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INVESTIGATION OF THE AFRICA SPLITTING INTO TWO AS NEW OCEAN FORMS

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Abstract. Scientists believe that Ethiopian tectonic plate changes indicate that Africa is breaking apart, opening the path for the emergence of the planet's sixth ocean. Ever since the East African Rift, a 35-mile-long fissure in Ethiopia's desert, appeared in 2005, there has been a continuous movement between the tectonic plates. The second-largest continent in the world will virtually split in two due to the separation of the Somalian tectonic plate from the larger Nubian tectonic plate. This event has not been seen in hundreds of millions of years, when South America and Africa were separated into separate continents. The Somali and the Nubian tectonic plates are slowly disintegrating from each other, while the Arabian plate continues to pull away. The continental rift will happen along the east African Rift Valley, a geologically active region whose formation millions of years ago is similar to that of the tectonic movements that happen at the bottom of oceans. This means landlocked countries such as Rwanda, Uganda, Burundi, the Democratic Republic of Congo, Malawi, and Zambia would inadvertently find themselves with a coastline, and thus, build harbours that connect them to the rest of the world directly. Kenya, Tanzania, and Ethiopia would have two territories each. Though that will take between five to 10 million years, the continent will eventually split into two sub-continents, creating a new ocean basin between them.

Keywords: Africa continents, splitting, a new ocean, GNSS, displacement, motion.

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1. Introduction

In the far future, scientists believe that the emergence of a new ocean may divide Africa in two. There might be the formation of an ocean as a consequence of the separation of two of the continent's primary portions. That would imply that in a few years, landlocked nations like Zambia and Uganda may have beaches. The emergence of a new sea was initiated in 2005 with the construction of the East African fissure, a 56-kilometer-long fissure in Ethiopia's deserts. It is reported that a new ocean is forming in the Afar region of Ethiopia as a result of the continent splitting in two. While the new ocean is expected to complete its formation within 5 to 10 million years, it is thought that the cause of this event is the increasing pressure of the rising magma. In 2005, a rift opened in Afar in a very short period of ten days, stretching for 60 kilometres and reaching a width of 8 metres. Extremely hot and molten rock fragments are being pushed out of this rift, causing it to open wider and wider. It is thought that this rift, which is powered from below the ground, will separate East Africa from the rest of the continent in 5–10 million years, and that a new ocean will come to life in the area of the rift. The so-called East African Rift was formed at least 22 million years ago, but has started to show activity in recent years. In 2005, a crack appeared across the deserts of Ethiopia and continues to widen at a rate of 2.54 cm per year (Boos & Emanuel, 2009; Chorowicz, 2005; Ebinger, 2005; Emry et al., 2019; Fernandes et al., 2004; Furman, 2007; Koptev et al., 2016; Munday et al., 2021, 2023; Rajaonarison et al., 2023; Scoon, 2018; Washington et al., 2019). The aim of our study is to determine this separation in the African region with millimetre accuracy by using GNSS stations.

2. Materials and methods

2.1. Study site

The rift was identified as the edge of three tectonic plates that have already been drifting apart for some time: the African Nubian, African Somali, and Arabian. GNSS tracking shows that ground movements between these tectonic plates have been occurring continuously at different rates, with the Arabian plate moving away from Africa at a rate of one inch (2.54 cm) per year. The Red Sea and Gulf of Aden will flood the Afar region and the East African Rift Valley and become a new ocean, while the East African part will become a separate continent.

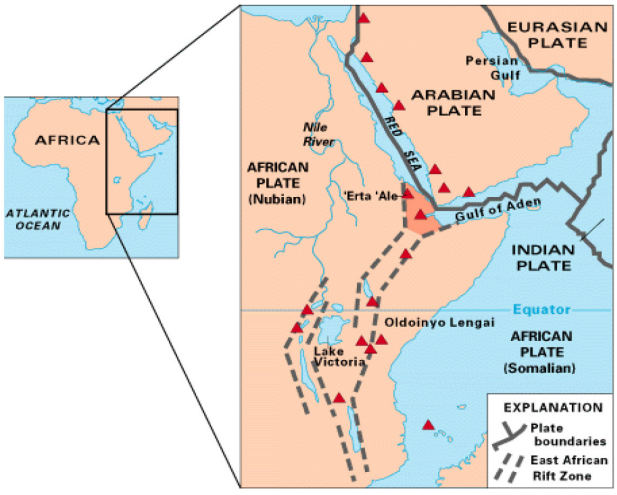

Figure 1. A map showing tectonic plate boundaries as well as the East African Rift zone (dotted lines) (source: IFLScience, 2023)

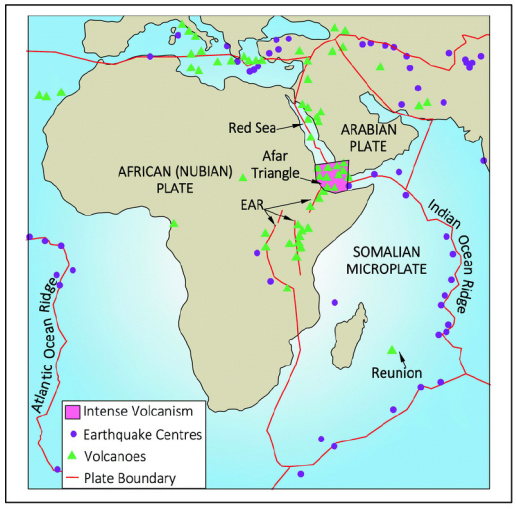

Figure 2. Sketch map of the African plate showing the boundaries and extent of the East African Rift system

The Eastern African Rift (EARS) is a geological feature that is thought to have started around 22 million years ago. But in recent decades, there has been a notable upsurge in activity that has sparked considerable scientific attention. A notable fissure appeared in Ethiopia's deserts in 2005. This seems to be an extension of the continuous tectonic process, growing one inch a year. The Somali plate in the east and the Nubian plate in the west are two tectonic plates that are steadily migrating apart, resulting in the Eastern African Rift (Figures 1 and 2). This has long been recognized, but until recently, the exact processes causing this tectonic separation were unknown (Boos & Emanuel, 2009; Chorowicz, 2005; Ebinger, 2005; Emry et al., 2019; Fernandes et al., 2004; Furman, 2007; Koptev et al., 2016; Munday et al., 2021, 2023; Rajaonarison et al., 2023; Scoon, 2018; Washington et al., 2019).

2.2. CSRS-PPP software

Using CRSR-PPP AR software, all twelve stations' RINEX observations were processed. On Tuesday, October 20, 2020, Natural Resources Canada's (NRCan) Canadian Geodetic Survey (CGS) upgraded the Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP) service. For data collected on or after January 1, 2018, PPP with ambiguity resolution (PPP-AR) is included in this CSRS-PPP update. Updates to the CSRS-PPP outputs will also be made concurrently. Users gain greatly from ambiguity resolution because it converts imprecise carrier-phase measurements into exact ranges. Consequently, it is often possible to achieve centimetre-level accuracy more quickly. Resolving carrier-phase ambiguities also leads to better longitude (east) component estimations because of satellite geometry. For the time being, new PPP-AR-capable products are only accessible for data acquired on or after January 1, 2018. Before this date, there were insufficient analysis centres that could provide satellite phase biases that matched the orbits and clocks of the satellites, which are necessary for resolving ambiguities.

3. Results

Twelve IGS stations, which were used in this investigation, were described in the preceding section. These data were analysed on January 1, 2022, to study the displacement values plainly apparent in the time history. For this time period, the IGS server provided 24 hour RINEX observation file with 30-second intervals (Receiver Independence Exchange). The 24-hour RINEX observation file was provided from the twelve IGS stations and analysed by using the CSRS-PPP program (static, 24 hours, record interval: 30 seconds), Figure 3.

Figure 4 is prepared as a three-dimensional projection.

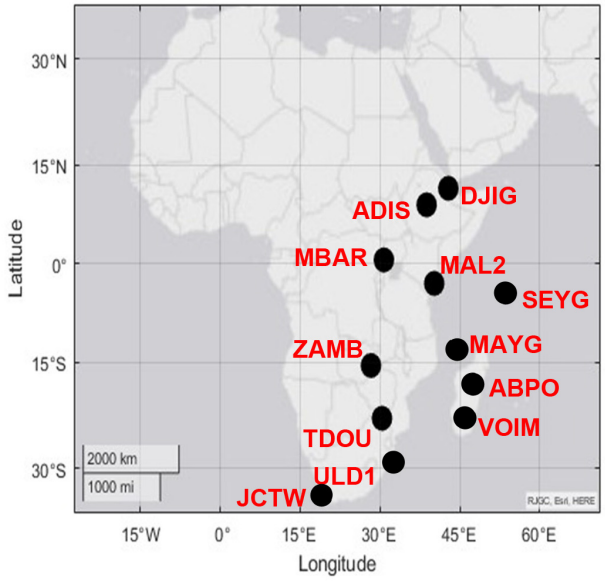

Figure 3. Graphic of the selected twelve IGS points on the African continent

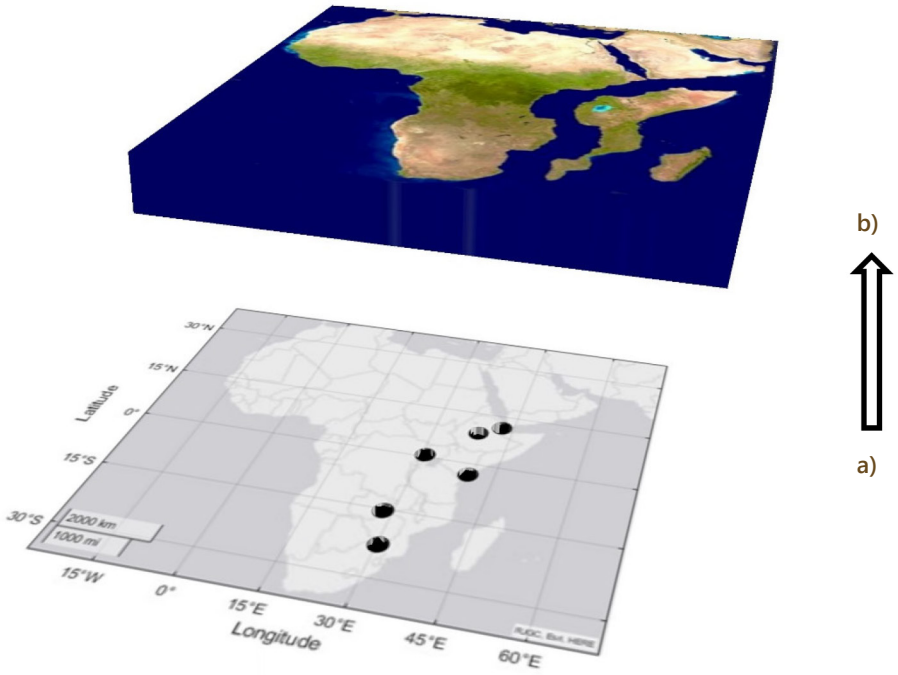

Figure 4. Three-dimensional representation of the African continent today (a) and approximately 5 to 10 million years from now (b)

It is a representation of the future state of the African continent.

As seen in Figure 5a, the total horizontal displacement of 38.91 cm in the north-east direction was obtained at the ADIS point from 2010 to 2023. The vertical displacement value of ADIS point was calculated as 3.6 cm (collapse). As seen in Figure 5b, the total horizontal displacement of 28.17 cm in the north-east direction was obtained at the DJIG point from 2015 to 2023. The vertical displacement value of DJIG point was calculated as 0.5 cm (collapse).

Figure 5c illustrates that from 2010 to 2023, the MAL2 point had a total horizontal displacement of 39.94 cm in a north-eastern direction and 1.1 cm (collapse) was computed to be the vertical deformation value of the MAL' point. Figure 5d illustrates that from 2015 to 2023, the DJIG point had a total horizontal displacement of 53.98 cm in a north-easterly direction. 1.5 cm (collapse) was obtained for the vertical displacement value of the DJIG point.

The overall horizontal displacement from 2015 to 2022 at the TDOU station was 38.91 cm in the north-east, as shown in Figure 5e. The TDOU point's vertical deformation value (collapse) was determined to be 1.6 cm. As can be seen in Figure 5f, from 2005 to 2023, the ZAMB point had a total horizontal displacement of 55.73 cm in the north-east direction. 0.4 cm (collapse) was determined to be the vertical deformation value of the ZAMB point.

As can be seen in Figure 5g, from 2010 to 2023, the ABPO point had a total horizontal displacement of 31.83 cm in the northeast direction. It was determined that the ABPO point's vertical deformation value was 0.1 cm (collapse). The total horizontal displacement of 7.25 cm in the northeast direction was obtained at the JCTW point between 2020 and 2023, as shown in Figure 5h. It was determined that the JCTW point's vertical deformation value was 0.1 cm (collapse).

The total horizontal displacement of 40.96 cm in the east-north direction was obtained at the MAYG site from 2015 to 2023, as shown in Figure 6. It was determined that the MAYG point's vertical deformation value was 18.6 cm (collapse). As can be seen in Figure 5j, from 2015 to 2023, the SEYG point had a total horizontal displacement of 23.59 cm in the north-east direction. It was computed that the SEYG point's vertical deformation value was 0.2 cm (collapse).

At the ULD1 site, a total horizontal displacement of 19.04 cm in the northeast was obtained between 2015 and 2023, as shown in Figure 5k. The value of the ULD1 point's vertical deformation was computed to be 0.5 cm (collapse). As can be seen in Figure 5l, from 2015 to 2023, a total horizontal displacement of 18.48 cm in the north-east was computed at the VOIM station. It was determined that the vertical deformation value of the VOIM point was 0.7 cm (collapse).

As a result of the processing was performed at twelve IGS points, the largest horizontal displacement values were obtained at ZAMB (55.73 cm/18 years), MBAR (53.98 cm/18 years), and MAYG (40.96 cm/8 years), respectively. In vertical deformation, the largest values were calculated at MAYG (18.6 cm/8 years), ADIS (3.6 cm/13 years), TDOU (1.6 cm/7 years) and MBAR (1.5 cm/18 years), respectively (Figures 4 and 5).

Among these twelve points we examined, the horizontal and vertical displacements occurring at the MAYG point are remarkable. In particular, the horizontal displacement

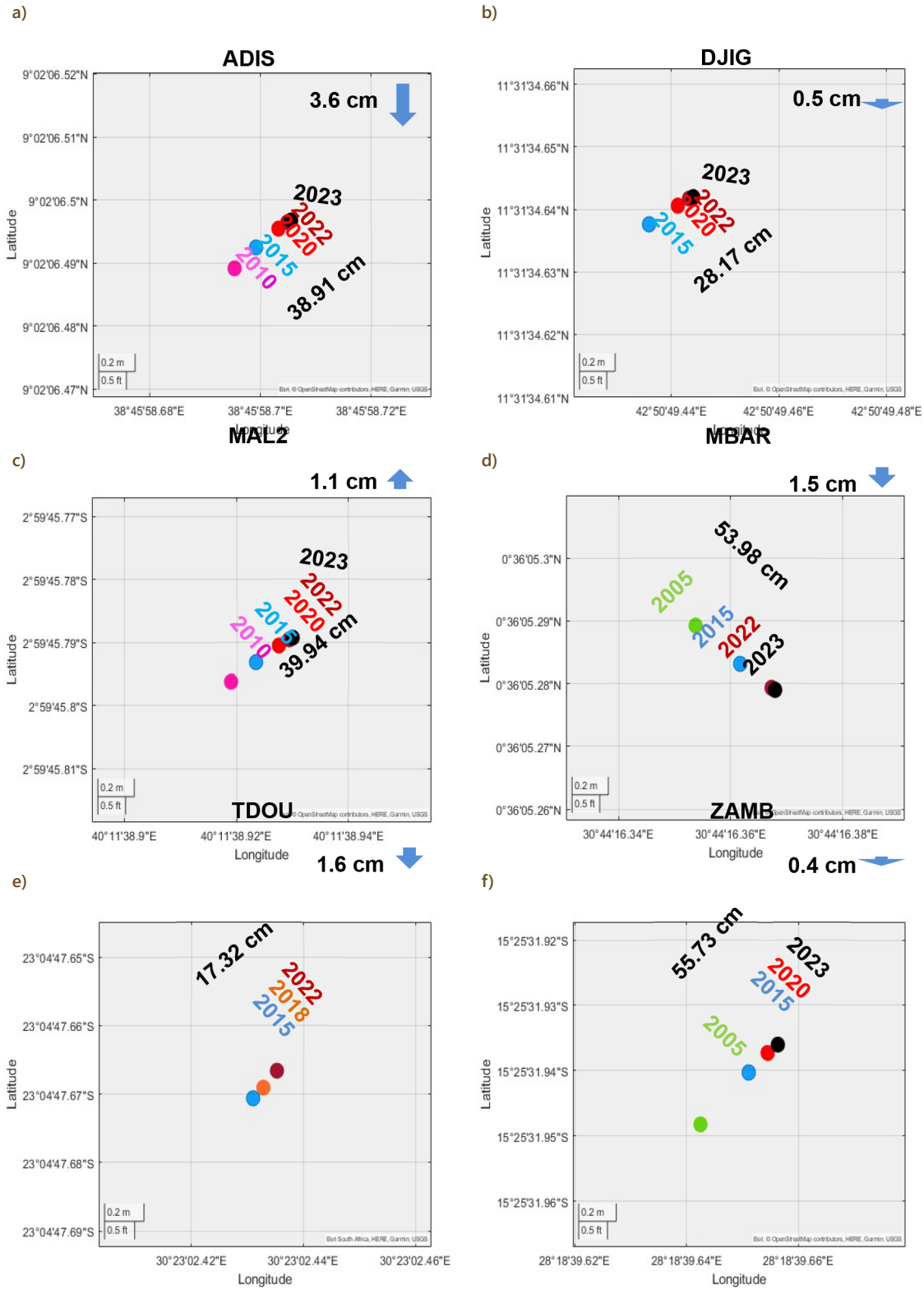

Figure 5. *To be continued*

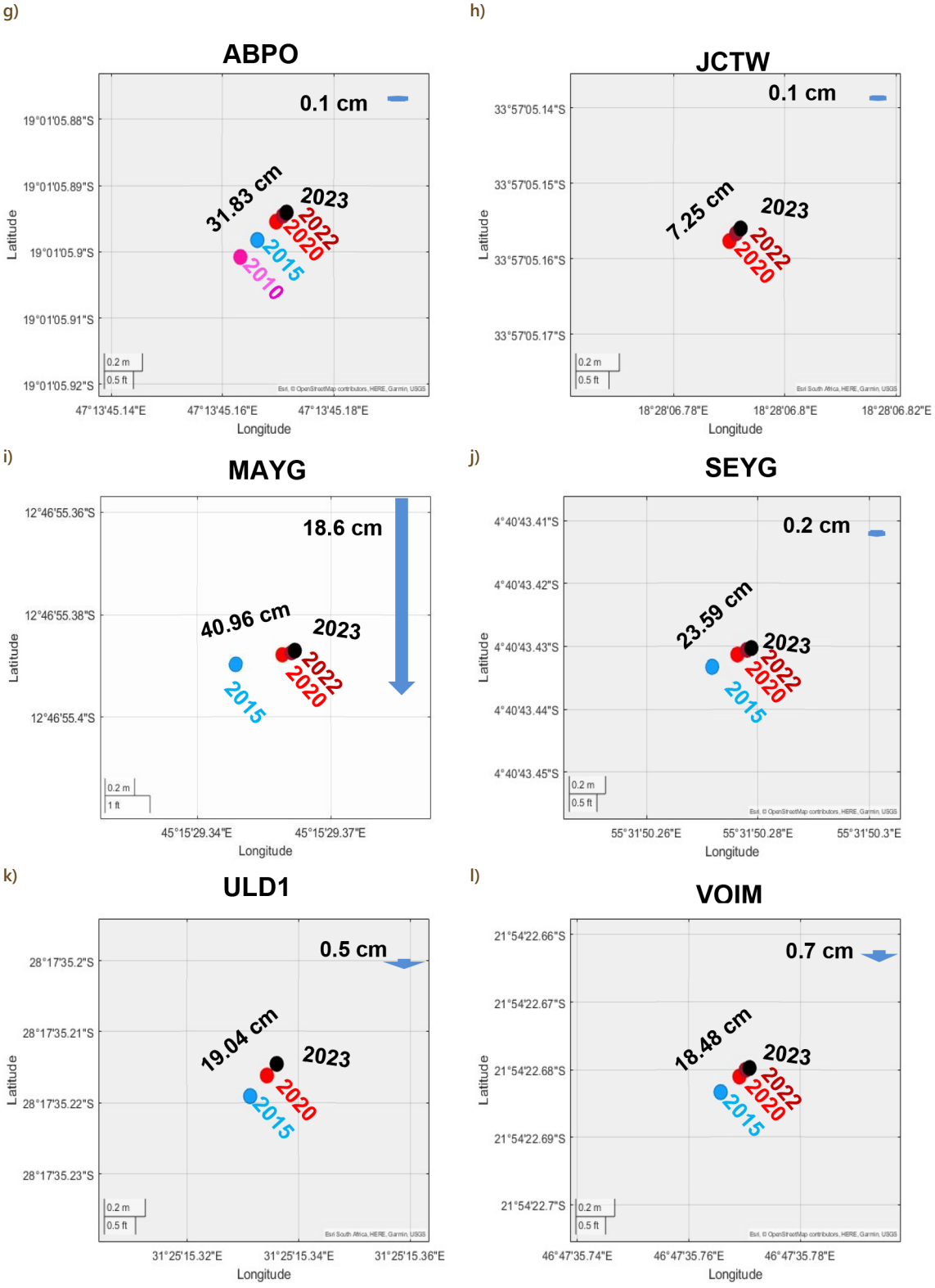

Figure 5. Horizontal and vertical displacement values of twelve IGS points in Africa

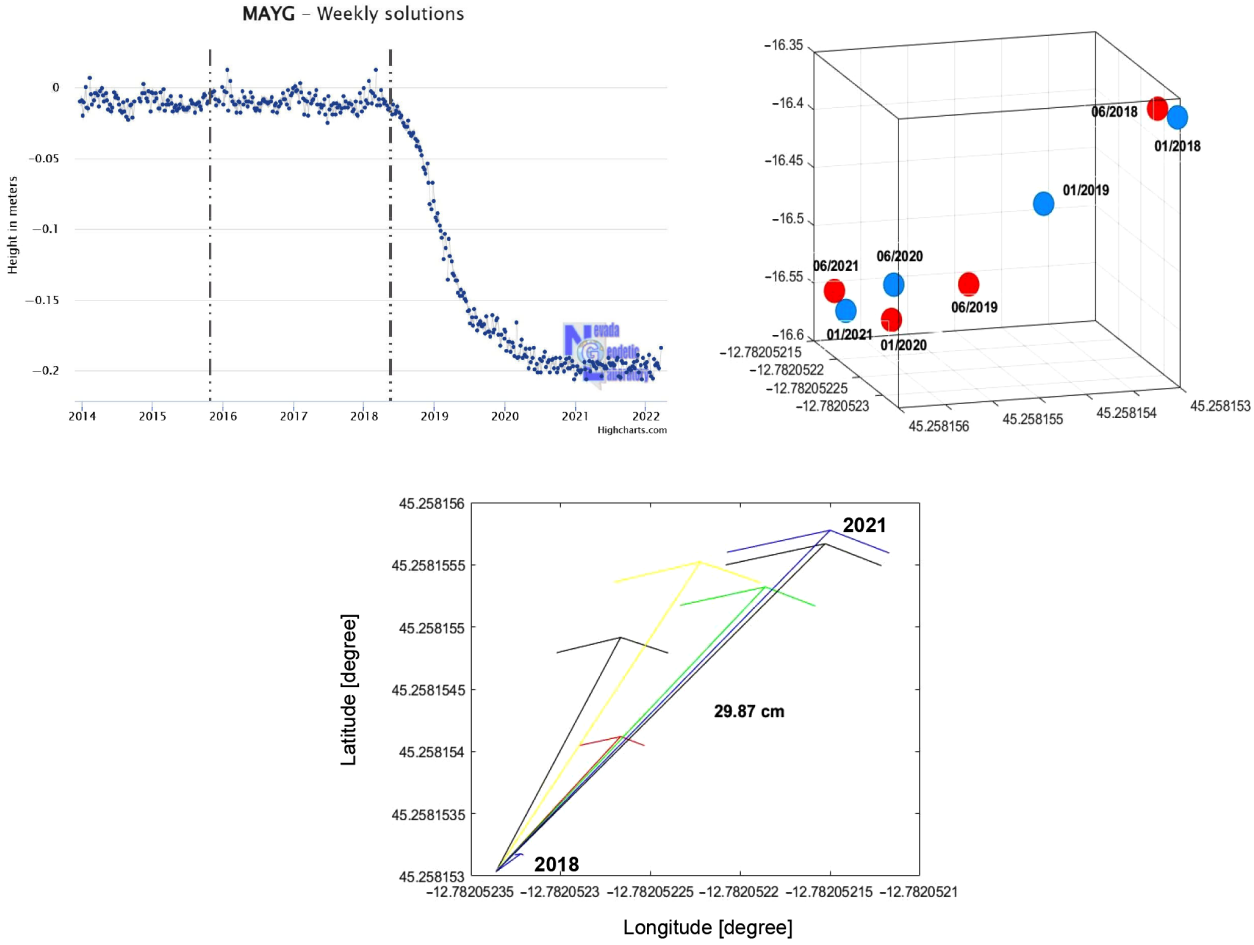

Figure 6. Major seismic events and active volcanoes (MAYG station) are aligned with plate boundaries and rifts (source: National Oceanography Centre, 2024)

starting from May 2018 until January 2021 is about 30 cm, while the vertical displacement is about 20 cm, see Figure 6. The reason for this deformation is explained as earthquakes caused by volcanic eruptions under the ocean. This activity reached its maximum level especially between January 2018 and June 2019. In addition, an acceleration in the movement of the Somalian microplate was observed between these dates.

4. Conclusions

The annual movements of the twelve points were analysed on the African continent (ADIS, DJIG, TDOU, ZAMB, ABPO, JCTW, MAYG, SEYG, ULD1 and VOIM) and were calculated in the range of 2.3–5.12 cm per year in the north-east direction. However, at the MBAR point, which is located outside these points, the horizontal movement was obtained as 3 cm per year in the south-east direction. As can be seen, the movement of the African plate is clearly calculated around 3 cm per year in the north-east direction. The continuous motion within the continental crust has also seen the formation of the East African Rift valley, which continues to be active and to widening and could see the formation of a new ocean in Africa.

References

Boos, W. R., & Emanuel, K. A. (2009). Annual intensification of the Somali jet in a quasi-equilibrium framework: Observational composites. *Quarterly Journal of the Royal Meteorological Society, 135*(639), 319–335. https://doi.org/10.1002/qj.388

Chorowicz, J. (2005). The East African rift system. *Journal of African Earth Sciences, 43*(1), 379–410. https://doi.org/10.1016/j.jafrearsci.2005.07.019

Ebinger, C. (2005). Continental break-up: The East African perspective. *Astronomy and Geophysics, 46*(2), 2.16–2.21. https://doi.org/10.1111/j.1468-4004.2005.46216.x

Emry, E. L., Shen, Y., Nyblade, A. A., Flinders, A., & Bao, X. (2019). Upper mantle earth structure in Africa from full-wave ambient noise tomography. *Geochemistry, Geophysics, Geosystems, 20*(1), 120–147. https://doi.org/10.1029/2018GC007804

Fernandes, R. M. S., Ambrosius, B. A. C., Noomen, R., Bastos, L., Combrinck, L., Miranda, J. M., & Spakman, W. (2004). Angular velocities of Nubia and Somalia from continuous GPS data: Implications on present-day relative kinematics. *Earth and Planetary Science Letters, 222*(1), 197–208. https://doi.org/10.1016/j.epsl.2004.02.008

Furman, T. (2007). Geochemistry of East African Rift basalts: An overview. *Journal of African Earth Sciences, 48*(2–3), 147–160. https://doi.org/10.1016/j.jafrearsci.2006.06.009

IFLScience. (2023). *Africa is splitting into two continents and may open a vast new ocean*. https://www.iflscience.com/africa-

is-splitting-into-two-continents-and-may-open-a-vast-new-ocean-67848

Koptev, A., Burov, E., Calais, E., Leroy, S., Gerya, T., Guillou-Frottier, L., & Cloetingh, S. (2016). Contrasted continental rifting via plume-craton interaction: Applications to Central East African Rift. *Geoscience Frontiers, 7*(2), 221–236. https://doi.org/10.1016/j.gsf.2015.11.002

Munday, C., Savage, N., Jones, R. G., & Washington, R. (2023). Valley formation aridifies East Africa and elevates Congo Basin rainfall. *Nature, 615*(7951), 276–279. https://doi.org/10.1038/s41586-022-05662-5

Munday, C., Washington, R., & Hart, N. (2021). African low-level jets and their importance for water vapor transport and rainfall. *Geophysical Research Letters, 48*(1), Article e2020GL090999. https://doi.org/10.1029/2020GL090999

National Oceanography Centre. (2024). https://psmsl.org/data/obtaining/stations/1642.php

Rajaonarison, T. A., Stamps, D. S., Naliboff, J., Nyblade, A., & Njinju, E. A. (2023). A geodynamic investigation of plume-lithosphere interactions beneath the East African Rift. *Journal of Geophysical Research: Solid Earth*, *128*, Article e2022JB025800. https://doi.org/10.1029/2022JB025800

Scoon, R. N. (2018). The East African rift system. In *Geology of National Parks of Central/Southern Kenya and Northern Tanzania* (pp. 19–28). Springer. https://doi.org/10.1007/978-3-319-73785-0_3

Washington, R., Hart, N. C. G., & Maidment, R. I. (2019). Deep convection over Africa: Annual cycle, ENSO, and trends in the hotspots. *Journal of Climate, 32*(24), 8791–8811. https://doi.org/10.1175/JCLI-D-19-0274.1