GESGB 2023 abstract – first draft

The origin of basins and minor fragments around southern Africa in a unified plate-tectonic model

Colin Reeves, Earthworks, The Netherlands and

Duncan MacGregor, MacGeology, UK.

A model that explains satisfactorily the initial development of the triple-junction between Africa, Antarctica and South America in Jurassic and Early Cretaceous time has proved elusive until now. Viewing the animation https://www.reeves.nl/gondwana/aac-anim-1 reveals our solution. From about 120 Ma (earliest Aptian) the model has all three main continental fragments intact in their present-day shape and separated by the rift-rift-rift (r-r-r) Bouvet triple junction that was to prove long-lived (Figure 1). We trace the history of several smaller fragments that were involved in the earlier events of Gondwana disruption (Figures 2-5).

The path by which Antarctica and Africa separated before 83.64 Ma (Campanian, marine magnetic anomaly C34) was defined by fracture-zone matching (Reeves & de Wit, 2000), smooth interpolation through the Cretaceous Quiet Zone and then honouring the M-series anomalies mapped by Mueller & Jokat (2019) for times before 121.4 Ma (earliest Aptian). The path avoids impossible situations (gaps or overlaps) across the whole Gondwana model. The result shows a 40-degree clockwise direction change in the motion of Antarctica in a fixed global reference frame between 140 and 120 Ma. Apart from an early ridge-jump over the Beira High, the mid-ocean ridge in the Africa-Antarctica Corridor (AAC) remained simple and central.

Immediately west of the AAC, a continental fragment – Limpopia – filled the gap that would otherwise exist in reassembled Gondwana (Figure 5). Limpopia remained fixed to Antarctica until the end of Jurassic time when detachment began. Copious magma supply had created the 'basement' below the Mozambique plains that was already abandoned on the Africa plate by about 152 Ma (Kimmeridgian) with a southward ridge-jump towards Limpopia. By about 130 Ma (Hauterivian) Limpopia itself had been left behind as a part of the Africa plate, the two mid-ocean ridges, Africa-South America and Africa-Antarctica, developing further to its west and south respectively as Africa continued to move NE, away from the active triple junction. The long transform immediately east of Limpopia (Mozambique Ridge) dates from this time. Renewed magmatism in and around Limpopia had produced the magmatic crust that now makes up the Mozambique Ridge by about 130 Ma. The direction change of Antarctica about this same time brought the Davie fracture zone into compression and opened (Hauterivian) grabens below the Mozambique plains (Figure 2) before active mid-ocean spreading became exclusively *east* of the Maurice Ewing Bank (MEB), south of the Agulhas fault zone.

The MEB was attached to Africa until ~135 Ma (Valanginian, Figures 3-5) but extension between it and the Malvinas Plateau (including the Falkland Islands) had started already at ~165 Ma (Kimmeridgian, Figure 4) by means of dextral strike-slip along the Agulhas fault, about 30 Myr before the onset of rifting in the southernmost South Atlantic. Our reassembly has the 'sole' of the plateau opposite the Coats Land coast of Antarctica (Figure 5), the whole plateau occupying the present-day Weddell Sea, outboard of the present-day ice-shelf. A total displacement of the plateau by about 860 km with respect to the remainder of South America along an extension of the Agulhas fault was achieved by ~130 Ma (Hauterivian) when motion ceased.

After ~130 Ma (Hauterivian) new, faster and re-directed ocean growth in the AAC and the onset of extension in the southernmost South Atlantic left the two 'continental' pedicles of (1) the Mozambique Ridge and (2) the MEB, attached to the Malvinas plateau, as stable parts of Africa and South America respectively. Extension in the Salado and Colorado rifts (Figure 2) north of the Agulhas extension was coupled with rapid onset of transtension in the Agulhas fault zone off South Africa with ~150 km of lateral extension by ~120 Ma (earliest Aptian).

Figure 6 shows that basins that are now widely separated share a common paleo-geographical region. Despite stratigraphical differences, they all show evidence of major tectonic events 130-120 Ma (Hauterivian to Barremian).

References

Mueller, C.O. and Jokat, W., 2019. The initial Gondwana break-up: a synthesis based on new potential field data of the Africa-Antarctica Corridor. Tectonophysics, **750,** pp 301-328. doi: 10.1016/j.tecto.2018.11.08.

Reeves, C.V. and de Wit, M.J., 2000. Making ends meet in Gondwana: retracing the transforms of the Indian Ocean and reconnecting continental shear zones. Terra Nova vol **12**, pp 272-280.

[720 words]

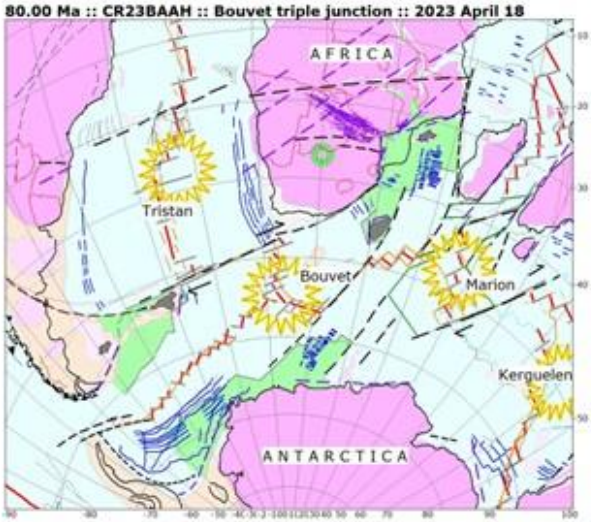

Figure 1. 80 Ma (Campanian). The three plate outlines established at ~129 Ma were still stable around the Bouvet rift-rfit-rift triple junction and its associated plume head.

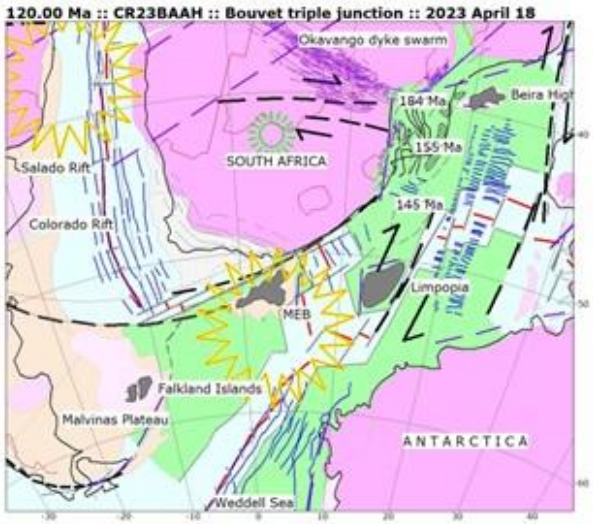

Figure 2. 120 Ma (Earliest Aptian). The Malvinas plateau was in its present position with respect to South America and with the MEB attached. Salado and Colorado rifts were fully extended.

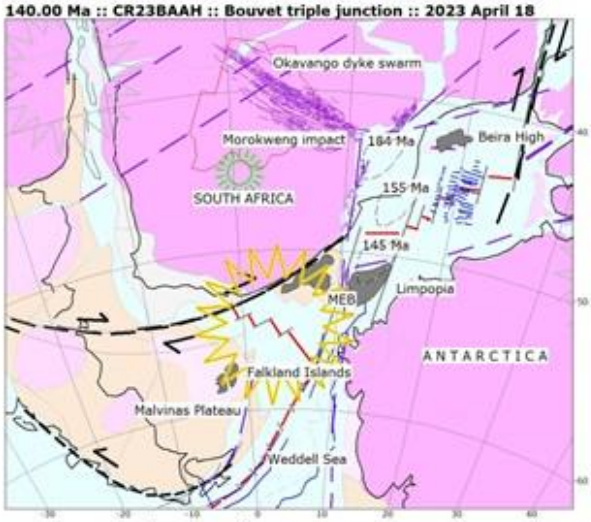

Figure 3. 140 Ma (Berriasian). Limpopia had started to leave Antarctica and the long transform separating it form Africa had started to migrate to its east. The southward extension of the old transform had become a new mid-ocean ridge location in the Weddell Sea. 640 km extension between MEB and Malvinas plat.

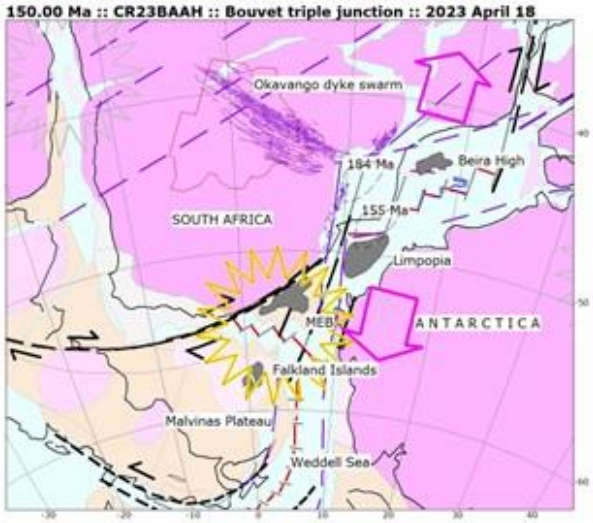

Figure 4. 150 Ma (Kimmeridgian). The active ridge in the AAC was now south of the Beira High; Limpopia was still attached to Antarctica but with a new ridge immediately to its north. 280 km of extension already achieved between the MEB and the Malvinas plateau. MEB still attached to Africa.

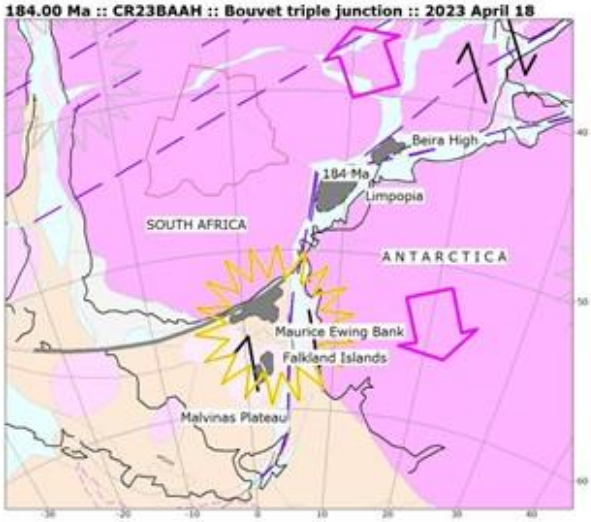

Figure 5. 184 Ma (Toarcian). Gondwana reassembled with the micro-fragments in their pre-rift positions. The Malvinas plateau and associated terranes of Patagonia were 870 km east of their present position in South America and closed against the Agulhas fault.

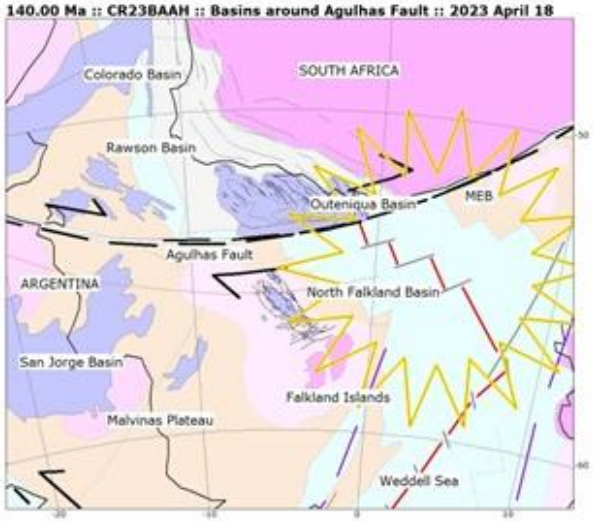

Figure 6. 140 Ma (Berriasian). The locations of the Rawson, Outeniqua and North Falkland basins with respect to the Agulhas Fault before the latter went into transtension at about 130 Ma (Hauterivian).