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A review of Wilson Cycle plate margins: What is the role of mantle plumes in continental break-up along former sutures?

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It was Tuzo Wilson (1966) who recognised that the different faunal distributions on both sides of the present-day North Atlantic Ocean required the existence of an earlier proto-Atlantic Ocean. The observation that the present-day Atlantic Ocean mainly opened along a former suture was a crucial step in the formulation of the Wilson Cycle theory. The theory implies that collision zones are structures that are able to localize extensional deformation for long times after the collision has waned. We review margin pairs around the Atlantic and Indian Oceans with the aim to evaluate the extent to which oceanic opening used former sutures and to analyse the role of mantle plumes in continental break-up. We aid our analyses with plate tectonic reconstructions using GPlates (www.gplates.org).

Already Wilson recognized that Atlantic break-up did not always follow the precise line of previous junction. For example, Atlantic opening did not utilize the Iapetus suture in Great Britain and rather than opening along the younger Rheic suture north of Florida, break-up occurred along the older Pan-African structures south of Florida. As others before us, we find no correlation of suture and break-up age. Often continental break-up occurs some hundreds of Myrs after collision, but it may also take more than a Gyr, as for example for Australia-Antarctica and Congo-São Francisco. This places serious constraints on potential collision zone weakening mechanisms.

Several studies have pointed to a link between continental break-up and large-scale mantle upwellings. It is, however, much debated whether plumes use existing rifts as a pathway, or whether plumes play an active role in causing rifting. It is also important to realise that in several cases break-up cannot be related to plume activity. Examples are the Iberia-Newfoundland, Equatorial Atlantic Ocean, and Australia-Antarctica plate margins. For margins that are associated with large igneous provinces (LIPs), we find a positive correlation between break-up age and LIP age. We interpret this to indicate that plumes can aid the factual continental break-up. However, plumes may have been guided towards the rift for margins that experienced a long rift history (e.g., Norway-Greenland), to then trigger the break-up. This could offer a partial reconciliation in the debate of a passive or active role for mantle plumes in continental break-up.

(Wilson, J.T., 1966. Did the Atlantic close and then re-open? Nature 211, 676-681)