AGNeSS: NEW DENSE GPS OBSERVATION NETWORK ON THE NORTHERN PART OF THE SUMATRAN FAULT SYSTEM

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ABSTRACT

After the 2004 Sumatra Andaman Earthquake, it is important to understand the stress accumulation and release process on the northern part of Sumatran Fault. In order to investigate the activity of the Sumatran Fault, especially the strain accumulation in the northern part, a collaboration research between Nagoya University, Bandung Institute of Technology, Syah Kuala University and the Agency for the Assessment and Application of Technology was initiated. This collaboration research establishes a dense GPS continuous stations namely AGNeSS (Aceh GPS Network for Sumatran Fault System) since November 2007. The configuration of the stations are constructed across the Seulimem Segment and Aceh Segment of Sumatran Fault system, and divided into two blocks, north and south block. The creep or lock motion of the block around the fault should be detected by analyzing the continuous GPS data.

Keywords : Sumatran fault, GPS, stress, stress accumulation
1. INTRODUCTION

Since the Sumatran Fault is highly segmented, it is important to look more detail for each segment especially the northern part after the 2004 Sumatra-Andaman earthquake. Previous results had calculated the stress in the northern part of Sumatran Fault to increase up to 9 bars for about 300 km along the fault near Bandaaceh City (McCloskey et al., 2005).

It means the displacement related to the stress accumulation on that area for 200 years can reach 760 cm which equal to an earthquake with magnitude 8.1 if the stress is released (Chinnery, 1969). However, the magnitude of the earthquakes which were recorded on this area varies between 6.0 and 7.5. Therefore it is important to understand the stress accumulation and release process on the northern part of Sumatran Fault.

In order to investigate the activity of the Sumatran Fault, especially the strain accumulation in the northern part, a collaboration research between Nagoya University, Bandung Institute of Technology, Syah Kuala University and the Agency for the Assessment and Application of Technology was initiated.

This collaboration continuous research establishes a dense GPS continuous stations namely AGNeSS (Aceh GPS Network for Sumatran Fault System) since November 2007. The configuration of the stations are constructed across the Seulimem and Aceh segments (Sieh and Natawidjaja, 2000) and divided into two blocks, north and south block. The creep or lock motion of the block around the fault should be detected by analyzing the continuous GPS data.

2. ACEH GPS NETWORK for SUMATRAN FAULT SYSTEM (AGNeSS)

Sumatran fault system in Indonesia is one of the major trench-parallel strike-slip fault systems in the world. The length of Sumatran fault system is over 1900 km. After the 2004 Sumatra Andaman Earthquake, the seismic activity is increase. In 2007, the Magnitude 6.4 and 6.3 earthquakes already occurred at Sumatran Fault system.

The geological slip rates of the Sumatran fault system have been estimated in several previous studies. The estimated slip rates have a characteristic pattern, which is a monotonous increase toward the northwest. The maximum slip rate based on the geological estimates at the northern part is approximately 38 mm/yr (Bennet et al., 1981). At the northwestern segment, the geological slip rate in this area is nearly four times larger than geological slip rate of the southeastern part.

![Figure 1. Geological slip rates on the Sumatran Fault System.](image)
Natawidjaja (2003) divided the 1900-km-long fault system into 19 segments from the geomorphological and seismological points of view. Based on the earthquake records, most segments have been broken within the last century. The magnitudes of these earthquakes were between 6.0 and 7.5. However, the northern part segments do not show any evidence of recent fault slip. There is no record of outstanding earthquake damage in the 200-year-long city’s history.

The stress accumulation rate is 3.8 cm/yr at northwestern part of the Sumatran fault system. Non-earthquake period is 200 yr. We estimate stress accumulation is over 760 cm. If all accumulated stress release by earthquake, Magnitude of earthquake is up to 8.1. However, large earthquake with a magnitude exceeding 7.5 has not been recorded at the Sumatran fault system. If magnitude 7.0 earthquake occur, stress release are only 120 cm. Where did the accumulated stress go? Thus the most important question is a process of stress accumulation and release.

To find out the answer, it is important to establish a GPS monitoring network to detect whether creeping or locking phenomenon occurs in this region.

Left illustration indicates a long-term full locking of fault plane and therefore stress is accumulating at the fault plane. If fault plane is locking, then the earthquake potential is high. The right case is a creeping at the fault. Since creeping fault cannot accumulate stress, therefore the earthquake potential is much lower. The goal of the establishment of the AGNeSS is to evaluate the earthquake potential along the fault in the Aceh and Seulimem segments by monitoring earthquake activity and detecting strain accumulation in the vicinity of the fault.

Figure 3. Illustration of the AGNeSS distribution with 4-digits station name.
The continuous GPS observation system consists of about 1.5-m-high concrete pillar supports the GPS antenna and other instruments including GPS receiver, download device, solar controller, and backup battery are stored in a steel box embedded in the foundation. Trimble 4000SSI receiver collects GPS data every second and data is automatically downloaded. At the same time 30-sec sampling data are converted from the 1-sec data.

3. DISCUSSION

In addition, the calculation on Coulomb Stress Changes (delta CFF) after the giant 2004 Sumatra-Andaman earthquake, it shows that the shear stress at the Sumatran fault is increase up to 43 KPa or 0.43 bar, which may trigger a fault slip of the northwestern part in the near future.

4. CONCLUSION

It is important to keep an eye in the northern part of the Sumatran Fault since some indicators show the high potential of seismic activity. Current continuous GPS network is capable of detecting stationary crustal movements with an accuracy of a few mm/yr.

Since the rate of block motion of the Sumatra forearc is much larger than the resolution of the GPS network, we expect AGNeSS can distinguish which type of the deformation (locking or creeping) is going on.
at the northwestern segment of the Sumatran fault system in a few years. The result will contribute greatly to the evaluation of earthquake potential in this region.

REFERENCES


