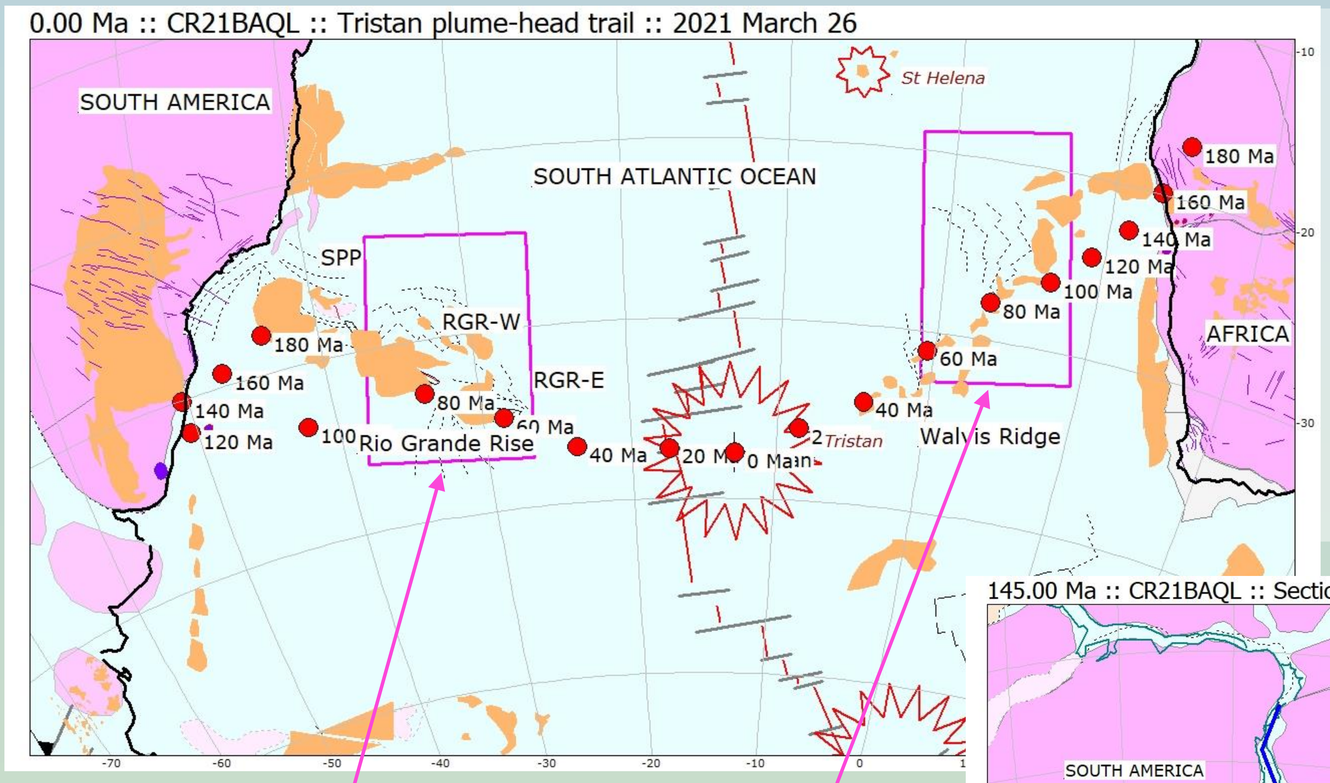
The lost ‘continents’ of the South Atlantic Ocean

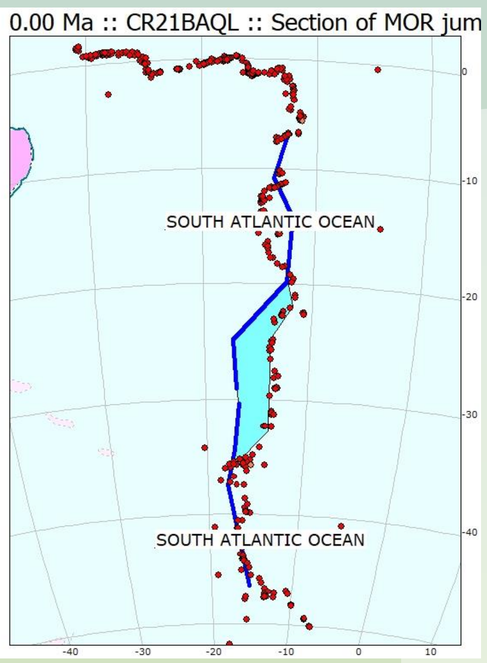
Colin Reeves (reeves.earth@planet.nl)
Pricilla Souza (pricilla.camoes@gmail.com)

This work forms part of the IGCP-628
The Geological Map of Gondwana
(Federal University of Rio de Janeiro)



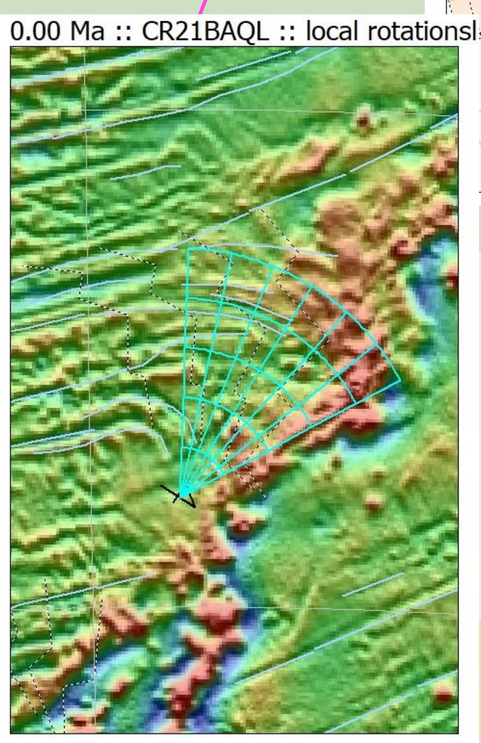
Oceanic plateaus, micro-continents or something else?

In the South Atlantic Ocean, two strings of submarine plateaus form a V-shaped pattern which has been interpreted as twin trails of the Tristan mantle plume, developed during South Atlantic opening (Wilson, 1963, 1965; Morgan, 1971; Hawkesworth et al., 1992). However, the recovery of granitic and metamorphic fragments (Santos *et al*., 2019) and the interpretation of anomalously thick crust under some of these plateaus may indicate a more continental affinity (Graça *et al.*, 2019). Here we argue that, while the plume trail idea may be true for the Walvis Ridge on the Africa plate, the São Paulo Plateau (SPP) and the Rio Grande Rise (RGR-E and RGR-W) have a more complex tectonic history, including ridge jumps, ridge-plume interactions and local rotations of small plates.



Eastward ridge jumps

If we draw a line separating Africa and South America in their ‘fit’ position (left figure), rotate it at exactly half the rotation that has separated this pair of continents and compare with the present-day mid-ocean ridge seismicity (right figure), we see an area of about 300 km (width) x 1400 km (length) (shaded blue) where they are separated. This implies that the ridge has moved eastwards from its original position during the development of the ocean. In other words, an area of oceanic crust that started out on the Africa side of the central rift is now somewhere on the South America plate. This area corresponds roughly to that of the SPP, RGR-E and RGR-W.



Local rotations

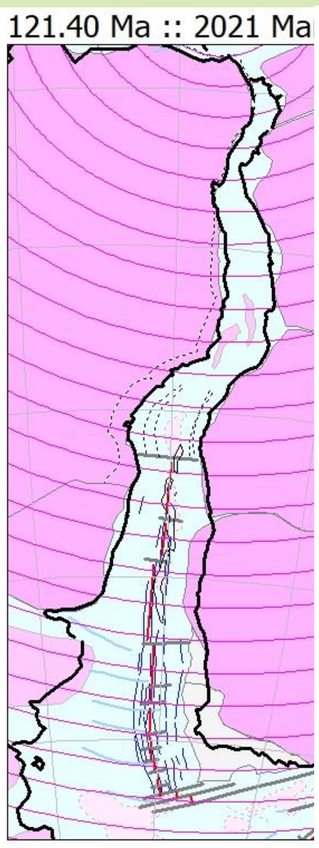
Sea-floor topography provides evidence that local ~45° rotations occurred both away from the Walvis Ridge (right image) and towards the conjugate South America side (left image). For the RGR-W, we interpret a counter-clockwise rotation during the interval 100-85 Ma.
(Images from Geognostics)

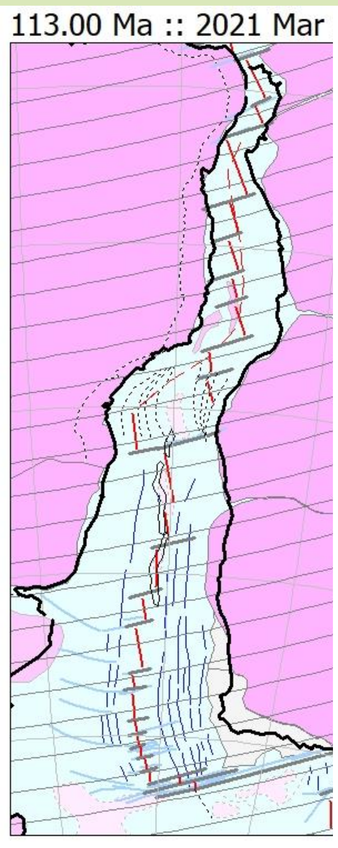
But when did all this happen?

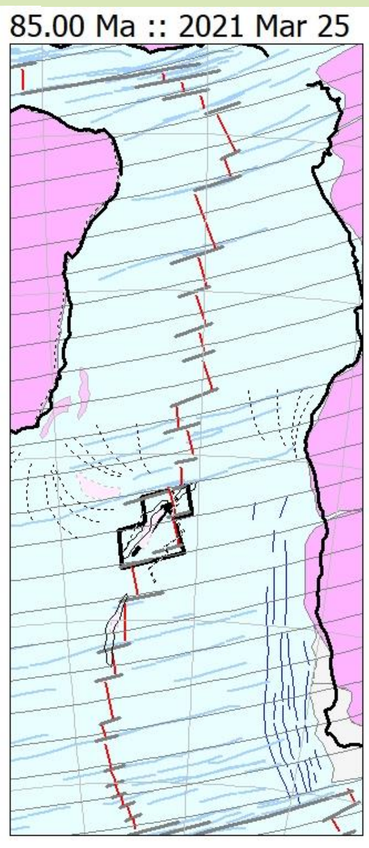
121.4 Ma (M0, GTS2020)
The mid-ocean ridge in the southern South Atlantic was well developed, penetrating northwards from an origin near the Bouvet plume head, south of Africa. However, north of the RGR, the rift was still incipient. The grain of the Precambrian Ribeira and West-Congo belts offset its direction eastwards from the line of the southernmost ocean.

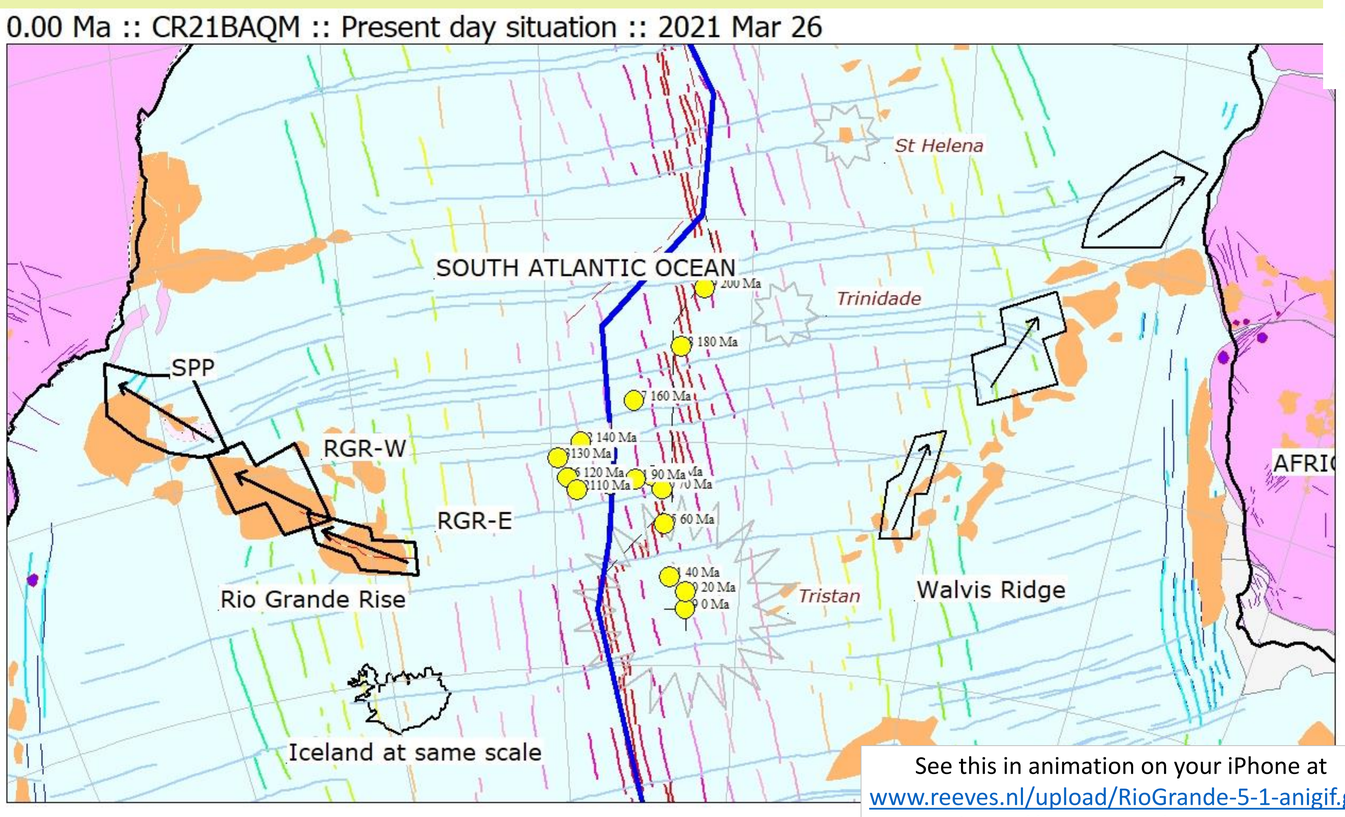
113.2 Ma (Aptian-Albian boundary)
There is a change in spreading direction. The established southern MOR (including the RGR) penetrates east of the SPP while a new ridge to the north penetrates south, west of the SPP.

85 Ma (Santonian)
The southern and northern ridges are connected forming a continuous ridge. However, the ridge located west of the SPP has jumped to its eastern side. RGR-W starts to rotate away from Africa and eventually fully joins the South America plate by about 70 Ma. Note that, by this time, the ridge as a whole lies slightly west of the plume head, favouring a more easterly position for it.









See this in animation on your iPhone at
www.reeves.nl/upload/RioGrande-5-1-anigif.gif
https://vimeo.com/530730106

Conclusion

We support the idea that the Walvis Ridge is the trail of the prolific Tristan mantle plume. However, we advocate that the RGR was part of the active MOR between Africa and South America - in an Iceland-like fashion - until a new active ridge started to the east of it, penetrating southwards and causing the old, dying ridge to rotate counter-clockwise in sections before being abandoned completely on the South America plate. The fragments with continental affinity recovered in the RGR may be attributed to its prolonged existence, first within the extensional zone between two major continental plates and then preserved as micro-plates at the active ridge before being abandoned westwards.

CPSL ‘Atlas’ software used throughout
More info? Visit www.reeves.nl

Earthworks
- global thinking in exploration geoscience