INTRODUCTION

The Mw 9.3 Sumatra-Andaman Earthquake occurred at 00:58:53 UTC (07:58:53 Thai time) on 26 December 2004 at 3.316ºN and 95.854ºE off the West coast of Northern Sumatra, Indonesia. The earthquake triggered a series of devastating tsunamis that spread throughout the Indian Ocean, killing people and inundating coastal communities across South and Southeast Asia, including parts of Indonesia, Sri Lanka, India, and Thailand. The United States Geological Survey reported the death toll more than 283,000 people, 14,100 missing, and 1,126,900 people displaced (USGS, 2005).

The earthquake occurred at the interface of the Indian and Burma Plate, a small plate south of the Eurasian Plate (Curray, 2005). According to the USGS report, this earthquake was caused by the release of stresses that develop as the India plate subducts beneath the overriding Burma plate. A sudden uplift of parts of the ocean bottom started the tsunami with devastating effects to Thailand west coast. The trench is the surface expression of the plate interface between the Australian and India Plate.

The Indian Plate is moving 61 mm per year in NNE direction relatively to the Burma Plate. This is part of the overall movement of the Indian plate northwards resulting in the collision with the Eurasian Plate and the formation of the Himalaya mountain range, and the Tibetan Plateau (USGS, 2005). The collision resulted in a mechanical overbalance of the area forcing the mass of the Southeast Asian area moving in southeast direction, associated with several major and minor fault and fault related structures.

In Southern Thailand, there are a series of faults, mainly the Ranong and Khlong Marui Fault Zones, which were so far identified as dormant by the Department of Mineral Resources (DMR). However, the 26 December 2004 Earthquake caused concerns among people and governmental agencies for possible (re)activation of these and other fault zones in Southern Thailand.

Shortly after the devastating earthquake, the Geophysics Research Group in the Department of Physics at the Faculty of Science, Prince of Songkla University established in collaboration with the Department of Mineral Resources a seismic network in Southern Thailand in order to monitor possible earthquakes along the Ranong and Khlong Marui Fault Zones.

ESTABLISHMENT OF A SEISMIC NETWORK IN SOUTHERN THAILAND

In the end of December 2004, members and graduate students of the Geophysics Research Group went to Phang Nga, Krabi and Phuket provinces to set up a network of altogether four short-period, three-component seismometers. At that time, one station already existed on the Phuket Campus of the Prince of Songkla University in Khatu District. The site selection for the other three stations was done together with geologists from the Department of Mineral Resources, as the seismometers preferable should be located on hardrock in order to get high quality data. Two locations in Phang Nga and one location in Krabi were chosen for the seismic stations (Table 1).

<table>
<thead>
<tr>
<th>Station</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station 1</td>
<td>98°30'E</td>
<td>8°26'N</td>
<td>near telecommunication station, Muang District, Pang Nga Province</td>
</tr>
<tr>
<td>Station 2</td>
<td>98°39'E</td>
<td>8°33'N</td>
<td>in Thap Put District, Phang Nga Province</td>
</tr>
<tr>
<td>Station 3</td>
<td>98°21'E</td>
<td>7°53'N</td>
<td>Prince of Songkla University, Phuket Campus, Khuat District, Phuket Province</td>
</tr>
<tr>
<td>Station 4</td>
<td>98°44'E</td>
<td>8°23'N</td>
<td>Tanbokkorane National Park, Ao Luek District, Krabi Province</td>
</tr>
</tbody>
</table>

where the data had to be transferred every two weeks to a computer. Therefore, members of the Geophysics Research Group had to visit all stations
every two weeks. Local residents nearby provided power for the equipment and looked after the station for safety reasons. Figure 1a shows a schematic diagram of Station 2 in Phang Nga Province and a photo from the inside (Fig. 1b). The short-period seismic network was fully operating for nearly six months.

**Figure 1:** (a) Schematic diagram of the seismic station, with the seismometer covered by a concrete tube and the seismometer inside a small house. (b) Photo from the inside showing the seismograph sitting on the cover of the cement tube which is hosting the seismometer, see (a).

**SEISMICITY IN SOUTHERN THAILAND AFTER THE 26 DECEMBER, 2004 EARTHQUAKE**

From January 14 to June 30, 2005, the short-period seismic network of the Geophysics Research Group in Southern Thailand detected 210 local earthquakes. They occurred in areas between 7.25°N and 10.12°N longitude and 97.26°E to 99.69°E latitude, with the local magnitude (Ml) ranging from -1.4 to 2.2 Richter scale (-1.4 < Ml < 2.2). Figure 2 shows the distribution of the earthquakes in relation to the magnitude.

**Figure 2:** Earthquake locations in Southern Thailand in relation to their local magnitudes (Ml, in classes of 0.5) determined from 14 January to 30 June 2005. The known faults and fault zones (DMR). KMFZ - Klong Murui Fault Zone, RFZ - Ranong Fault Zone.
Figure 3: Schematic drawings of the geodynamic situation in Andaman Sea and Southern Thailand before (A) and during/after the 26 December 2004 Earthquake (B). The Indian-Australian and the Eurasian Plate with the smaller Burma Plate (not shown here) were locked and both moved to the East (A), resulting in a compressional state of the Burma Plate (close spaced shading). Some sinkholes (closed triangles) and earthquakes (closed circles) occurred in Southern Thailand. With and after the 26 December Earthquake (B) both plates were unlocked. The Eurasian Plate moved to the West. This caused an extension or crustal dilatation in the Eurasian Plate (larger spaced shading) with an increase in sinkhole and earthquake occurrences. The lower figures in (A) and (B) are adopted from Hyndman and Wang 1993.
GEODYNAMIC SITUATION BEFORE AND AFTER THE 26 DECEMBER 2004 EARTHQUAKE

The analysis of the earthquake locations in figure 2 reveals that some earthquakes might follow a linear trend indicating that they generated by fault movement, as others do not show this kind of trend. The occurrence of these earthquakes in Southern Thailand can be directly linked with the movement of the Burma Plate during and after the 26 December 2004 Sumatra-Andaman Earthquake. Before this major earthquake, the Indian and the Burma Plate were locked and the Indian Plate pushed the Burma Plate to the East, consequently both plates moved to the East. The 26 December 2004 Earthquake unlocked the plates and as a result, the Burma Plate moved to the West, while the Indian Plate still moved to the East, and still moving today. The stress relief and the West movement of the Burma Plate caused an expansion of the plate itself and consequently the movement or reactivation of existing faults and fault zones, as observed in Southern Thailand and shown here. The GRACE gravity satellites also observed this expansion, respectively crustal dilatation, of the Burma Plate (Han et al., 2006).

Therefore, the earthquakes measured between 14 January and 30 June, 2005 occurred in an extensional stress regime, not in a compressional one, which explains their low magnitudes. After the 26 December 2004 Earthquake, there was a stress relief and not a stress build-up in the Burma Plate. The increased number of sinkholes also can be explained by the dilation.

The earthquake data are constrained by Global Positioning System (GPS) measurements at a Phuket site (Vigny et al., 2005). As the 26 December 2004 Earthquake caused a major movement of the Phuket site to the West, an increase in the earthquake activities in Southern Thailand could be also observed. However, the 28 March 2005 Earthquake did not cause any major movement of the Phuket site, and consequently there was not a significant increase of the earthquake activities in Southern Thailand (Dangmuan et al., 2006).

The ongoing GPS measurements will reveal that at one time, the Burma and Indian Plate will be locked again and consequently the Burma Plate then will be pushed back again to the Eastern direction as before the 26 December 2004 Earthquake. This will change the stress situation in the Burma Plate from extensional to compressional again. As a result, the existing fault zones might be reactivated again, but then in a compressional stress regime, increasing the probability of higher magnitude earthquake in Southern Thailand.

ACKNOWLEDGEMENTS

The authors would like to thank the Department of Mineral Resources for their initiative and their collaboration throughout the work, and all the people at the seismic stations for their valuable support. Financial assistance from the Prince of Songkla University, the Faculty of Science, the Department of Physics and the Graduate School, and the equipment support by the International Science Program (ISP) of Uppsala University, Sweden, is highly appreciated.

REFERENCES


