

Title: Tectonics and crustal deformation in Ethiopia from Continuously Operating Reference Stations

Abstract

Measurements of tectonics and crustal deformation have contributed greatly to our understanding of tectonics earthquakes, volcanism and landslides. The objective of the study is to investigate tectonics and vertical crustal motion across the Ethiopian Nubia-Somalia plates and within the Main Ethiopian Rift using a network of Continuously Operating Reference Stations (CORS). Twenty nine CORS stations with a tie to 7 IGS stations located outside of Ethiopia were used to assess relative motion between Nubia and Somalia plates and evaluate the dynamics of velocity fields in the North, East and UP (NEU) across the whole region of Ethiopia. Global Navigation Satellite System data from the CORS were processed using GAMIT/GLOBK software package with a tie to the 2008 International Terrestrial Reference Frame (ITRF08) to give time series of position coordinates in the NEU. Later the velocities were computed in the NEU from position time series that spans over the period ranging from 2007 to 2015. Spatial cross-covariance, Semivariogram and other geostatistical techniques are used to assess tectonics and vertical crustal deformation across MER and Nubia-Somalia plates as well as to determine their relative motion. The level of tectonics across Nubia and Somalia was evaluated by comparing mean velocities in north and east of one plate with the other. The dynamics between plate motion and rifting was also assessed by comparing the magnitude of net velocities of the Nubia and Somalia with respect to the corresponding velocities of the MER. The results of the study showed that the MER has experienced consistent deformation at a rate of 8.48 mm/yr in the north, -8.31 mm/yr in the east, and 15.44 mm/yr in the UP directions. Whereas, stations across the Nubia plate have moved in the order of (north: 17.84 mm/yr, east: 24.43 mm/yr, UP: 1.4 mm/yr). Similarly, on average, the Somalia plate is motion in the order of 15.84 mm/yr, 27.56 mm/yr and 1.61 mm/yr, respectively in the north, east and UP. In general, velocities in the east directions are relatively faster across both Nubia (39.54 mm/yr) and Somalia plates (27.91 mm/yr). In contradiction, maximum vertical crustal deformation across the Nubia (20.94 mm/yr) and Somalia (3.23 mm/yr) are slow when compared to their corresponding north and east velocities. Moreover, range values of stations across the MER exceed those of the Nubia-Somalia plates by an amount of 26.59 mm/yr, 46.5 mm/yr and 28.03 mm/yr, respectively for the north, east and UP velocities. The relative tectonic motion between Nubia and Somalia plates is 2.0 mm/yr in the south to north direction and -3.13 mm/yr in the west to east direction; accounting for an overall linear resultant relative plate velocity of 3.74 mm/yr at an azimuthal orientation of -57.45 degree anticlockwise direction over the period from 2007-2015.

Key words: Tectonics, vertical crustal motion, CORS, MER, Nubia-Somalia plates