Iapetus Suture, South of Scotland

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Stone, P, McMillan, A A, Floyd, J D, Barnes, R P, and Phillips, E R. 2012. British regional geology: South of Scotland. Fourth edition. Keyworth, Nottingham: British Geological Survey.

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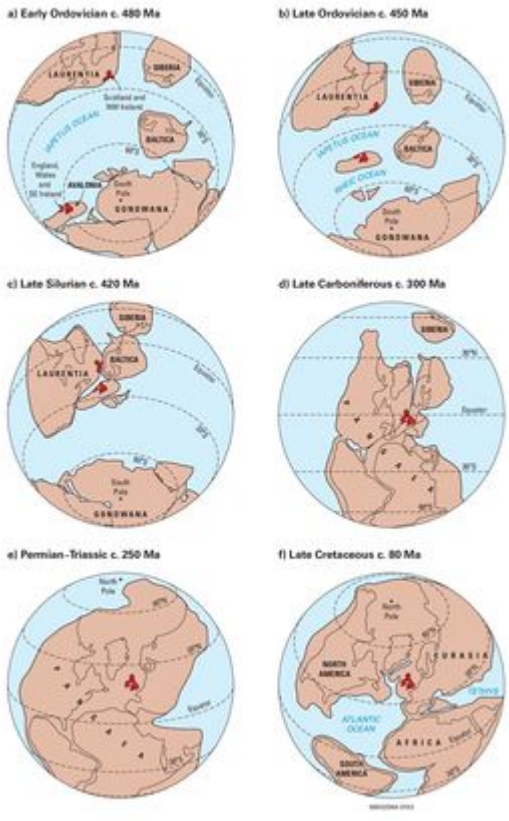
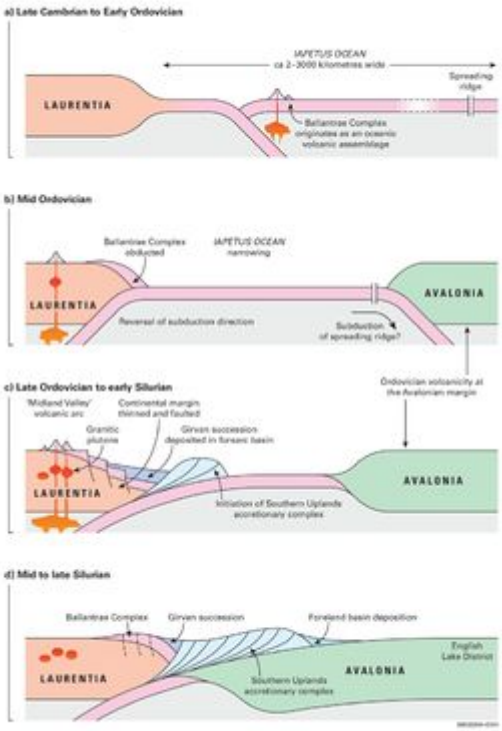
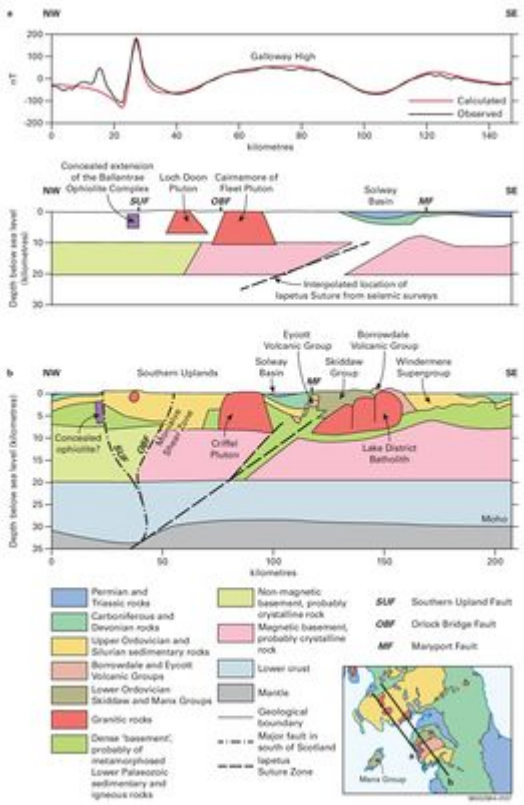
Iapetus suture



Palaeogeographical reconstructions from the Ordovician to the Cretaceous. P912314.



Stages in the closure of the Iapetus Ocean. P912315.



Deep crustal sections across the Iapetus Suture Zone. P912318.

By late Silurian times the Iapetus Ocean had all but closed (P912314c), though the ultimate

continental collision was something of a tectonic anticlimax. It was not a mountain-building event of orogenic proportions and the effects are hard to find in the tectonic record preserved on either the Laurentian or Avalonian margins. There was instead something of a tectonic continuum, as the Southern Uplands accretionary thrust terrane overrode Avalonia and continued southwards as a foreland fold and thrust belt (P912315d). Initially, a load-induced, flexural foreland basin advanced ahead of the thrust front and was an influential control on sedimentation during the accumulation of the mid to late Silurian parts of the Windermere Supergroup in the south of the English Lake District. This situation did not last, and by the end of Ludlow times convergence between Laurentia and Avalonia had ceased, the foreland basin failed to migrate farther southwards, and isostatic adjustments reversed the earlier effects of loading.

The tectonic effects seen within the exposed rock sequence, though created by collision-related processes, give little indication of the deeper structure of the suture zone. This is more usefully modelled from geophysical data. A number of seismic lines have traversed the Iapetus Suture Zone and have generally been interpreted in terms of a north-west-dipping, reflective zone projecting to the surface close to the northern coast of the Isle of Man and thence striking north-east beneath northern England. When the seismic results are integrated with regional interpretations of gravity and magnetic data a rather more complicated picture emerges in which Avalonian-type crust is caught up in a compound suture zone that extends well to the north beneath the Southern Uplands terrane (P912318).

It is something of a geological paradox that the Lower Palaeozoic rocks of the Laurentian margin did not experience substantial deformation as a result of the Laurentia–Avalonia collision. One possible effect is seen in the Girvan district, where the normal faults that had controlled deposition of the Ordovician to Silurian forearc basin succession were reactivated as north-directed thrusts late in the Silurian. Another possible tectonic outcome of the collision is implicit in P912318, wherein Laurentian-type crystalline basement extends from the Midland Valley terrane beneath the northern part of the Southern Uplands. Perhaps large-scale northward thrusting of the accretionary complex onto the Laurentian margin accompanied the demonstrable north-directed thrusting of the Girvan succession. The considerable horizontal shortening of the accretionary complex that would have been likely in such circumstances could have been accommodated by the widespread rotation of bedding towards the vertical, an attitude widely seen throughout the Southern Uplands and one hard to attain throughout the terrane only by accretionary activity.

Despite the uncertainties, it is clear that the continental collision between Laurentia and Avalonia was not an orthogonal event. A wealth of evidence shows that a sinistral stress regime was important during the later stages of convergence, and indeed may have been the dominant final effect. With a sinistral shear sense applied to the major north-east-trending strike faults, a conjugate pattern of smaller, cross-cutting, late Caledonian strike-slip faults was established across both the Southern Uplands terrane and the Lower Palaeozoic outcrop in northern England. The conjugate fault system comprises strike-slip faults trending either generally north-west with a dextral sense of displacement, or generally east-north-east with sinistral displacement. Though individually minor, these faults were to have a profound structural influence during subsequent episodes of extensional tectonism when their reactivation controlled Late Palaeozoic basin development and geometry. More immediately, in the transtensional tectonic regime pertaining during latest Silurian to Early Devonian times, strike-slip basins opened across the region and were filled with the clastic, terrestrial sediments of the Old Red Sandstone lithofacies. The transtensional regime may also have been an important factor in the intrusion of the Early Devonian granite plutons.

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