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Preliminary Study of Geodetic Measurement for Crustal Deformation in Myanmar

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Background

Myanmar is located at the junction between India, Eurasia, Sunda and Burma plates. The Indian Plate collides with Eurasia Plate at the rate of 50 mm/yr (GIAC, 2002), while the relative motion between India and Sunda plates is 35 mm/yr (Socquet et al,2006) and the rate of subduction of Indian plate beneath the Burma plate is about 12 - 24 mm/yr (Mallick et al.,2019).

In Myanmar, earthquakes are mainly caused by the tectonic movements related to the subduction of the Indian plate beneath the Burma Plate along the Andaman Islands and Rakhine-Chin-Naga Ranges in the western part of Myanmar. Another major active geological structure that generates major earthquakes in Myanmar is the Sagaing Fault, which is a right lateral strike slip fault and its slip rate is 18 – 20 mm/yr. Many large earthquakes have struck in the vicinity of this fault, and due to those earthquakes many hundreds of casualties and several damages have been occurred in Myanmar. Most of the major cities in Myanmar as Yangon, Mandalay, Nay Pyi Taw, Bago, Sagaing, Taungoo, Meiktila, etc. lie near-by and along the Sagaing Fault. From the nature of seismicity and exposure, we can understand the high seismic hazard condition in the near future. Therefore, we urgently need to understand slip budget available along convergence between the Indian-Burma Plates and the Sagaing Fault in Myanmar.

GPS Network

A GPS network was constructed under the collaboration between Myanmar Earthquake Committee (MEC), Earth Observatory of Singapore (EOS) and Department of Meteorology and Hydrology (DMH) for geodetic survey in Myanmar since 2011. We installed 17 continuous GPS stations with 3 transect perpendicular to the Sagaing Fault from upper to lower Myanmar. As illustrated in Fig 1, the southern transect consists of 4 stations which started operation in November 2011. The northern transect that include 4 stations started observation in February 2012, while the middle transect consisting of 9 stations has been in operation in November 2017. Two stations were destroyed because of the weather erosion during in these years. Therefore, we constructed new one near the previous stations of replacement for these in 2015 and 2018.

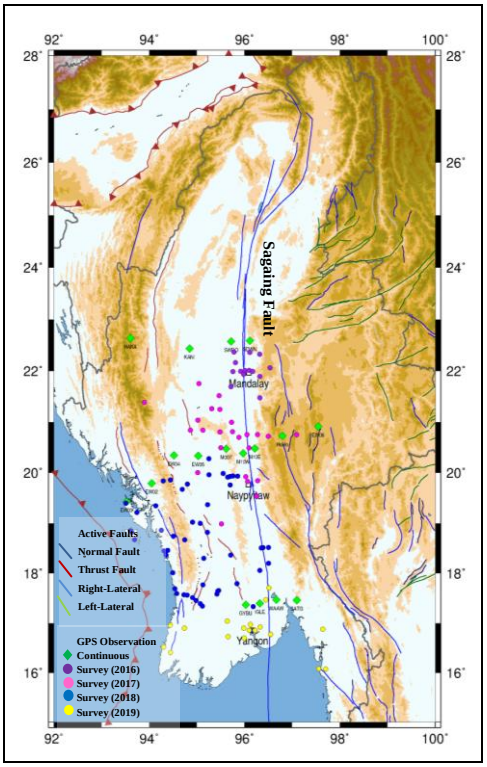

Fig. 1 GPS stations in Myanmar

For more coverage of the enough data for Indo-Myanmar (Burma) Ranges in the west and Eastern

Highland in the east, the campaign measurements have been repeated since 2016. Now we possess more than 113 campaign stations and 17 continuous stations to estimate of crustal deformation in Myanmar.

Data Processing

We estimated site velocities for 17 permanent stations and 41 campaign stations since 2016. We can also obtain 17 permanent IGS network stations for RINEX data to improve the site positions and solution of consistent reference frame in our research area (LHAZ, CUSV, IISC, HYDE, BAKO, HKSL, HKWS, COCO, XMIS, CMUM, CPNM, ANMG, NTUS, WUHN, WUH2, JFNG, LCK4). Daily coordinate positions for permanent and campaign stations in the International Terrestrial Reference Frame 2014 (ITRF2014) are computed by using GIPSY-OASIS ver 6.2 software from Jet Propulsion Laboratory (JPL). Ocean tide loading was calculated by the Onsala Space Observatory using FES2014b model (http://holt.oso.chalmers.se/loading/) with respect to the joint mass center of solid Earth and ocean combined.

Discussion and Result

As mentioned above, most of earthquakes in Myanmar have been generated by the tectonic motion between subduction of Indian Plate beneath the Burma Plate in the western Myanmar. Another major source is the 1200 km long Sagaing Fault (a dexteral strike slip fault). Sagaing Fault is considered as the tectonic boundary between two paleo-micro continental blocks; Shan Plateau on the eastern side and Burma Plate on the western side. In this analysis we intend to estimate the present-day relative motion between India plate, Sunda plate and Burma plate. The resulting velocities in International Terrestrial Reference Frame 2014 (ITRF2014) are used to estimate crustal deformation in Myanmar for further analysis. Our geodetic data confirm that the presently relative motion rate and the direction of movement between the GNSS stations on two paleo-micro continental blocks are consistent with the dextral strike slip of this fault system. The stations on the eastern side show the smaller velocities (3 - 8 mm/yr), with relative to the Sunda plate, than those on the western side (18 – 38 mm/yr) of the Sagaing Fault (Fig. 2). This result implies that the eastern side is more stable than the western side of the Sagaing Fault. The velocities in Mandalay area show WSW direction due to the effect of clockwise rotation of Eastern Himalayan Syntaxis from the north.

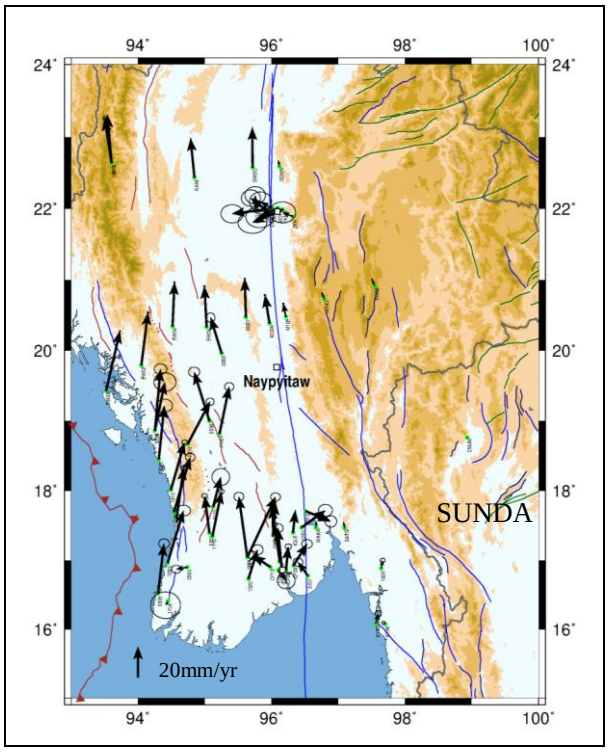

Fig (2) GPS velocities vectors with respect to Sunda Plate. Error ellipse show 95%confidence level.

Keywords: Sagaing Fault, Burma Pate, Shan Plateau, Adaman Island, Rakhine-Chin-Naga –Ranges, Eastern Himalayan Syntaxis