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The extension discrepancy at non-volcanic margins: depth-dependent stretching or unrecognised faulting?

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Rifted margins show an apparent discrepancy between the amount of extension measurable from faults (Beta-f) and the amount of crustal (Beta-c) or lithospheric thinning determined from wide-angle data or subsidence; generally Beta-f << Beta-c. This extension discrepancy has commonly been interpreted in terms of depth dependent stretching (DDS) in which the upper crust is extended and thinned far less than the rest of the crust. However there are some problems with this idea. 1. the magnitude of the discrepancy would require that at some margins the entire crust is thinned to well below 5 km without significant brittle extension of the upper crust, which would seem mechanically difficult. 2. assuming that the total amount of extension across a margin is the same at all lithospheric levels, any extension discrepancy must be balanced by an equally significant inverse discrepancy somewhere: these have not been reported. 3. detailed velocity structures from conjugate or close to conjugate non-volcanic rifted margins of the North Atlantic show that upper crustal thinning closely follows thinning of the whole crust. This implies that these margins display no significant crustal depth-dependent stretching. An alternative is that the extension discrepancy arises from the failure of the seismic method and of the seismic interpreter to identify all the brittle extension of the upper crust (Beta-uc). In other words that Beta-f << Beta-uc. Distributed deformation too small to be resolved seismically is not sufficient, but major faulting may not be recognised if the faults have been rotated and/or dismembered during progressive extension. Both polyphase faulting and large-offset top basement faults rotated toward or beyond horizontal are present at some rifted margins, but are difficult to interpret, particularly on time migrations. In conclusion the extension discrepancy at North Atlantic non-volcanic rifted margins is not due to DDS but represents the failure of the interpreter to recognise all the extension of the upper crust. It is likely that the same conclusion applies to other rifted margins.