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Evidence of changes in the velocity field in the Asal-Ghoubbet rift using GPS data: results of repeated GPS campaigns over a 13-year period.

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The Asal-Ghoubbet rift is located at the western tip of the Aden Ridge, propagating into the eastern part of the Afar Depression (East Africa). The region has been intensevely studied to improve the understanding of the rifting process through a long series of geophysical and geodetic measurements. In particular, GPS campaigns have been performed since the early 90's, with the repetition of measurements of a dense network of geodetic points in 1999, 2001, 2003, 2010 and 2012 within the rift. We determine the horizontal velocity field associated with the opening rift over a total period of 13 years (1999-2012), and its evolution by the decomposition into two periods (1999-2003 and 2003-2012). This data analysis leads us to list significant changes in the velocity field. First, the velocity field obtained during the second period appears more homogeneous with a regular gradient from the southern to northern margins through the whole densely faulted rift. However, because of the important deformation in the southern margin observed since 2003, the deformation associated with the divergent motion of the Arabia/Somalia plates appears more distributed after 2003. Indeed the sites located south of the Tadjoura Bay and the Asal Rift are affected by slow (<3mm/yr) NE-trending movement during the first period and exhibit clear northwards displacements during the second period. The origin of such an important change is not clear: it could be related to the aseismic activity of large normal faults forming the large scarps bounding the south of the Afar Depression and/or (very) far field effects of the Ethiopian Rifting of Dabbahu-Manda Harraro which started in 2005. These displacements observed in the southern part of the region under study reduces the opening velocity across the rift to $\sim$9 mm/yr instead of the $\sim$15 mm/yr observed during the first period, or deduced from the long-term displacements. The dynamics and the location of the opening of the western part of the Aden Ridge is clearly not steady-state, implying the important role of the volcanic systems on the localization/distribution of the extensive deformation related to the plate boundary. At the regional level, this study suggests the contribution of the opening of the basins located within the transfer zone, between the Aden Ridge and the Red Sea branch into Afar, into the plate separation. At the rift scale, it suggests that such significant variations of velocity still bear witness to effects of the 1978 diking event.