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Monitoring of fault creeping at south part of Metro Manila, Philippines

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Metro Manila, in the Philippines, is the nation's center of politics, economy, and culture. It has rapidly grown into an overcrowded mega city with an economically active population of at least 10 million. On the eastern portion of Metro Manila lies the active Marikina Valley fault system (MVFS). According to results of a trench survey (Nelson et al., 2000, Rimando et al. 2006), it has a potential for a M6-M7 earthquake occurring along the northern part of MVFS' western segment. At the southern part of Metro Manila, while structures and pavements are damaged recently by ground deformation along the MVFS, no big earthquake whatever is involved. From a safety point of view of an urban area, it is important to monitor such the ground deformation.

In this study, monitoring of ground deformation was done through repeated leveling surveys and continuously through a creep measuring device installed across the MVFS' creeping zone in the southern part of Metro Manila.

To monitor the slip rate, periodic leveling surveys across the creeping fault zone at six sites had been done since September 1999. Since there is little or no horizontal slip, the survey employed a simple leveling method using an electronic digital level and barcode leveling staff. Overall accuracy is estimated to be 2-3mm. Survey interval was initially every three months and later, every six months. At first, eight survey lines at four sites were set up but two survey lines at two locations were lost due to road repairs. Two new lines at other one site were set up on September 2012.

Three survey lines (VOS, JUA-A, JUA-B) show continuous creep dislocation. The average slip rate is 1.70cm/y. One survey line (NPC-A) shows no creep dislocation since the survey started in 1999 even though echelon cracks on the pavements are still visible. Two survey lines (NPC-B, NPC-C) and three survey lines (GRV-A, GRV-B GRV-C) show continuous creep dislocation until December 2007 and March 2010, respectively. The average slip rate of these five survey lines ranges from 1.07cm/y to 2.61cm/y. However, movement direction by creep was changed from East-up (West-down) to East-down (West-up) since December 2007 and March 2010.

To track detailed displacement changes at the creeping fault segments, continuous monitoring at NPC-B has been carried out since September 2008. The sampling interval is 3 hours. Until January 2009, the average slip rate gathered from this site is 0.01mm/day (3.65mm/y), the east side of the fault subsided (or the west side uplifted). Although the fluctuation of the displacement is +/-0.5mm, the fault creep appears to have stopped as of July 2009.

There are two hypotheses for the triggering mechanism of the continuous dislocation of the MVFS' creeping zone segment. One is excessive withdrawal of groundwater due to rapid urban growth; the other is tectonic.

Several ground deformation anomalies were detected in Metro Manila through the InSAR time series analysis (Deguchi et al. 2011). Most of the vertical movements can be correlated with groundwater level changes. Some of the deformation are independent of the groundwater level changes in the areas surrounding MVFS. Therefore, the possibility that some of the deformation by creep are tectonic in nature cannot be denied.

Keywords: Active fault, Creep, Monitoring, Metro Manila