Applying Gravity Method for Mapping Seulimeum Fault System in Krueng Raya, Aceh Besar (Indonesia)

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ABSTRACT

The gravity method involves measuring the earth's gravitational field at specific location and time on the earth's surface to determine the location of subsurface variations in density. It has found many applications in engineering and environmental including identifying fault. The aim of this study is to identify the location of the Seulimeum fault system in Krueng Raya, Aceh Besar (Indonesia) by utilizing gravity method. CG5 Autograv Scintrex was used to conduct the gravity method in the study area. The gravity data was taken randomly with a distance stations between 200 m to 300 m. The data was then processed using Microsoft Excel and Surfer8 software. The results was displayed in a contouring map form and from the map, the fault can be identify from the contrast of the bouguer anomaly. Local gravity value was -21 mGal to -30 mGal. At the northeast of the contour map, the value of gravity data is high compared to the value at the southwest which is low, the fault system was between these high and low value of gravity data.

KEYWORDS: Gravity, Seulimeum fault, Krueng Raya, Aceh Besar

INTRODUCTION

Gravity method works when buried structure has different masses which lead to different value of density than the surrounding area. Evidently, the earth's gravitational field measured at the earth's surface is affected by changes in topography, the earth's shape and rotation and earth tides. These influences need to be removed before interpreting the gravity data for subsurface features. The results are then appearing in the form of bouguer maps based on the bouguer anomaly. The gravity method can be an easy geophysical technique to conduct and interpret. It requires only simple but precise data processing (Mickus, 2003).

GENERAL GEOLOGY

The regional geology of Banda Aceh Quadrangle has been mapped by Bennet et al., 1981. The lithology of Krueng Raya is dominated by Lam Tuba volcanic which is composed of andesitic to dacitic volcanic, pumiceous breccia, tuffs, agglomerate and ash flows that intruded the Seulimeum formation with composition of tuffaceous and calcareous sandstones, conglomerates and slight amount of mudstones (Bennett et al., 1981). It forms a topographic depression, occupied by alluvial flat and low, flat-topped hills within broken, rocky and uneven surface mountain ranges that run along the entire western edge of Sumatra Island called the Barisan Range. The crest of the Barisan Range is a continuous system of axial valleys, including the Kr. Tangse valleys, which marks the outcrop of the main fault line of the Sumatera fault system. This is essentially a right lateral fracture system (Katili and Hehuwat, 1967; Page et al., 1979). The area is controlled by two main faults system, with orientation NW to SE. The geomorphology of the Krueng Raya is downcast because the rocks are strongly disintegrated and altered.

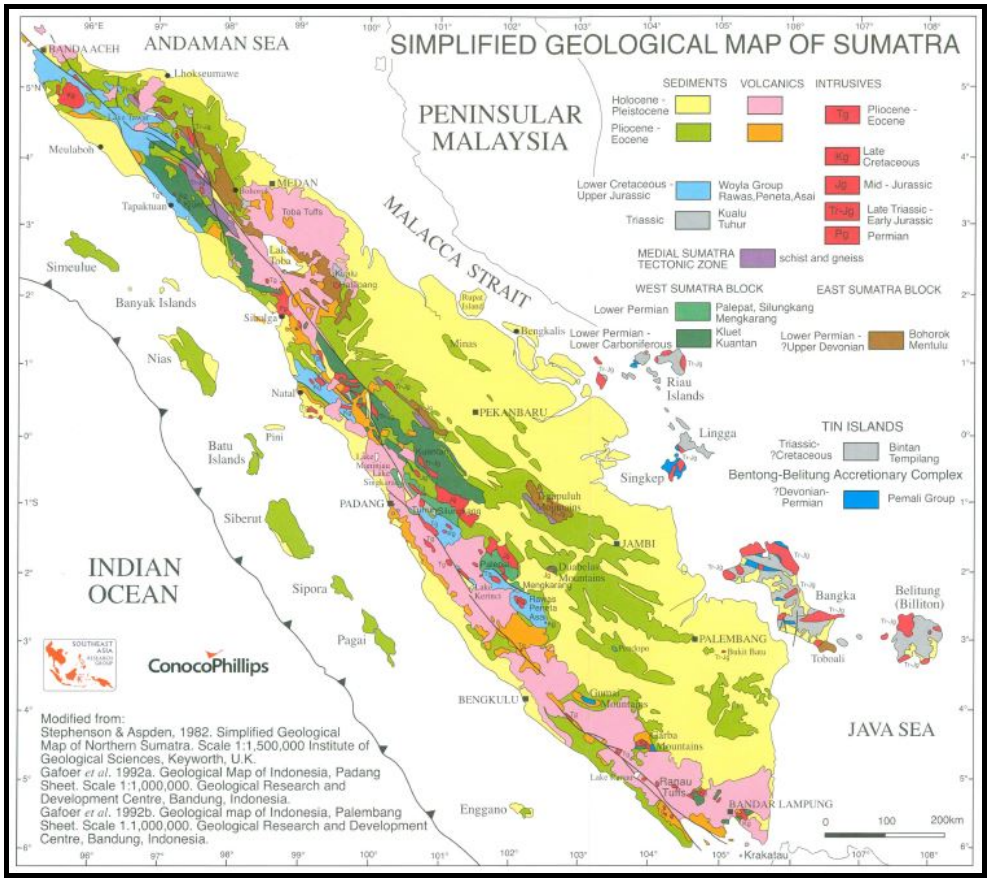

Figure 1: Geology map of the study area

SUMATRAN FAULT ZONE

Krueng Raya is located in Banda Aceh district and precisely located at the line of Sumatran Fault Zone (SFZ). The SFZ with the length of 1900 km long, trench-parallel Sumatran fault accommodates a significant amount of the right-lateral component of oblique convergence between the Eurasian and Indian/Australian plates. SFZ was highly segmented with approximately 20 segments starting from the southernmost Sumatra Island having small slip rate and increasing to the north end of Sumatra Island as shown in Figure 2 (Sieh and Natawidjaja, 2000). Fault zone is the area in the earth crust located at the boundary of two tectonic plates. The movement of rocks and the plates at fault zone usually induces earthquakes. By identifying the minerals present in a given rock, geologists can begin to understand the history of that rock. In this paper, gravity method was applied to the area of Krueng Raya, Banda Aceh (Indonesia). The gravity investigation, aimed at identifying and mapping fault zones as critical steps in evaluating the earthquake potential of the region.

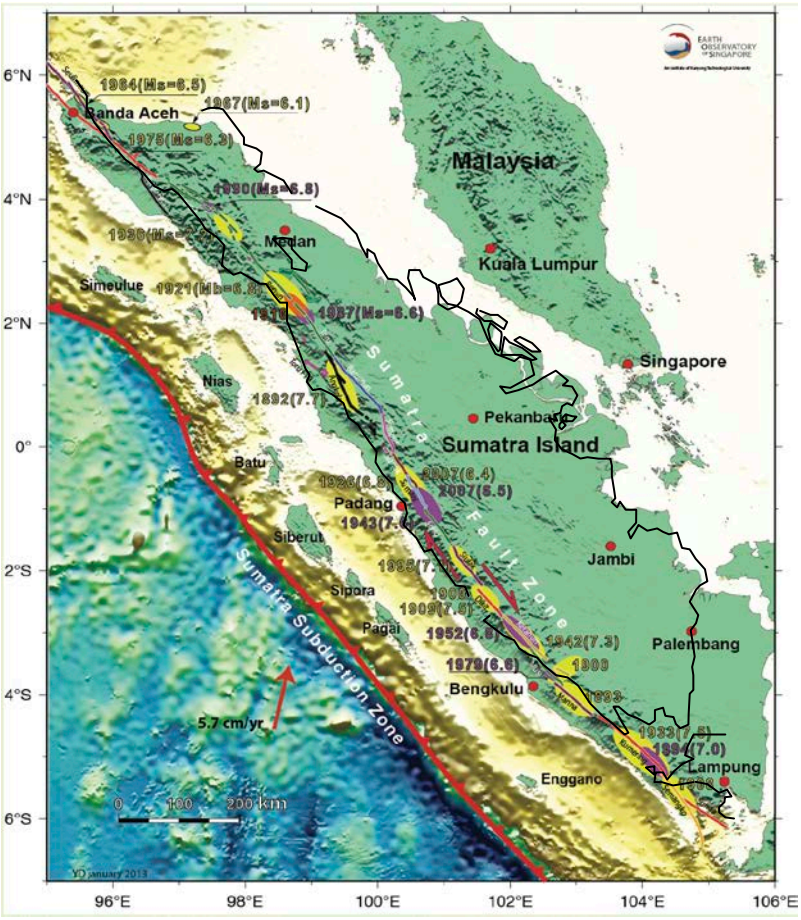

Figure 2: The SFZ is; a) a trench parallel, right-lateral strike-dip fault and b) segmented into approximately 20 fault segments.

STUDY AREA

The study was carried out in the area of Krueng Raya, Banda Aceh (Indonesia) at the area around the coordinates shown in Figure 3. A gravity survey was carried out with random moving station. The distance was set at 200 m to 500 m spacing between stations to cover the survey area as shown in Figure 4.

Figure 3: Study area of gravity survey at Krueng Raya, Banda Aceh (Indonesia).

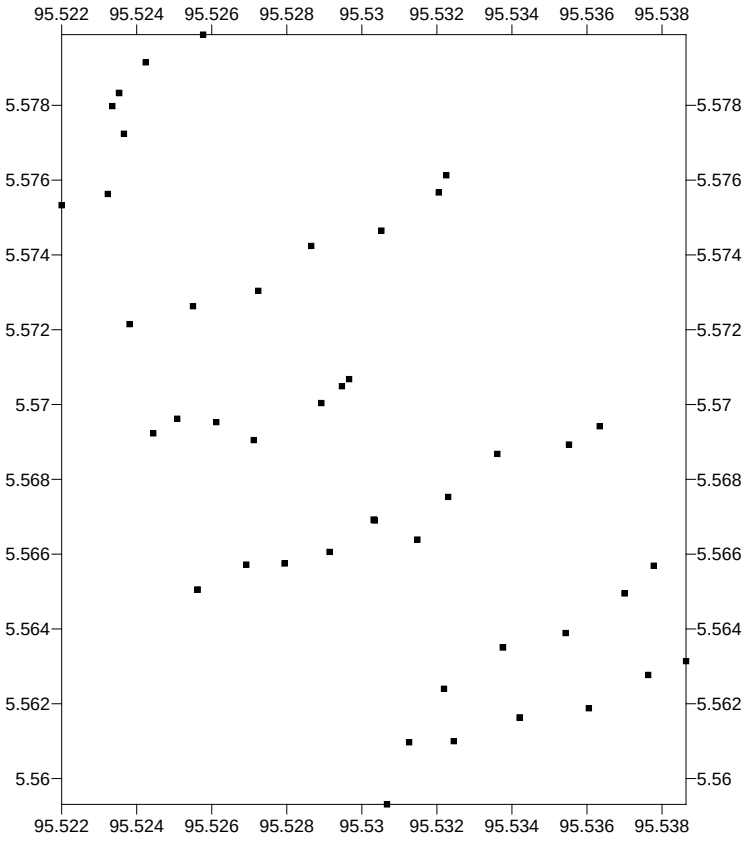

Figure 4: Gravity stations.

METHODOLOGY

The spacing for each gravity station was carried out with randomly moving station with interval of 200 m to 500 m around the study area. A local base station was located at one place where one repeats a gravity reading in the morning and in the afternoon after finishing survey line for each day. These repeated readings are performed because of reading drift with time due to elastic creep within the gravity meter's springs and to help remove the gravitational effects of the earth tides. The gravity survey covered most of the area, except at some locations due to obstruction by nature.

The observed gravity readings obtained from the gravity survey reflect the gravitational field due to all masses in the earth and the effect of the earth's rotation. Before interpret the data, the raw gravity data needs to be corrected due to several factors, which are latitudinal variations, elevation changes, topographic changes, building effects and earth tides (LaFehr, 1991). The vertical decrease of gravity with increase of elevation from a predetermined datum plane (usually sea level) and the gravitational field of the mass between the datum plane and a gravity station, a free-air and Bouguer corrections are applied to the observed gravity data. After correction has been applied, the results will be shown as Bouguer gravity anomaly. The Bouguer gravity anomaly values are then imported into Surfer8 software and contour map was created.

RESULTS AND DISCUSSION

Based on Bouguer anomaly gravity contour map, two gravity anomalies may be related to the Seulimeum fault where it is located at northeast part and southwest part. Low gravity values are located at the southwest and high gravity values at northeast part of Krueng Raya. Gravity results show lateral view of the faulting system in the study area. The local gravity values covered from

-30 to -21 mGal (Figure 5). From the fault map, the general trend of the interpreted fault directed from northwest to southeast. The interpreted faults then tend to follow the geological map based upon Bennet et al. (1981) as it bends slightly to the west-east direction. The gravity contour map shows the same trend.

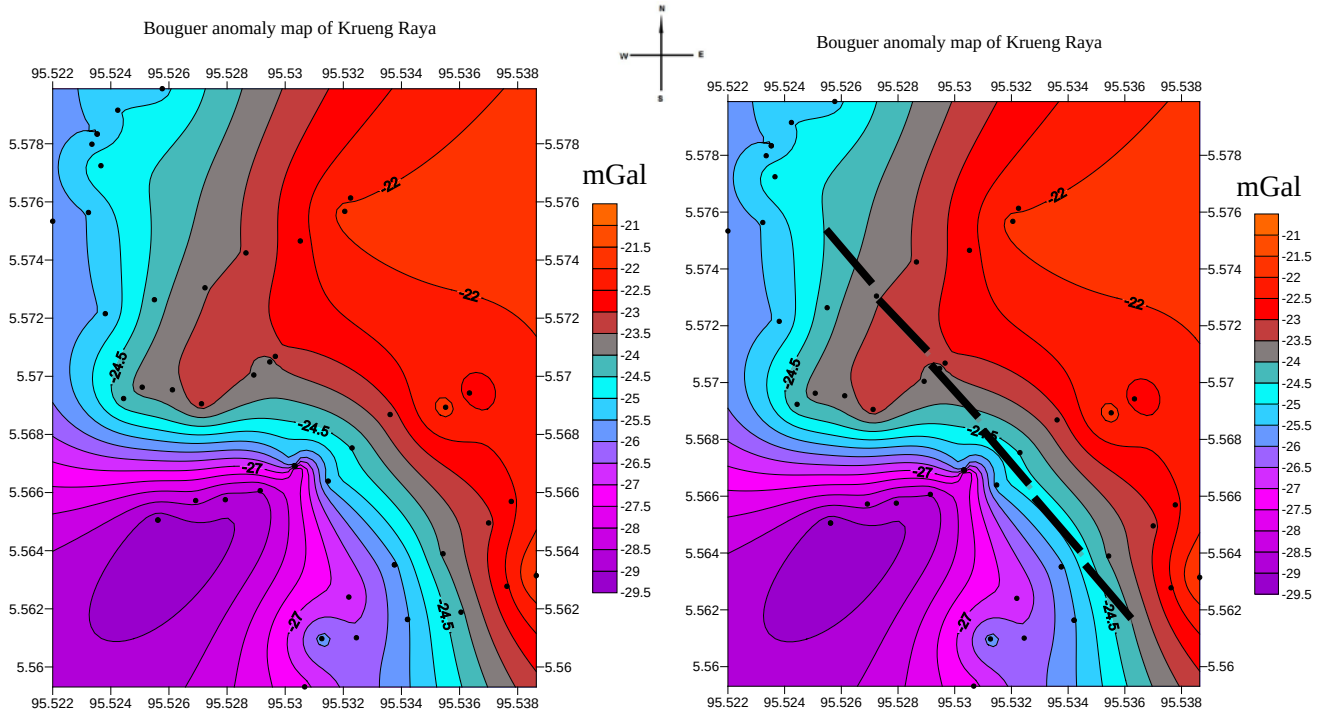

Figure 5: Bouguer gravity anomaly map in Krueng Raya with gravity meter station; a) Local gravity b) Fault system.

CONCLUSION

From the bouguer gravity anomaly data, it provides increased understanding of the shallow structures related to the Seulimeum fault system. The gravity results supported with geological map suggested the existence of several small fault plans in the study area. It is clear that the main trend of the Seulimeum faults in Krueng raya is in the NW-SE direction. Application of gravity survey can be easily determine the fault zones as well as the subsurface characterization in the study area.

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