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Continuous Monitoring Permanent GPS Station at Imphal for Crustal Deformation and Earthquake Studies

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Abstract: ***The north eastern part of the Indian subcontinent is one of the most seismically active regions of the world and displays a complex geodynamic situation. It consists of Eastern Himalayan Mobile belt, Mishmi Block, Indo-Myanmar Mobile Belt, Meghalaya Plateau, Mikir Hills and Brahmaputra Valley. The plate motion and geodynamic processes are poorly understood due to the complex geodynamic setting of the region. In order to understand the earthquake occurrence process and assess the future seismic hazards in this region different permanent GPS station has been established. A brief description of one of the GPS permanent station i,e, IMPH in the Indo-Myanmar wedge (IMW) , data processing , analysis during the 2004 Sumatra Andaman earthquake (M 9.2) and Manipur earthquake (M 6.7) as a case studies are presented in this paper.***

Keywords: GPS, Crustal deformation, Indo Myanmar Wedge (IMW)

1. Introduction

The continuously operating GPS permanent station at Imphal (Fig.1) was installed in 2003. The station is located on a hill within the campus of Manipur University. The station is located on a pillar approximately 7 m high and is rooted in the outcropping Disang formation. It is equipped with a Trimble 5700 receiver and a Trimble Choke ring antenna. The Antenna is fixed on an 8 feet high RCC pillar and the receiver and battery are housed in a small nearby shed. The receiver is powered by the AC as well as through batteries which are charged using the solar panels (Fig. 1). Operational from January 2003.

Figure 1: GPS permanent station at Imphal

Data processing and analysis

The GPS data obtained from the site have been converted into RINEX observation files and quality check was performed using TEQC (Translation, Editing and Quality Checking Software). The quality check plots of all the GPS data were carefully examined and the data with high cycle clips, multipath and of duration with <18 hours observation were removed from the analysis.

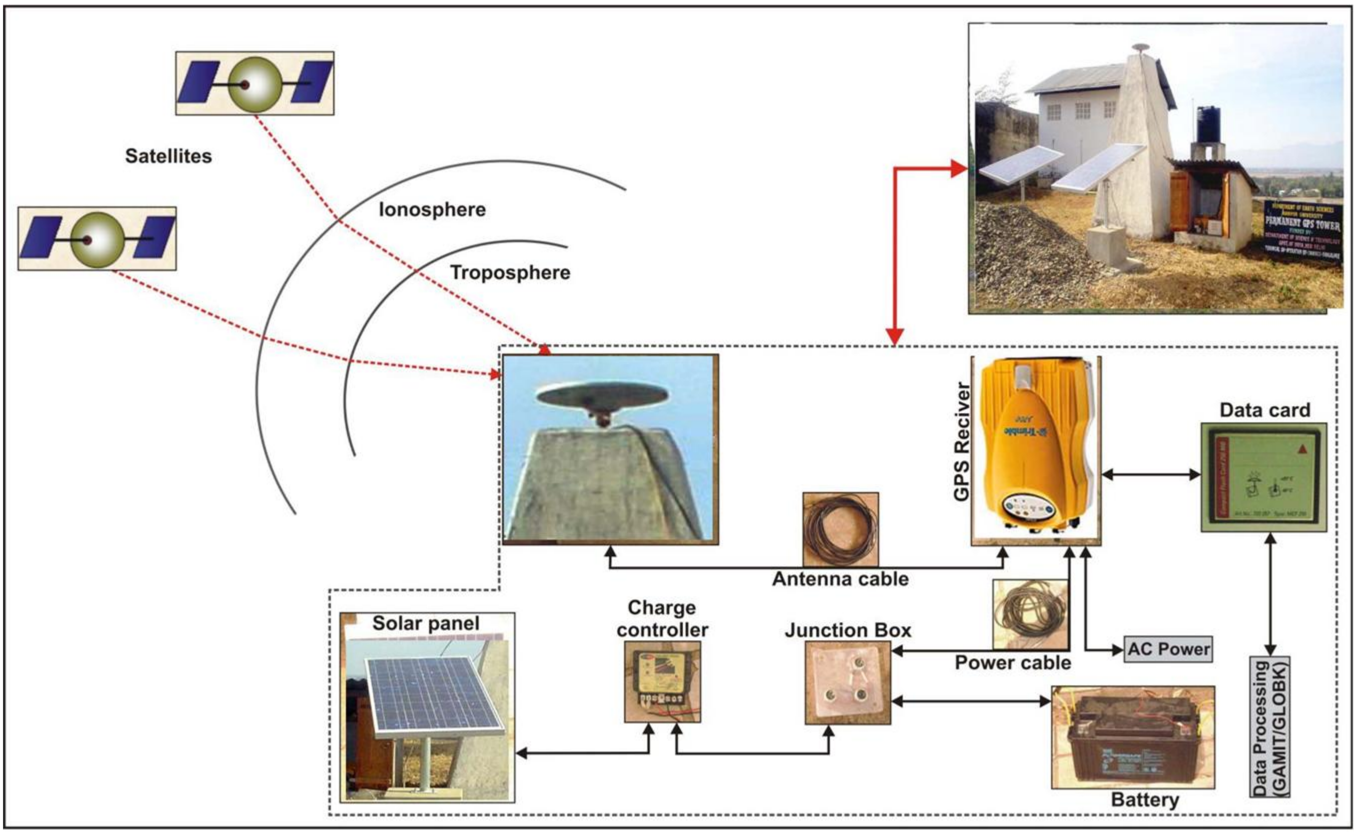

Figure 2: Schematic representation of GPS Permanent Station, GPS instrument and its associated flowchart

The processing of the GPS data from station is routinely performed at Department of Earth Sciences Manipur University using the GAMIT/GLOBK software (Herring et al., 2010a,b). Data from IGS (International GPS Service) sites, namely, BAHR, IISC, HYDE, LHAS, KIT3, KUNM and POL2. These data were processed on daily basis producing loosely constrained station coordinates and satellite orbits. These were further combined with loosely constrained solutions of globally distributed nearby IGS station data available from the Scripps Orbital and Positioning Analysis Centre (SOPAC; http:garner.ucsd.edu). Using the GLOBK software (Herring, 2005), position estimates and velocity stabilization in ITRF08 were achieved.

2. Results and Conclusion

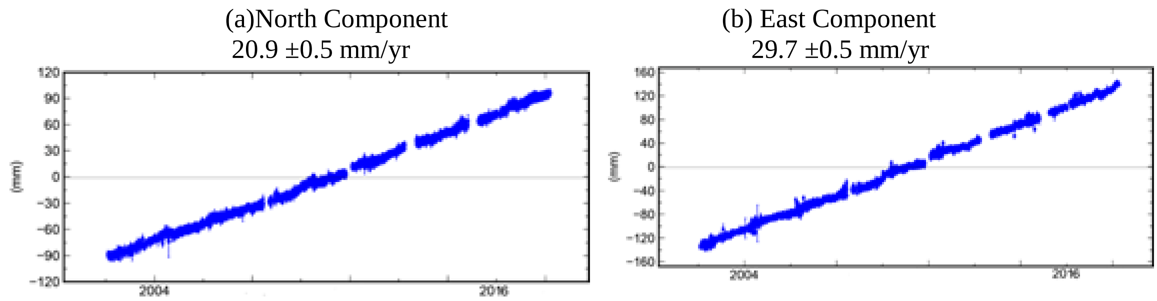

Figure 3: Time series at IMPH in ITRF2008

Time series 2003-2016 of IMPH site is shown in Fig. 3. In the time series north component shows deformation 20.9 ±0.5 mm/yr, east component shows deformation 29.7 ±0.5 mm/yr and up components shows the deformation 0 ±19 mm/yr.

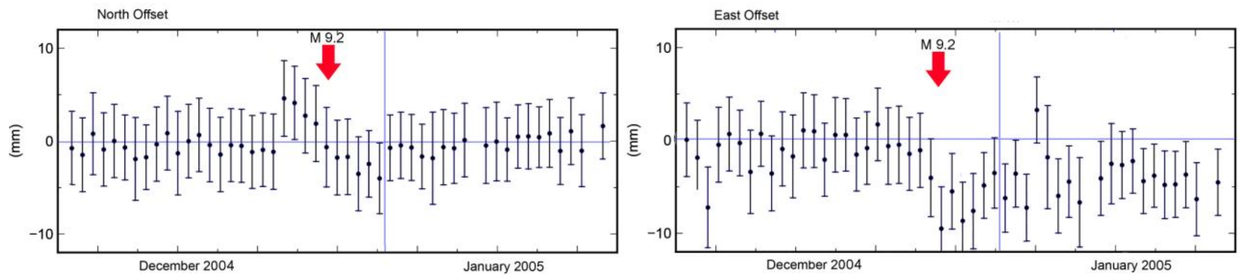

Figure 4: Time series at IMPH showing coseismic offset due to the 2004 Sumatra Earthquake

In the 2004 Sumatra Andaman earthquake (M 9.2) we analysed 2 months of GPS data from IMPH site, one month before and one month after the earthquake, and found that the earthquake actually caused some coseismic displacement at this site. The offset in the north coordinate is not very obvious but it could be anywhere between 0 to 3 mm towards south. The offset in the east component is quite prominent and is about 5 mm towards west (Fig. 4). Thus we suggest that the IMPH experienced predominantly southwestward offset during the 2004 Sumatra Andaman earthquake. The linear trend at the site after the earthquake discounts any effect of the postseismic deformation due to the 2004 earthquake

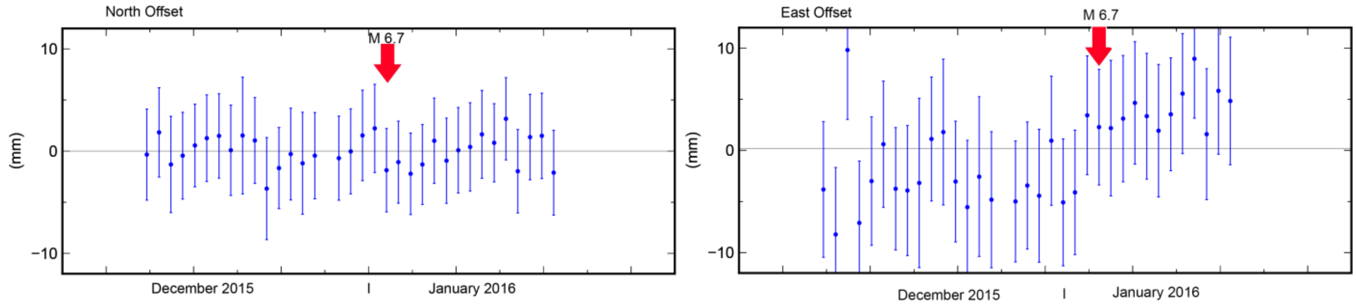

Figure 5: Time series at IMPH showing coseismic offset due to the 2016 Manipur earthquake

Again a major earthquake occurred in the region during the period of 2003-2016. This earthquake of Mw 6.7 which occurred near the Noney village of Tamenglong district, 30 km WNW of Imphal, Manipur on 4th January 2016. This is the largest earthquake occurred in the region during last six decades. The last event of M 7.3 occurred on 1st July 1957 at SW of Imphal in Manipur Valley. At the time of the shock Time series of IMPH a co-seismic displacement is evidenced of about ~ 8.5 mm in ENE (Fig. 5.) . The offset in the North component is not obvious, however it is quite distinct in the East component. In the North component the offset is ~3 mm and East component is ~ 8 mm. A weak pre-seismic signal is emerging from the background noise during the month preceding the main shock and is evidenced by a change in the slope of the time series. The mainshock is characterized by an abrupt change of the time series. A significant afterslip movement is seen for the month following the co-seismic rupture.

In ITRF2008 reference frame the IMPH site shows a velocity of 36.3 mm/year towards N55° . This velocity is significantly less than the velocity of Indian plate which is about 52 mm/year towards N52°. It implies that the difference in motion between the Indian plate and the IMPH site is accommodated somewhere west of the IMPH site. This can be better visualized by estimating the velocity of IMPH site in Indian reference frame. We use the euler pole estimated by Banerjee et al. (2008) for representing the Indian plate motion. In Indian reference frame, the IMPH site moves at a velocity of about 16.7 mm/year towards N222°, i.e. towards southwest. One of the immediate deductions from these results is that the site IMPH is not located on the Indian plate. The site is actually located on the Burma plate and the velocity with reference to the Indian plate provides a constraint on the motion accommodated at the plate boundary fault located between the India and Burma plate.

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References

[1] Akilan, A., Balaji. S., Malaimani E.C. , Ravikumar N. and Abilash K. (2012): Current scenario of crustal deformation and strain distribution around the equatorial Indian Ocean region using GPS-Geodesy J. Ind. Geophys. Union (January 2012) Vol.16, No.1, pp.21-28

[2] BANERJEE, P., BÜRGMANN, R., NAGARAJAN, B. and APEL, E. (2008) Intraplate deformation of the Indian subcontinent, Geophys. Res. Lett., v.35, L18301, doi:10.1029/2008GL035468

[3] Banner, D. and Helmeke., (1981): The Evolution of Asian Plate in Burma: Int. J. Earth Sc. Vol 70.

[4] Herring, T. A. (2005), GLOBK: Global Kalman filter VLBI and GPS analysis program version 10.01, Mass. Inst. of Technol., Cambridge

[5] Herring, T. A., R.W. King and S.C. McClusky (2010a), GAMIT reference manual: GPS analysis at MIT, Release 10.4, Mass. Inst. of Technol., Cambridge.

[6] Herring, T. A., R.W. King and S.C. McClusky (2010b), GLOBK Global Kalman Filter VLBI and GPS analysis program, Release 10.4, Mass. Inst. of Technol., Cambridge.
[7] Nandy, D. R., (2001): Geodynamics of northeast India and the adjoining region. ACB Publication
[8] Laishram Sunil Singh, V.K.Gahalaut , Arun Kumar "Nine years of GPS measurements of crustal deformation at Imphal, Indo-Burmese wedge" Journal of the Geological Society of India Vol. 83, May 2014. pp. 513-516 .