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Kinematics of the Capricorn microplate and its surrounding regions as inferred from the analyses of GPS data

A.Akilan*[1], K. K. Abdul Azeez[1], Sravan K. Kotluri[2], H.V.S. Satyanarayana[1], S. Padhy[3] and O.P. Pandey[1]
[1]CSIR-National Geophysical Research Institute, Uppal Road, Hyderabad- 500 007, India
[2]National Centre for Earth Science Studies, Triuvanthapuram-695011, India
[3]Department of Earth Sciences, Indian Institute of Technology, Roorkee-247667, India
*Corresponding author: akilan@ngri.res.in

ABSTRACT

The Capricorn microplate, located between the Indian and Australian Plates, is a prominent tectonic block introduced between the two plates, primarily to explain the inconsistency observed in the Indian oceanic plate motions and the prevailing intraplate seismicity. We evaluated the kinematics of this microplate, relative to adjacently located other tectonic plates using GPS data to understand the underlying plate tectonic processes and associated deformation/strain patterns. The lengths of baseline are computed from the DGAR GPS site, placed at the northern fringe of the Capricorn Plate, and adjacently positioned other GPS sites in different geotectonic blocks. The estimated baseline lengths indicate a relative convergent tectonics between Capricorn microplate and southern tip of India with a rate of 1 mm/yr. In comparison, a much higher rate of convergence (about 18 mm/yr) is seen between the Capricorn microplate and the Sunda Plates. Such a high rate of convergence, if persists, would considerably shrink the wide diffusive boundary that currently exists between the Capricorn microplate and the Sunda blocks. Similarly, the baseline length changes between Capricorn microplate and Australia, indicate a shortening at a rate of about 10 mm/yr, which is in good agreement with earlier findings with a diffusive convergent boundary inferred between Capricorn microplate and Australia. A complex rate of change in baseline length is also noticed between this plate and the two different sites inside the African Plate. The DGAR-ZAMB station pair shows divergence between the two plates at a rate of 9 mm/yr, while the DGAR-SUTH (southern margin of Africa) pair shows convergence at a rate of ~4 mm/yr. The observed divergence between the Capricorn and Rovuma microplates, can be explained by the presence of Comores hotspot in the Somalian Plate, which is centered between north Madagascar and Rovuma microplate. This feature causes deformation due to magmatic extrusion led internal rifting (or spreading) below the Comores Islands and its surrounding regions. Consequently, a broad deformation zone is being formed east to the Rovuma microplate due to internal rifting of the Somalian Plate that includes the northern part of Madagascar and northernmost part of the Lwandle Plate.

Key word: Capricorn microplate kinematics, Madagascar, Indian Ocean, GPS, intraplate seismicity, Deformation zone

INTRODUCTION

During the process of plate-tectonics, movement of rigid lithosphere over the ductile asthenosphere may undergo convergence, divergence and/or strike-slip motion. The relative motion between the major tectonic plates, associated with the underlying plate tectonic processes, is the mechanism for the generation of different geological features as well as land forms (mountains and basins, ocean ridges and trenches). Thus, it acts as the primary driving force for natural disasters like earthquakes and volcanic activities (Wilson and Burke, 1972; Chapple and Forsyth, 1979; Sinton and Detrich., 1992). Interestingly, several studies have indicated the presence of microplates within the major tectonic plates that act as a separate entity and show different kinematics than the major lithospheric plates over which they are located (Bird and Naar, 1994; Koehn et al., 2008). Therefore, it is necessary to study the nature and amount of relative motion between different lithospheric plates for better understanding of the various active tectonic processes and associated deformation.

The Global Positioning System (GPS) technology is one of the effective methodologies to study the deformation and movement occurring at any point on the surface of the earth by evaluating the kinematics of the lithospheric plates (Dixon et al., 1991; Larson and Agnew, 1991; Bevis et al., 1995; Bouin and Vigny, 2000; Sella et al., 2002; Vigny et al., 2005; DeMets et al., 2010; Akilan et al., 2016). The Indian Ocean being the third largest among the oceans, has several neighborhood continental regions, which are associated with diverse plate tectonic processes that govern the geodynamic events occurring in the eastern hemisphere (Schlich, 1982). This region is characterized by many geotectonic features, for example, prominent ridges and triple junctions where three plate boundaries meet. The Indian and Australian Plates have long been referred to as one Indo-Australian Plate. The trio of Indo-Australia, Antarctica and Somalia Plates, meets at the Rodrigues triple junction in the Indian Ocean (Royer and Gorden, 1997). The plate motions in the Indian Ocean do not define the rigidity of the Indo-Australian Plate, suggesting major deformation zones that divide the plate into different blocks (Minster and Jordan, 1978; Stein and Gorden, 1984; Royer and Change, 1991; Royer and Gorden, 1997; Conder and Forsyth, 2001). The distribution of strong earthquakes and the currently available GPS data indicate the presence of three active plates in the region: Indian, Australian and Capricorn microplate, which are moving relative to each other independently and have large regions of diffused boundaries.

The Capricorn microplate located between the Indian and Australian Plates, was basically proposed by Royer and