Analysis of hiatal surfaces and the stratigraphic framework for the plume mode in the East African Rift System (EARS): Progress and Limitations

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A - Introduction

• Rising of plumes and their impact at the surface causes long-wavelength vertical topographic changes over time called Dynamic Topography (Hager and Gurnis, 1987).

• Using Africa and the East African Rift System as examples, we produced Hiatus Maps and Stratigraphic Framework Maps to better understand the spatio-temporal dimensions of dynamic topography.

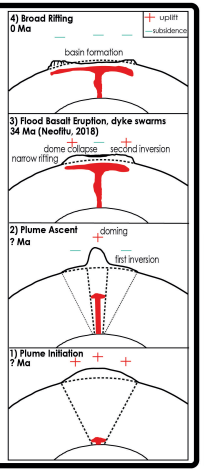


Figure 1 - Progressive vertical surface response of mantle-plume event with timing related to the East African Rift System. Modified after Neofitu (2018). Scaling of plume from Griffiths and Campbell (1990).

D - Method - Plume-Stratigraphic Framework Mapping

• **Goal**: determine duration of plume ascent. As this is unknown, we made a first guess based on:
  • eruption of flood basalts at 34 Ma (**Fig. 1.3, Fig. 5**),
  • hiatus maps (**Figure 4 - Palaeocene**) - assumed plume initiation at 66 Ma.

• Map geological units using colour scheme (**Figure 5**) and three different plume initiation timings (90, 66, 34 Ma).

• Distinguish between central, marginal, and distal regions (**Figure 6**) by mapping the boundaries as defined by **Figure 5.** This will reveal spatial dimensions of dynamic topography for all three cases.

Limitation: Time resolution of input map

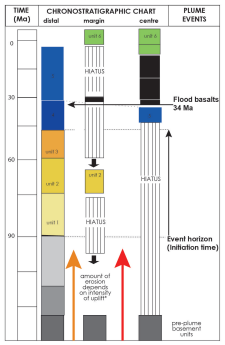


Figure 5 - Chronostratigraphic chart resulting from a mantle plume ascent. Modified after Friedrich et al. (2018) for initiation time of 90 Ma.

E - Results - Plume-Stratigraphic Framework Maps

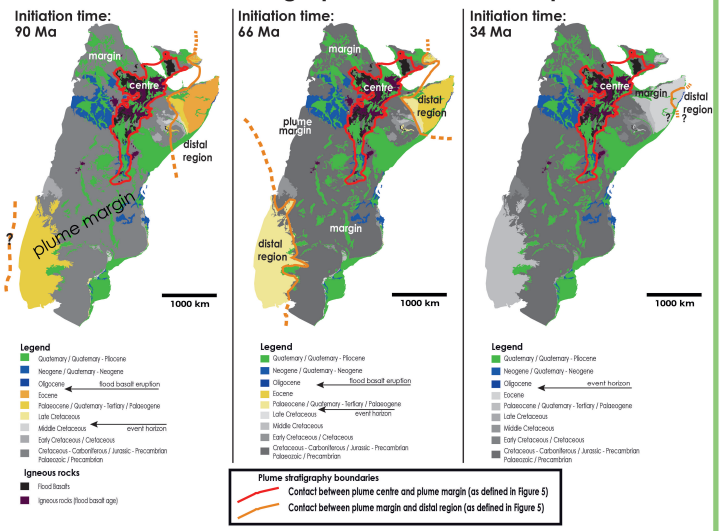


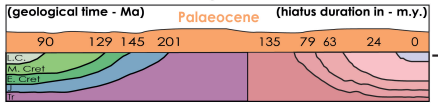
Figure 6 - Plume-stratigraphic framework maps for the East African Rift for initiation time at 90, 66, 34 Ma (Neofitu, 2018). For the three cases, Late Cretaceous, Palaeocene, or Oligocene are the oldest permissible syn-ascent sediments respectively. Colours as in Figure 5.

B - Method - Palaeogeological Hiatus Mapping

• Mark each basal contact for every time slice taken at each geological series on base map by Choubert et al. (1990).

• Calculate hiatus at base of series boundary (e.g., Palaeocene Fig. 3).

Figure 3



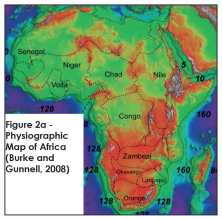


Figure 2a - Physiographic Map of Africa (Burke and Gunnell, 2008)

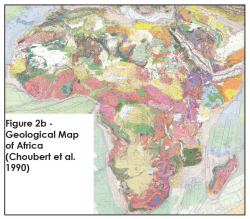


Figure 2b - Geological Map of Africa (Choubert et al. 1990)

C - Results - Palaeogeological Maps of Africa showing hiatus duration at base of series

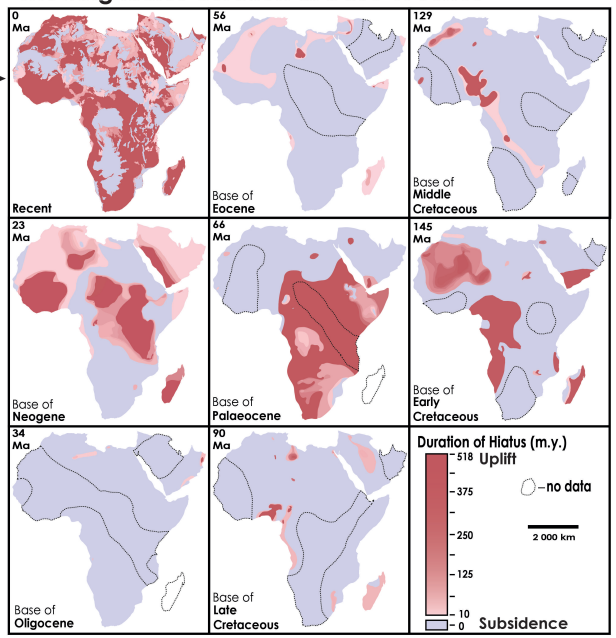


Figure 4 - Preliminary hiatus maps of time slices of Africa and the Arabian Peninsula as outlined in Neofitu (2018). Major hiatal surfaces seen at 0, 23, 66, and 145 Ma time slices. Hiatus durations as illustrated by Figure 3. Recent hiatus map is highly simplified.

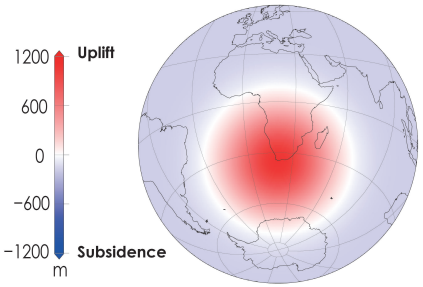


Figure 7 - Dynamic topography by assuming density anomaly in the lower mantle. Colli et al. (2016).

F - Conclusions

• The input geological maps were not designed for our purposes and our results are severely hampered by the temporal resolution used on them. Interregional-scale, geological maps at the resolution of stages, are needed.

• Additional criteria (eg.: flood basalts, thermochronologic data) are useful to improve palaeotopographic maps.

• Spatial distribution of major hiatuses correspond to previously mapped plume related uplift (Şengör, 2001; Burke and Gunnell, 2008); temporal distribution is in three episodes with durations of a few, to less than tens of millions of years.

• With the margins-distal boundary ~1000 km from the plume centre, the plume initiation time that is closest to a match is at 66 Ma. True initiation time may be younger but it is not likely to be much older.

• Geological mapping, biostratigraphy and radiometric dating are important tools to quantify the spatial and temporal dimensions of vertical surface motion in the context of mantle dynamics.

G - References

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