DIFFERENTIAL UPLIFT BETWEEN HYDERABAD AND BANGALORE GEOTECTONIC BLOCKS OF EASTERN DHARWAR CRATON, SOUTH INDIA

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Analysis of geological, geophysical and recently obtained GPS observations over Eastern Dharwar craton of south Indian shield suggest differential uplift between Hyderabad and Bangalore geotectonic blocks. It appears that Hyderabad Granitic Region is uplifting at a high rate of ~12 mm/yr while in contrast, Bangalore geotectonic block may possibly be subsiding(?)

Southern Indian shield forms one of the most diverse and dynamic regions among the cratonic shield areas of the earth. It is characterised by sheared and deformed lithosphere (Pandey and Agrawal, 1999; Agrawal and Pandey, 2004), evolved at different times by different processes. Thermotectonic activity can be traced almost through the entire geologic history beginning from late Archaean. Dynamic response to these events can be seen even today in various forms, which are well reflected in regional geological and geophysical signatures. Several of its cratonic segments (Fig. 1) like eastern part of the Dharwar craton (EDC) and Southern Granulite Terrain (SGT) have been uplifting and eroding for the last several hundreds of million years. As a consequence, granite-greenstone layer has been totally wiped out from SGT resulting in the exposure of deeper parts of granulitic crust at the surface.

Our recent multiparametric geological and geophysical studies (Pandey et al. 2002; Agrawal and Pandey, 2004) reveal that even EDC has been uplifting and eroding, though not as severely as SGT. Here the granitic crust is only about 2-8 km thick (Agrawal and Pandey, 2004). In some segments like 2.5Ga old Hyderabad Granitic Region (HGR), which covers an area of about 200x200 km and situated in the northern part of EDC (Fig. 1), uplift seems to have been very pronounced. Current morphotectonic features, drainage pattern, surface and lake sediment radioactivity, heat flow and earthquake tremors would indicate a prolonged history of neotectonic activity and uplift of HGR which is still continuing (Pandey et al. 2002). Morpho-structurally, HGR resembles a circular morphostructure (Rantsman et al. 1995), showing concentric circular features around a common center situated at Hyderabad (Fig. 2). Concentric elements of topography could be seen intersected by presently active lineaments. River courses (Godavari and Krishna) flow parallel to these circular features. The Manjira river, which is situated NW of Hyderabad takes a sudden upward U turn after reaching close to the city. Earlier this river is known to have been flowing into the Musi river, which still runs across Hyderabad. (Pandey et al. 2002). As a consequence of the uplift, only a thin veneer (~1-2 km) of granites now remain. This inference is consistent with low measured surface heat flow and underlying seismic structure (Gupta et al. 1987; Pandey et al. 2002). Occurrence of pyroxene bearing granite/ charnockite assemblages in and around Hyderabad, which

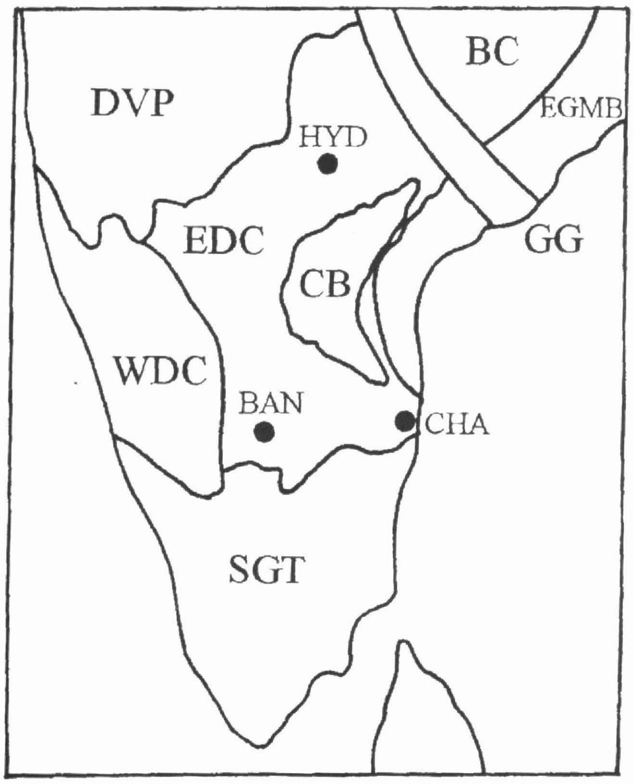

Fig.1. Major geotectonic divisions of southern Indian shield. DVP: Deccan Volcanic Province; BC: Bundelkhand Craton; EGMB: Eastern Ghat Mobile Belt; WDC: Western Dharwar Craton; EDC: Eastern Dharwar Craton; SGT: Southern Granulite Terrain; GG: Godavari Graben; CB: Cuddapah Basin; HYD: Hyderabad; BAN: Bangalore; CHA: Chennai.

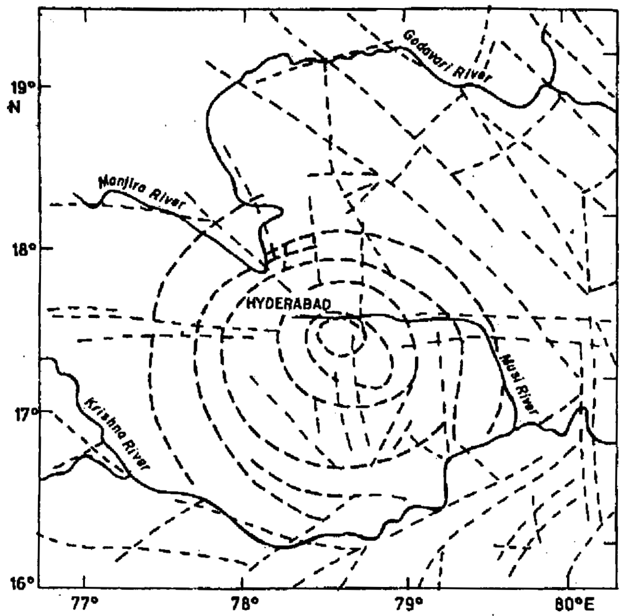

Fig.2. Morpho-structural pattern around Hyderabad segment of EDC (Revised after Rantsman et al. 1995).

initially evolved at considerable depths (Sarma, 1954; Sitaramayya, 1971), would further support this conjecture. Recently carried out detailed gravity measurements covering around 800 additional sites over this region (Singh et al. 2004) would, however, indicate on an average a little higher granitic thickness of ~4-5 km beneath Hyderabad granitic pluton. Interestingly, Moho beneath this region has also upwarped considerably, lying at the depth of about 32-33 km only (Saul et al. 2000).

In order to further study the upliftment of EDC in general and HGR in particular, a preliminary attempt has been made here to study the rate of vertical component from GPS (Global Positioning System) data which is now incidentally available for two IGS (International GPS service for Geodynamics) GPS stations Hyderabad (HYDE) and Bangalore (IISC), in order to ascertain whether signature of HYDE uplift is visible in GPS data sets also.

For this study, our selected network of stations include two IGS GPS stations IISC and HYDE on the Indian plate besides some other global IGS GPS stations like Lhasa (LHAS), Shanghai (SHAO), Wettzell (WTZR), Irkutzk (IRKT), Hartbeesthoek (HARK) and Yaragadee (YAR1). The epochs of GPS data used in this study are mostly of 24-hour duration selected at intervals of a week to 10 days. These selected epochs from 1997-1999 have been processed using Bernese 4.2 GPS data analysis software along with final official precise orbits distributed by IGS and pole orientation parameters. Station coordinates are computed in the ITRF96 (International Terrestrial Reference Frame) reference frame and in the Eurasia fixed frame by fixing the IGS GPS stations WTZR and IRKT, which

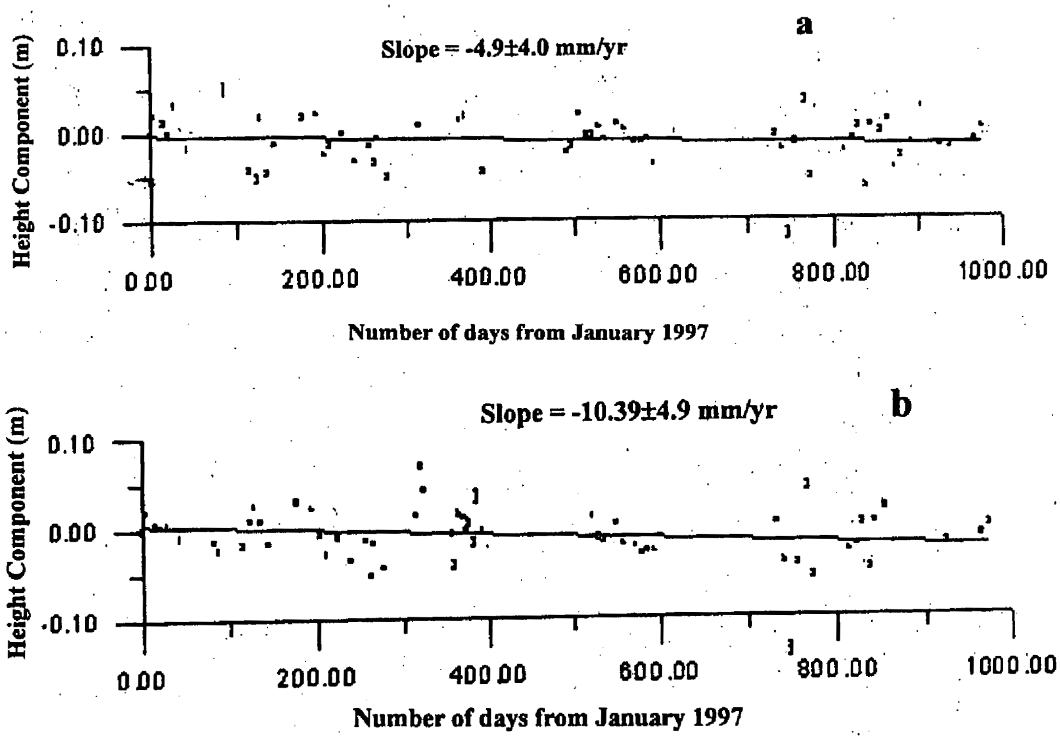

Fig.3. Time evolution of vertical components of HYDE (a) and IISC (b) in the Eurasia-fixed frame.

Table 1. The rate of vertical velocity components of HYDE and IISC with respect to Eurasia and ITRF96

Station	Vertical component (mm/yr)
HYDE	-4.94±4.0
IISC	-10.39±4.9

Table 2. The rate of vertical velocity components of HYDE and IISC in ITRF96

Station	Vertical component (mm/yr)
HYDE	11.7±2.6
IISC	-2.3±2.6

show insignificant motions (0.4 mm/yr and 0.3 mm/yr respectively) with respect to Eurasia (Chen et al. 2000). The ionosphere-free linear combination is used for estimating the station coordinates and baseline solutions. An elevation cut off angle of 20^0 is used in the data processing to reduce any multipath effects. The Saastamoinen atmospheric zenith delay with standard atmosphere is utilized to calculate an a priori model for tropospheric corrections. The error manifested in the estimation of station coordinates is a sum of all the errors due to ionosphere, troposphere, multipath etc. But it is assumed that the crustal deformation motion overrides the error budget from all these sources contributing to the error, when they are modeled as in the present study, than unmodeled. The detailed computational procedure is given in Catherine (2002, 2004).

The rate of vertical components of HYDE and IISC with respect to Eurasia are shown in Table 1, which reveal that both HYDE and IISC are associated with varying magnitude of vertical component velocity. The network analysis with respect to Eurasia reveals that IISC is subsiding more compared to HYDE (Figs.3a,b; Table 1). In other words, it might point out a possibility of relative uplift of HYDE in comparison to IISC. To examine it further, we attempted to re-analyze the intermediate baseline between HYDE and IISC, situated ~500 km apart by resolving the phase ambiguities. Resolution of phase ambiguities of this medium baseline is not feasible when this baseline is processed along with the other longer baselines of the network considered. The analysis is carried out by taking IISC as the reference point whose coordinates and velocity are known very precisely in International Terrestrial Reference Frame (ITRF). The coordinates of HYDE have been estimated by fixing IISC station to its ITRF coordinates. The rate of vertical components of HYDE and IISC as obtained from this re-analysis are given in Table 2 and Figs. 4a,b.

Despite the fact that the vertical component is poorly constrained by GPS data analysis, the re-analysis of the

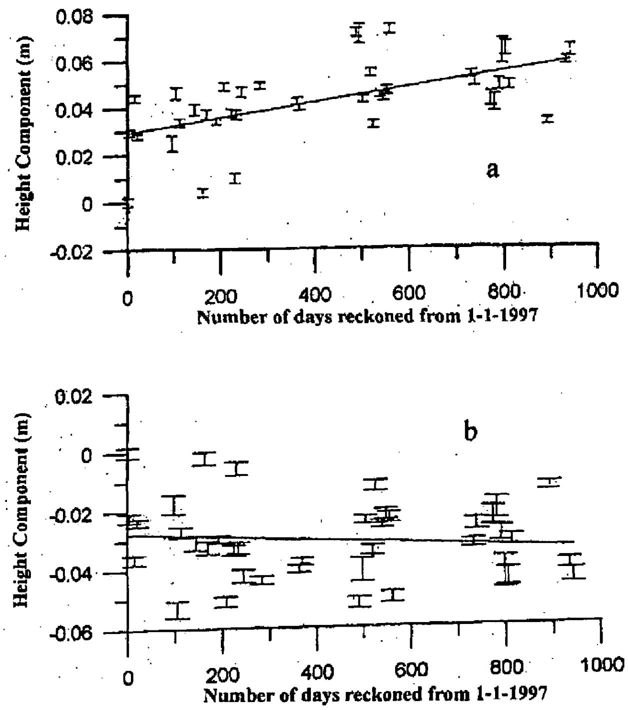

Fig.4. Time evolution of vertical component of (i) HYDE with respect to IISC (a) and (ii) IISC with respect to HYDE (b) in the ITRF96 reference frame.

medium distance baseline independently suggests that with respect to IISC, HYDE is uplifting at a relatively rapid rate of about 12 mm/yr which would mean that in the last 100,000 years, HYDE has uplifted to a tune of about 1 km or so, leading to disruption of the drainage and river courses. However, it poses an interesting question whether IISC, in contrast, is subsiding in relation to HYDE (as revealed clearly in the Eurasia-fixed frame analysis), or whether IISC is nearly stable as revealed by medium distance baseline analysis.

Our inferences drawn from this study are preliminary although they appear to conform with our earlier results and available geological/geophysical observations. The relative uplift between HYDE and IISC may be related in someway or other to the fact that both the stations are situated over totally two different tectonic blocks (Veeraswamy and Raval, 2003) which are in relative motion to each other (Catherine, 2004). To confirm the findings and to further assess neotectonic activity and deformational pattern of EDC, a well-organized GPS study need be carried out by mounting dense network of GPS stations.

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