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# The characteristics of Neogene sediments and structure in Siberuang area (Central Sumatra Indonesia) based on gravity data

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**Abstract:** Neogene sediments in Siberuang area consists of Sihapas Formation, Telisa Formation and Petani Formation. Sihapas Formation is a friable, white to brown sandstone which intercalated by claystone and some coal layers. It was deposited in the channel or bar of a braided-stream system during the N.4–N.8 period. Telisa Formation which lies unconformably above Sihapas Formation is a calcareous claystone intercalated by glauconitic sandstones and some limestone lenses. It was deposited under middle to outer neritic environment during the N.8–N.10 period. Petani Formation is a claystone containing land detrital fragments and in the upper section some coal lenses and tuffs. It was deposited in outer neritic environment on a regressive sequence. The Neogene sediments lie unconformably above the Paleogene Pematang Formation, which is mainly composed of brown conglomerate and conglomeratic sandstone. The Pematang Formation lies unconformably above the pre-Tertiary rocks. A gravity line had been run in northeast direction, crossing the structural trend of the region. The Bouguer density used is 1.9 g/cm$^3$. The Bouguer map shows that two anomaly wavelengths exist in the area, i.e. 10 km and 15 km. Moving average filtering is applied to separate the regional and residual anomaly. Gravity map analysis and modelling results show a graben type structure and that the Neogene sediment thickness increase to the southwest ranging from 600 m in the northeast to 2,800 m in the southwest and being thickest in the center of the graben. The faults in the southwest area are mostly dipping northeast while those in the northeast area are mostly dipping southwest.

## INTRODUCTION

Siberuang area is located in the direction of 265° from Pekanbaru at a distance of 105 km (Fig. 1). According to Mertosono and Nayoan (1974) the area is situated in one of the intramontane basins known as the Kampar Kanan Basin (Fig. 1). They divided the region based on the basement configuration and is used for the stratigraphic explanation of the area.

The studied area is physiographically located in the transition area of the Eastern Part of Barisan Foot Hills and Barisan Geanticline (Clarke, 1982, Fig. 2).

The morphologic expression of the region is related to the classifications mentioned before. In general, it can be divided into two parts, they are the mountainous region in the west and the gently undulated to flat area in the east. The mountainous region is underlain by pre-Tertiary and Paleogene rock formations. The gently undulating to flat area is underlain by Neogene sedimentary formations.

Based on the physiographic classification by Mertosono and Nayoan (1974), the sediment thickness is deeper in the middle part of the basin with some structural controls to the area. The geologic investigation was carried out to confirm the Neogene rock formations, and the gravity measurements were carried-out in the southwest-northeast direction for structural identification.

## STRATIGRAPHY

General stratigraphy of the studied area can be seen in Figure 3. Accordingly, the rock formations in the area are as follows (see also Fig. 4).

- Paleogene rock formation: Pematang Formation
- Neogene rock formations: Sihapas Formation-Telisa Formation
- Quaternary rock: Old Alluvial (Minas Formation)
- Alluvial

### Sihapas Formation

The name Sihapas Formation was used for the first name by Durham (see Cameron, 1983) and was called a quartz sandstone formation by Zwicrzcki (see Cameron, 1983). Some authors such as Mertosono and Nayoan (1974), De Coaster (1974), Wongsosantiko (1976) and Lee (1982) named this formation as the higher stratigraphic unit of the Sihapas Group. According to his study in the Caltex area (Wongsosantiko, 1976) divided the Sihapas Group into four formations as shown in Figure 5.

The type locality of Sihapas Formation is on Aek Sihapas (Clarke, 1982).

In the studied area the Sihapas Formation is a coarse grain sediment composed of white-brown sandstone with some grey claystone intercalations, siltstone and some coal layers. The outcrop shows friable properties, thus has low density value. No fossil was found in the area, therefore the age of Sihapas Formation is considered as ranging from N.4 to N.8 as mentioned by De Coaster (1974), or N.4–N.7 (Wongsosantiko, 1976) and N.4–N.6 (Cameron, 1983). The sedimentary structures, such as typical good parallel lamination and high angle cross bedding (the conglomeratic sandstone bodies truncating each other), indicates a channel or bar deposit in the braided stream system. By combining

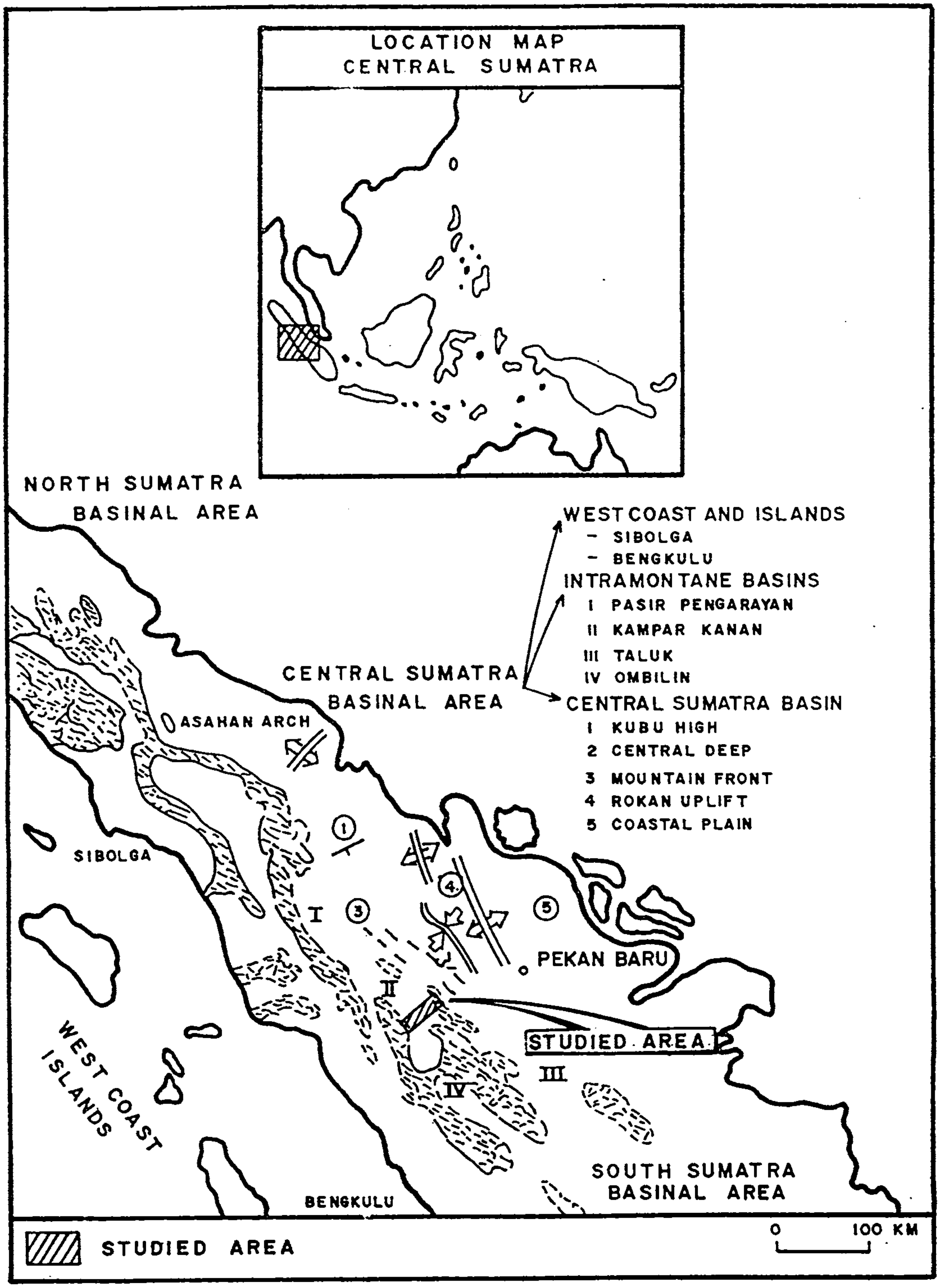


**Figure 1.** The studied area and physiography of Central Sumatra (Mertosono and Noyoan, 1974).

with the grain analysis result, the formation is interpreted to be deposited in a fluvial environment.

In the younger direction there is indication of increasing coal layers and lenses which are usually underlain by claystone. The sandstone from the upper part of the formation contains some glauconite minerals. It is also evidence that the environment changed from fluviatile to marine. The grain size analysis support an offshore delta environment.

## Telisa Formation

The name of Telisa Formation was used for the first time by van Bemmelen (1949). It's type locality is in the Telisa river, Jambi.

In the studied area the contact between Telisa Formation and Sihapas Formation is a fault contact. Based on literature it is believed to be an unconformity (Mertosono and Nayoan, 1974).

In the studied area Telisa Formation is mainly found as fine grained sedimentary rocks. The formation consists mainly of calcareous light grey claystone with some intercalations of glauconitic sandstone and some limestone lenses. Sedimentary structures found are mostly parallel laminations. The age of the Telisa Formation is identified using the foraminifera fossils content and shows a N.8–N.10 age.

Based on bentonic foraminifera fossils the formation is interpreted to be deposited in the middle to outer neritic environment. The Telisa Formation is succeeded unconformably by the Petani Formation. In the field this phenomenon is clearly shown by the presence of an erosional surface and a minor fault in the Telisa Formation below the erosional surface of the unconformity.

## Petani Formation

The name of Petani Formation had been used by Mertosono and Nayoan (1974), Wongsosantiko (1976), Eubank and Makki (1981), Lee (1982), Clarke *et al.* (1982), and Cameron (1983). The type locality of the formation is in the Petani Field Central Sumatra (Clarke, 1982). This formation consists mainly of dark green calcareous claystone. It is rich in fossils in the bottom part and gradually decrease in fossils content upward. There is existence of land detrital fragments such as quartz and mica. In the lower part some carbon and pyrite are also found. Towards the upper part, the intercalation of tuff layers also increases. Some lenses of coal and tuffs are also indicated. These conditions indicate that the environment of this formation ranges from outer neritic to the landward, representing a regressive sequence. The age of the Petani Formation is N.13–N.19 based on the foraminifera contents.

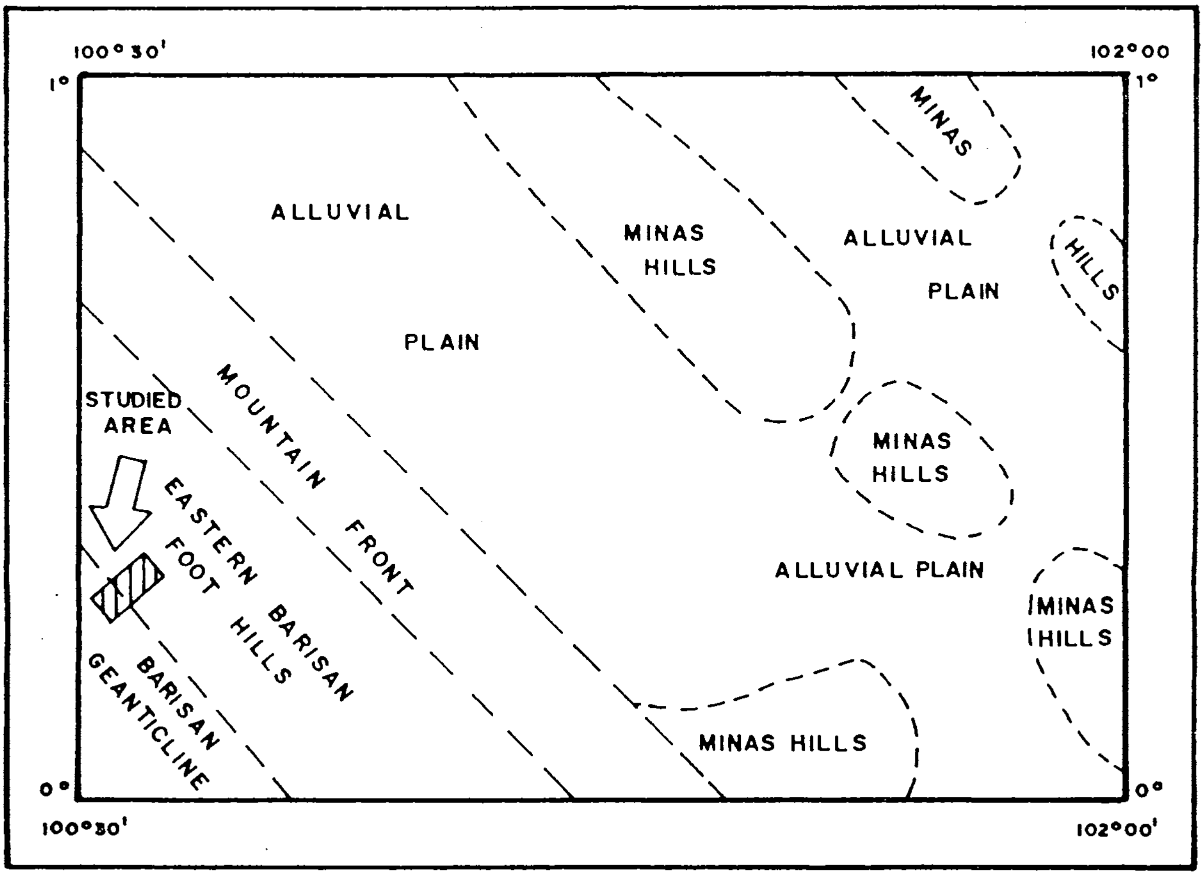


**Figure 2.** Physiography of Central Sumatra (Lembar Pekanbaru) (Clarke, 1982).

| FORMATION | AGE | ZONATION | THICKNES (M) | LITOLOGY | DESCRIPTION | ENVIRONMENT |
|---|---|---|---|---|---|---|
| ALLUVIAL | Recent | | >10 | | Sand, pebble, cobble and boulder of sandstone, metamorfhic, igneous and imbricated pebble | RIVER STREAM |
| | | | | | *Unconformity* | |
| OLD ALLUVIAL | Pleistocene -Recen | | >10 | | Clay, sand. pebble, cobble of metamorfhic rocks sedimentary rocks with crossbedding | RIVER STREAM |
| | | | | | *Unconformity* | |
| PETANI | Middle Miocene - Pliocene | N-21? N-14 N-13 | > 200 | | Claystone, dark, green, tuffaceous, carbonaceous, bioturbation. The lower part calcareous, fossil with coal lenses and parallel lamination. | NERITIC SWAMP |
| | | | | | *Unconformity* | |
| TELISA | Early Miocene Middle | N-10 N-8 N-7? | >340 | | Claystone, light grey, calcareous, bioturbation with, intercalation of glauconitic sandstone, limestone, some parallel lamination. | NERITIC |
| | | | | | *Fault Contact* | |
| SIHAPAS | Early Miocene | N-7 N-4? | > 90 | | Sandstone fine - coarse, white glauconitic, intercalation of grey-claystone, bioturbation, some coal lenses. Lower part, conglomeratic sandstone, micaceous, cross-bedding | BRAIDED STREAM |
| | | | | | *Unconformity* | |
| PEMATANG | Oligocene | | > 205 | | Clayey, Siltstone, sandstone, clonglomeratic sandstone, cross bedding and parallel lamination and some coal lenses. conglomerate, brownish red, coble of quartz dominated, igneous, metamorphic and sedimentary rocks | ALLUVIAL FAN |

**Figure 3.** General stratigraphy of Siberuang and Qurrouding area.

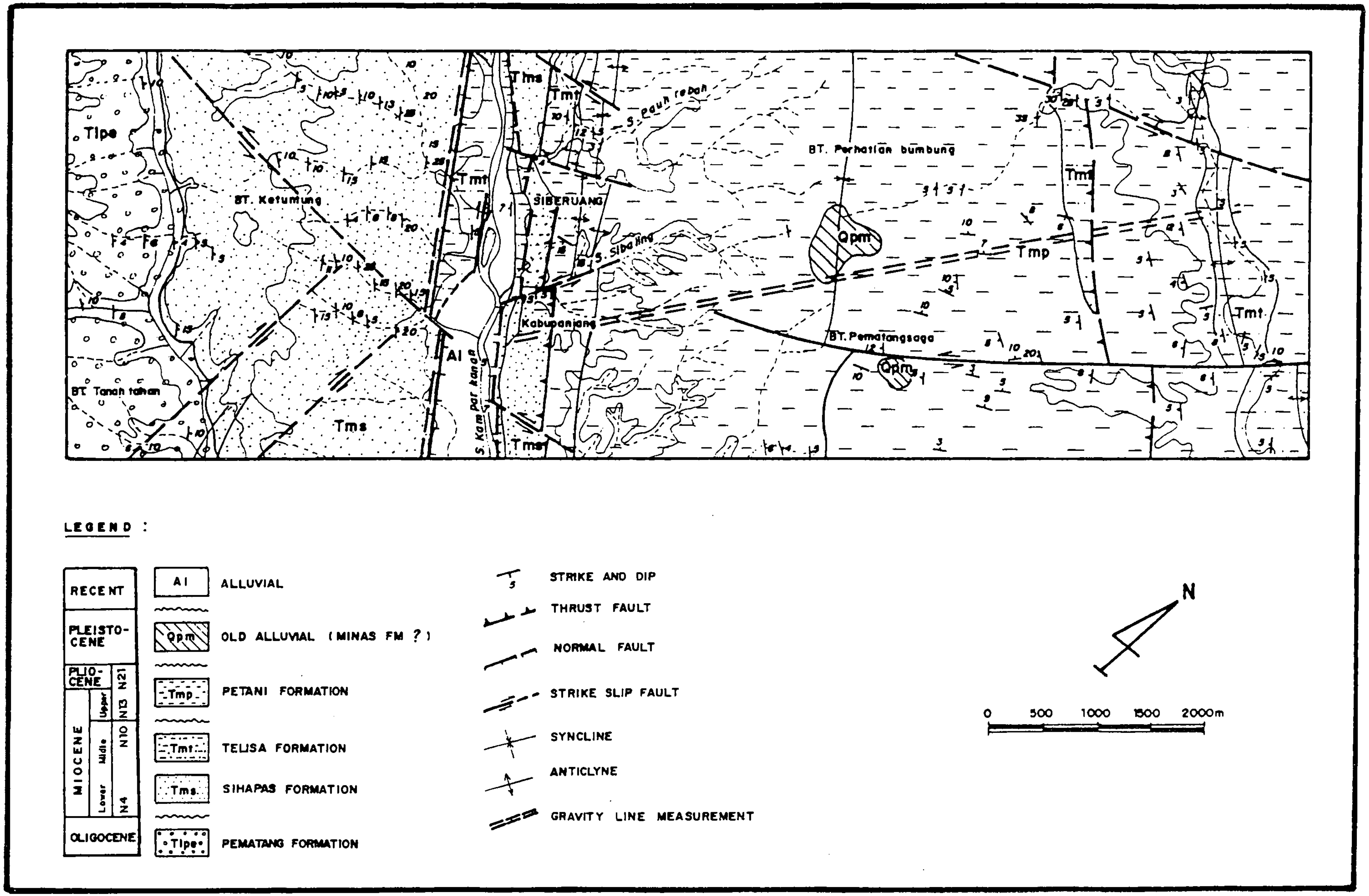


**Figure 4.** Geology of the Siberuang area, Central Sumatra.

## GRAVITY

A gravity profile in the area was measured and analyzed. The direction of the profile is southwest-northeast across the structural trend of the region. The spacing of measurement points is 300 meters.

The Bouguer anomaly profile were calculated using a density of 1.9 g/cm$^3$. The subsurface condition then modelled using the Talwani Polygonal method.

Before modelling, the data was filtered using the moving average method. According to the evaluation of the gravity data, the window size was determined as 10 km and 15 km wavelengths of anomaly. These window sizes were applied to the Bouguer anomaly profile. The basic idea of this method was that shallower material will have shorter wavelengths compared to deeper ones.

The modelling of the subsurface physical condition was carried out by using the assumption that the Neogene sedimentary rock has an average density of 1.7 g/cm$^3$, Paleogene sedimentary rock 2.3 g/cm$^3$ and basement 3.1 g/cm$^3$. The thickness (or depth to Paleogene Formation) of the Neogene sediments was calculated by the Talwani Polygonal method (see Fig. 6). The structural condition of the area is interpreted by looking at the shape of the physical model (Fig. 6).

## DISCUSSION

The result shows that the Neogene formation's thickness increase to the southwest, from around 600 m in the northeast to 2,800 m in the southwest. Structural control in the region is represented by a graben type feature. Some faults can be interpreted as dipping to the northeast in the southwest of the area and toward southwest in the northeast area. The thickest Neogene formation is found in the center of the graben.

The fault system deduced from gravity data shows at least two events influencing the area, namely deformations in the Middle-Miocene and Plio-Pleistocene. The first deformation gives the fault pattern found only in the basement, and the second gives the fault pattern both in the basement and Tertiary sediments.

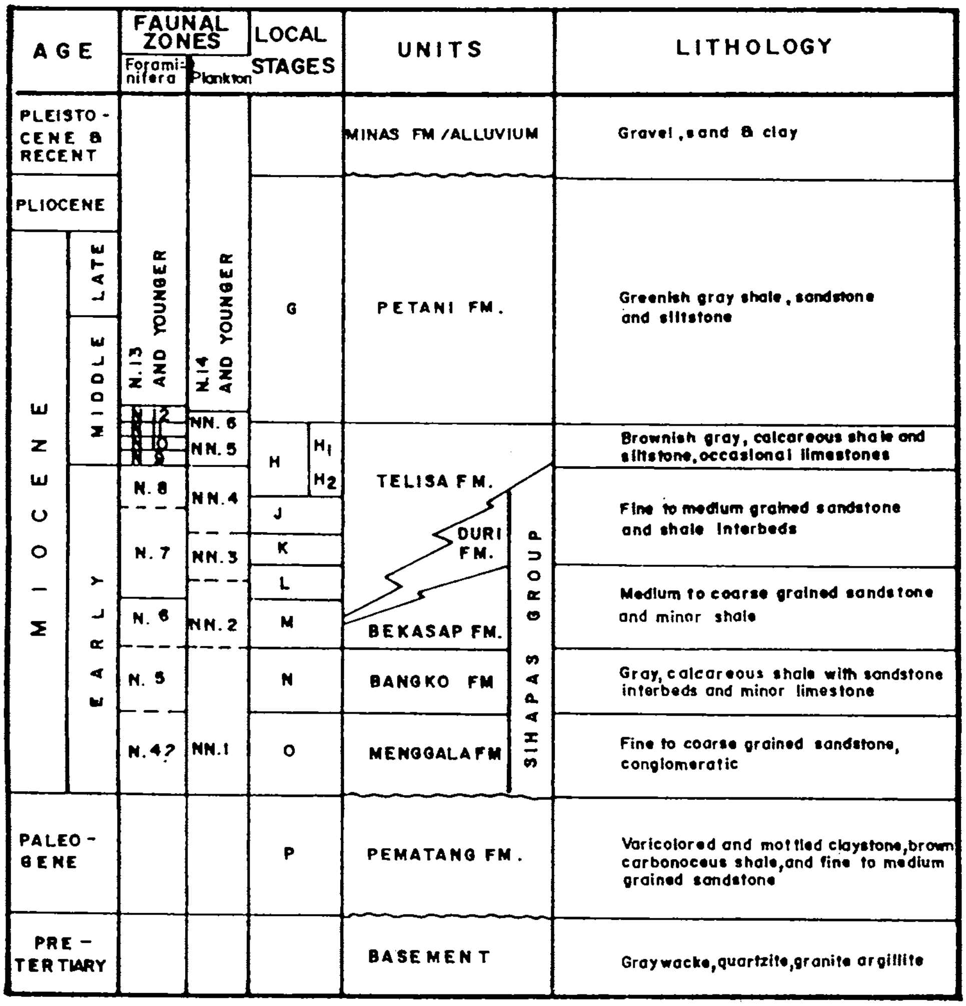


**Figure 5.** Stratigraphy of Central Sumatra (Wongsosantiko, 1976).

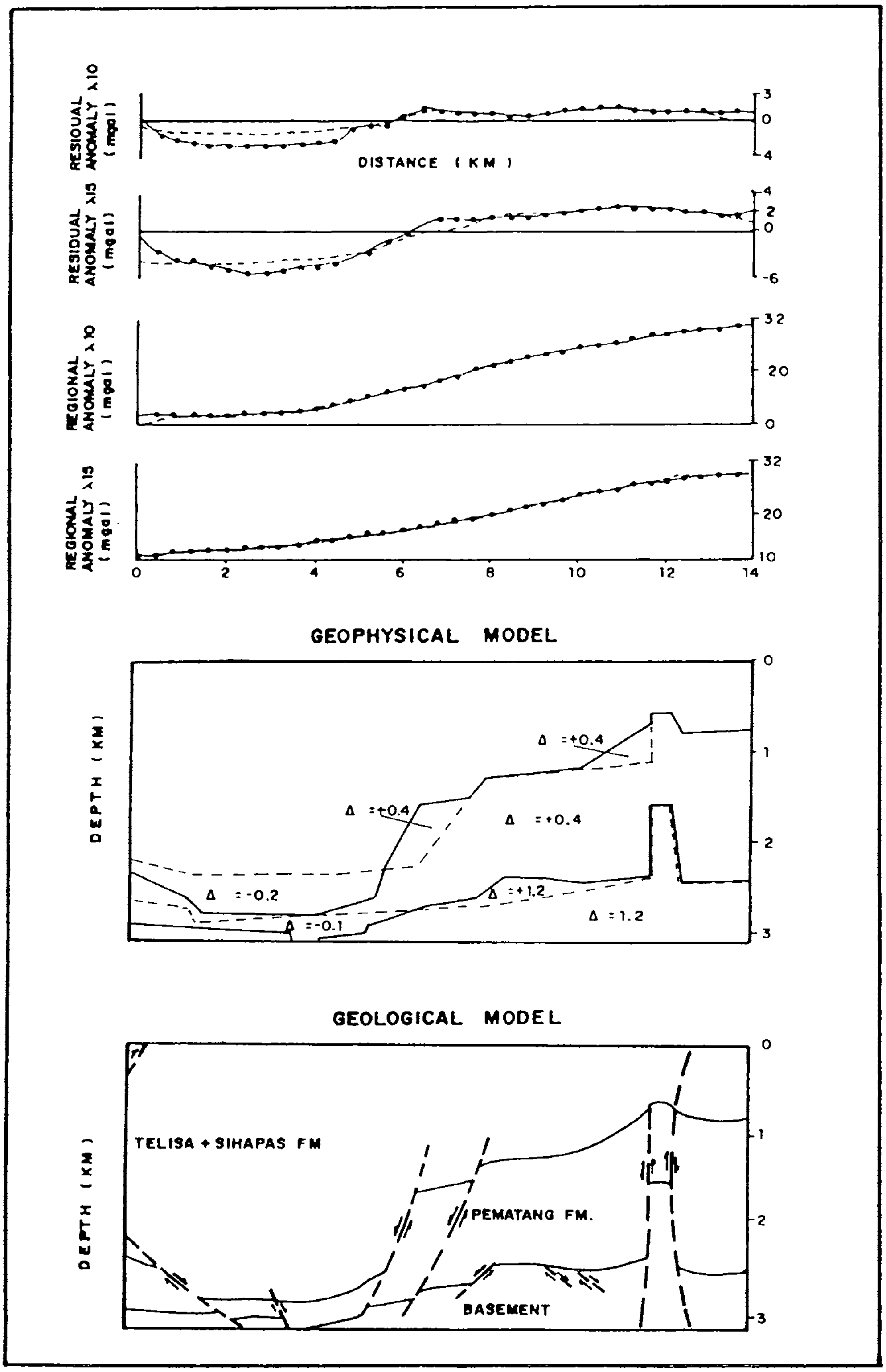


**Figure 6.** Geology and structural interpretation along the gravity profile.

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