

### Research Update No.3, October 2016

This Update follows that dated 2016 July 22 (No.2) and describes innovations in the Gondwana assembly and dispersal model applied to model CR16AAGE since that time to give the current models, CR16AAJJ (Africa fixed) and CR16ABJJ (Hotspot reference frame).

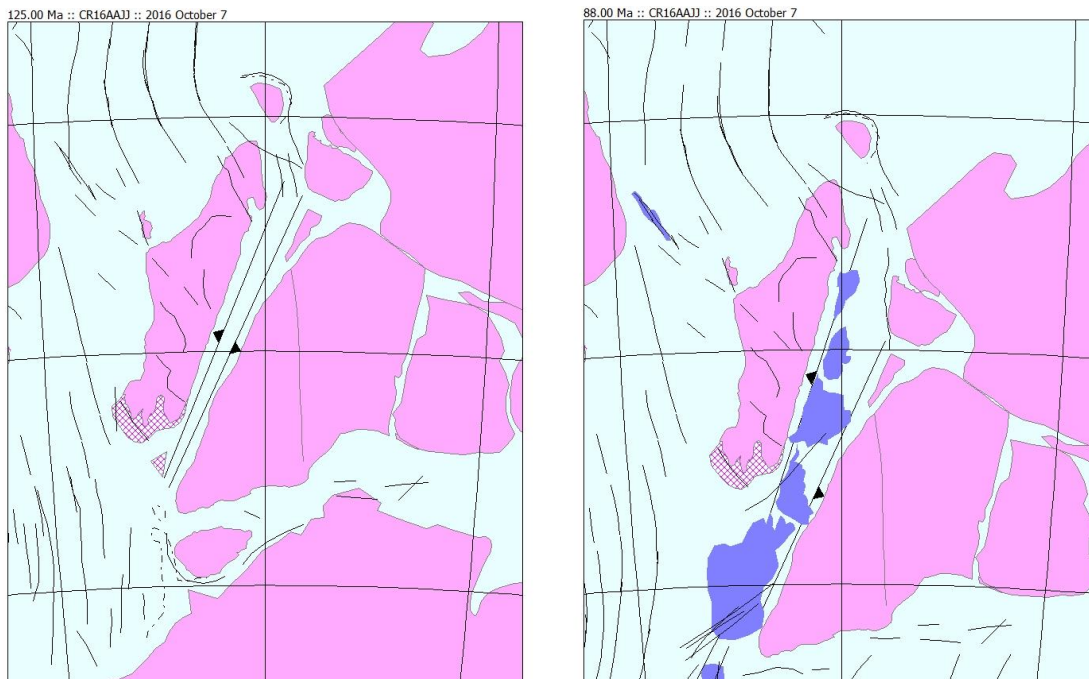
Series CR16AAHA... - re-adjustment of the Gulf of Aden closure which was abandoned.

Series CR16AAIA... - adjustment of the timing of operation of the poles controlling the folding out of Sri Lanka against India. None of these ideas were adopted in the accepted model.

Series CR16AAJA... to CR16AAJE - Adjustment of the path followed by The Seychelles to give a 'fit' position that matches the arcuate shape in the ocean off Somalia. The fragment stays in this position until 176 Ma, i.e. is part of Africa for a while after break-up, then follows Madagascar.

Series CR16AAJF to CR16AAJG – New movements and timings for the Mascarene fragments. These only appear as parts of the 'Large Igneous' dataset but now behave more credibly during the period of rifting between India and Madagascar 120-88 Ma and subsequently during the growth of the Mascarene ocean basin.

Series CR16AAJH to CR16AAJJ – This sequence involved a re-examination of the movement of India with respect to Antarctica in the interval 88 to 120 Ma. The object was to avoid a small compressive event between India and Madagascar in the earlier models and add smoothness to the motion overall. Notable in the adopted solution is that the fracture zones SE of The Seychelles are now parallel to the Kurduwadi lineament crossing India. This suggests that dextral strike-slip was pervasive east of Madagascar following



**Figure 1.** Dextral transtension between India and Madagascar in the interval from 125 Ma (A) to 88 Ma (B) with the creation of space filled, in part, by the Mascarene fragments. Note the movement of India is parallel to the direction of the Kurduwadi lineament that crosses the continent.

the Aptian Sidestep and the demise of the Somali Ocean ridge and may even have penetrated the Indian continental landmass. Figures 1A and 1B illustrate the movement envisaged in the period until the departure of India from Madagascar.

To Model CR16AAJJ was added the movements of Africa with respect to the Hotspot Reference Frame to give model CR16ABJJ. This model was used to produce a renewed animation launched on the website on September 29 and used in the plenary talk under preparation for the 48<sup>th</sup> Brazilian Geological Congress in Porto Alegre, Brazil to be given on October 14.

Mid Ocean ridges for the Africa-India system were revised but incompletely. This needs revisiting since, for example, The Seychelles are crossed by the India-Madagascar ridge at one stage as it is.

On August 14, scenes for the IGCP-628 poster at the Cape Town IGC were sent to Renata Schmitt in Rio de Janeiro. On August 19, SCO files created by Lawrence Rush and derived from the SHP files sent from Rio, were unzipped and added to a new directory of geological data for Atlas. All files worked except Antarctica for which there was a problem and New Zealand was not in the consignment.

Table 1 below gives the main rotation parameters for the model CR16AAJJ. Changes and additions to that released in Research Update 2 are highlighted in yellow.

**Colin Reeves**

*Delft, 2016 October 7.*

**Table 1: Euler interval rotation poles, model CR16AAJ**

```
// Antarctica versus Africa
ANT-AFR 100 400 0.00 20.00 12.58 -43.60 1.53 CR14AAGD - Registration in the Scotia Sea
ANT-AFR 100 400 20.00 43.00 12.58 -43.60 5.52 CR14AAGD -
ANT-AFR 100 400 43.00 54.00 12.58 -43.60 3.10 CR14AAHC -
ANT-AFR 100 400 54.00 72.00 -43.16 -28.97 5.35 CR12AAGA - sigmoidal movement retimed to match triplet in Indian O.
ANT-AFR 100 400 72.00 83.64 15.50 -39.56 4.56 CR13AAEC - Anomaly 34 fits.
ANT-AFR 100 400 83.64 100.87 15.50 -39.56 7.94 CR13AAEI - new calculation
ANT-AFR 100 400 100.87 124.00 -15.15 -8.76 16.00 CR14AADD - follow rifted margin off ANT more closely until 'sidestep'
ANT-AFR 100 400 124.00 127.61 -33.52 -8.60 3.00 CR14AADE - better 'Aptian sidestep' back to K&J 2010 at 127.61 Ma
ANT-AFR 100 400 127.61 140.00 -23.02 0.63 8.50 CR16AAEL - enough rotation to close Madinda line at 140 Ma
ANT-AFR 100 400 140.00 151.40 -16.40 -32.61 4.00 CR16AAFE - M22 as a waypoint, single pole 140-165 Ma
ANT-AFR 100 400 151.40 165.00 -16.40 -32.61 2.46 CR16AAFE - single pole 140-165 Ma that follows the oldest FZs off ANT
ANT-AFR 100 400 165.00 182.70 13.93 85.00 -4.50 CR16AAFB - close with pole common to MAD; 'Lebombo first'.
ANT-AFR 100 400 182.70 555.00 90.0 0.0 0.00 CR14AAEI - new starting time for break-up a la JT.

// India versus Antarctica
IND-ANT 300 100 0.00 47.00 14.61 32.06 -25.00 CR12AANA - Revise Regime 4 triplet closure '12 dec 9
IND-ANT 300 100 47.00 63.00 7.86 2.52 -20.20 CR13AAIA - to fit Somalia, Antarctica and triplet at 75 MA
IND-ANT 300 100 63.00 78.00 7.86 2.52 -19.75 CR14AAJA - same speed 63-88 Ma
IND-ANT 300 100 78.00 88.00 7.86 2.52 -13.16 CR14AAJA - back to more southerly position at 88 Ma
IND-ANT 300 100 88.00 100.87 14.70 -34.51 -6.00 CR16AAJJ - undo what ANT vs AFR does in this interval
IND-ANT 300 100 100.87 120.00 -34.85 -16.27 -8.62 CR16AAJI - get IND back to where we want it at 120 Ma (AAGE)
IND-ANT 300 100 120.00 124.00 -48.60 16.19 -3.20 CR16AACH - IND stays still wrt MAD in this interval
IND-ANT 300 100 124.00 140.00 -60.47 33.95 -11.00 CR16AAGA - IND closed to ANT with PC geology more parallel
IND-ANT 300 100 140.00 555.0 90.0 0.0 0.0 CR12AAEO - IND fixed to ANT for good

// Madagascar versus Africa
MAD-AFR 401 400 0.00 20.00 -21.66 8.14 0.3 CR16AABF - EAR wrt AFR ... MAD does same as SOM
MAD-AFR 401 400 20.00 120.00 90.0 0.0 0.00 CR14AADF - MAD fixed until Aptian
MAD-AFR 401 400 120.00 139.00 -8.86 74.65 -16.00 CR16AAEM - DF2 works faster so that MAD not o'taken by IND
MAD-AFR 401 400 139.00 151.40 -19.27 -28.22 4.41 CR16AAEH - M22 (Somalia) as a waypoint.
MAD-AFR 401 400 151.40 165.00 -16.00 -4.33 3.04 CR16AAFA - pole that follows the oldest FZs off ANT
MAD-AFR 401 400 165.00 182.70 13.93 85.00 -4.50 CR16AAFB - close with pole also common to ANT, 'Lebombo first'
MAD-AFR 401 400 182.70 250.00 90.0 0.0 0.0 CR12AAIE - MAD fixed between Karoo and break-up
MAD-AFR 401 400 250.00 300.00 8.30 64.12 -2.63 CR12AAIF - small opening for Karoo
MAD-AFR 401 400 300.00 555.00 90.0 0.0 0.00 CR12AACQ - MAD fixed to AFR before the Karoo

// Seychelles versus Madagascar - adjusted in CR16AAJI
SEY-MAD 402 401 0.00 64.00 90.0 0.0 0.00 ** seychelles fixed to MAD
SEY-MAD 402 401 64.00 88.00 1.99 39.84 -28.00 CR16AAJA - Seychelles to Mad in one new motion
SEY-MAD 402 401 88.00 120.00 90.0 0.0 0.00 CR16AAJD - fixed to Mad after Aptian sidestep
SEY-MAD 402 401 120.00 140.00 -7.94 49.45 -16.00 CR16AAJD - follows IND in this interval
SEY-MAD 402 401 140.00 176.00 90.0 0.0 0.0 CR16AAJE - Seychelles fixed to MAD
SEY-MAD 402 401 176.00 182.70 9.63 82.37 1.8 CR16AAJE - Seychelles stays with Somalia
SEY-MAD 402 401 182.7 555.00 90.0 0.0 0.0 CR16AAJE - Seychelles fixed to MAD again.

// Sri Lanka versus India
SRI-IND 301 300 0.00 114.00 90.0 0.0 0.0 CR13AABO - inner ghost fitted to Gunnerus
SRI-IND 301 300 114.00 122.00 9.67 80.86 -29.0 CR16AACL - later start to avoid o'lap with ANT
SRI-IND 301 300 122.00 140.00 9.22 69.77 8.56 CR16AAGB - PC geology better parallel
SRI-IND 301 300 140.00 555.00 90.0 0.0 0.0 CR16AACJ - fitted to India as with CR15GSCB
```

CVR

Delft, 2016 October 7