clew Bay Line which is interpreted as the southwesterly extension <sup>[15]</sup>, or major splay <sup>[16]</sup>, of the Highland Boundary Fault in Scotland ([P947789](#)). This regional magnetic lineament, which extends southwestwards to Clew Bay in Co. Galway, is located 10 km north of the Variscan Omagh Thrust Fault, but is concealed beneath Dalradian rocks that were thrust southwards over the Midland Valley Terrane ([see Variscan \(Hercynian\) Orogenic Cycle article](#)).

### Midland Valley Terrane

The Midland Valley Terrane in Scotland lies between the Highland Boundary Fault and the Southern Upland Fault ([P947789](#)). In Northern Ireland, as in Scotland, Upper Palaeozoic, Mesozoic and Palaeogene rocks cover much of the terrane. However, in Co. Tyrone a late Ordovician to early Silurian succession is exposed at Pomeroy ([see Midland Valley Terrane article](#)) with part of an early Ordovician ophiolite and island arc volcanic complex (Tyrone Igneous Complex) at its base <sup>[17]</sup>. At the core of the Tyrone Igneous Complex is the fault-bounded Central Inlier. This consists of schist and gneiss of Moinian affinity ([see Central Highlands \(Grampian\) Terrane - metamorphic basement article](#)) and originally formed part of the Central Highlands (Grampian) Terrane.



## Southern Uplands-Down-Longford Terrane

The Southern Uplands-Down-Longford Terrane ([P947789](#), (see [Southern Uplands-Down-Longford Terrane article](#))) lies between the Southern Upland Fault and the Navan Fault (Iapetus Suture Zone) and in Ireland is also referred to as the Central Terrane <sup>[18]</sup>. It is interpreted as a fore-arc accretionary prism of Ordovician and Silurian marine sediment. As the ocean closed by northwards subduction of oceanic crust, clastic sediment scraped in slices from the ocean floor was diachronously accreted to the over-riding Laurentian continent. The terrane is segmented into northeast-southwest orientated tracts separated by major strike-parallel faults. Within each tract the rock successions generally young to the north and successive tracts become incrementally younger towards the south by one or two graptolite zones each time. These apparently contradictory observations are the essential Southern Uplands paradox, ultimately resolved by the introduction of the accretionary prism model <sup>[19][20]</sup>. The widespread folding and faulting of rocks in the accretionary prism is almost entirely related to the process of subduction and accretion.

Closure of the Iapetus Ocean ceased following the oblique collision of the Laurentian and Avalonian foreland margins in late Silurian time. In response to the collision a continuous mountain range, the Caledonides, developed from the Appalachians through New England, Nova Scotia, Newfoundland, Greenland, Ireland, Scotland (Caledonia), to Scandinavia and Spitzbergen. Dismembered and eroded remnants of those mountains are found today in all of these areas.

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