

Stratigraphic Position of the Rangsi Conglomerate in Sarawak

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Abstract

The Rangsi conglomerate that outcrops in the Tatau Horst area in Sarawak has for a long time been regarded as the basal unit of the Tatau formation. The interpretation was, however, primarily based on the succession of the geological formations, and no detailed stratigraphic work was done to support the interpretation. A study conducted in this area using seismic stratigraphic technique shows that the Rangsi conglomerate is much younger than the Tatau formation. This conglomeratic rock unit is possibly equivalent to the Balingian formation that is of late Miocene age. Furthermore, the area that is called Tatau Horst, seismically does not represent structural feature such as a "horst" of extensional tectonics. Instead, it is characterized by positive flower structure, suggesting that the structure was formed as a result of a transpressional strike-slip tectonic episode, during early to late Miocene times.

Kedudukan Konglomerat Rangsi Dalam Stratigrafi Sarawak

Abstrak

Konglomerat Rangsi yang tersingkap di kawasan Horst Tatau di Sarawak telah lama dikenali sebagai batuan dasar formasi Tatau. Tafsiran ini hanya berdasarkan jujukan formasi geologi dan tidak terdapat kajian stratigrafi terperinci untuk menyokong tafsiran tersebut yang telah diterbitkan sebelum ini. Kajian yang dilakukan di kawasan ini dengan menggunakan teknik stratigrafi seismik menunjukkan bahawa konglomerat Rangsi terletak lebih muda berbanding formasi Tatau. Konglomerat ini berkemungkinan sama dengan formasi Balingian yang berusia Miosen akhir. Tambahan pula kawasan yang dinamakan Horst Tatau secara seismik tidak menunjukkan fitur struktur 'horst' daripada tektonik regangan. Sebaliknya, ia disifatkan oleh struktur bunga positif, mencadangkan pembentukan struktur hasil daripada episod tektonik gelinciran jurus transpresi semasa Miocene awal hingga akhir.

INTRODUCTION

In the Tatau Horst area (Figure 1), the Rangsi conglomerate that unconformably overlies the Belaga formation (Figure 2), has been regarded by many workers as a classical example of the geological contact between the Tatau and Belaga formations. The interpretation was, however, primarily based on the generalized sequence in the succession of the geological formations. No detailed biostratigraphic work has been published to support and determine the age of this particular conglomerate unit. In the area adjacent to this particular outcrop, (Figure 2), it is known that the age of the Tatau formation is mainly of late Eocene-early Oligocene and the Bawang member of Belaga formation is predominantly of Eocene age (Yin, 1992).

A seismic stratigraphic study on the regional lines from this region reveals that the Rangsi equivalent belongs to a younger sequence, compared to the equivalent unit of the Tatau formation. In addition, the area that has been called Tatau Horst (Figure 1) seismically does not seem to represent a structural feature such as a "horst" of extensional tectonics.

This paper is aimed at discussing the new interpretation of the stratigraphy of the Rangsi conglomerate that has previously been described as the representative unit of the basal part of the Tatau formation, the oldest sedimentary

unit in Sarawak. It is also aimed at describing the tectonic history of the study area that may contribute towards a better understanding of the regional tectonics of Sarawak.

MATERIALS AND METHODS

Overseas Petroleum and Investigation Corp (OPIC) was the former petroleum exploration company operating in this area referred to as SK12. In its five-year exploration period, OPIC drilled several wells and acquired extensive seismic coverage of the area. Two of the regional seismic lines passed through the Tatau Horst area (Figure 3). The present study used the information from these lines together with many other lines in the onshore area as well as data from all the wells drilled in the area.

The two regional seismic lines were tied to the other lines, which have been interpreted and calibrated earlier with the well data from the area (Ismail, 1996). The interpretations were carried out using seismic sequence stratigraphic techniques, i.e. to correlate the unconformities and their correlatable conformities that formed as bounding surfaces for a sequence, and to analyze the internal character of the packages in addition to the structural interpretation. All the subsurface unconformities in the area have also been dated earlier.

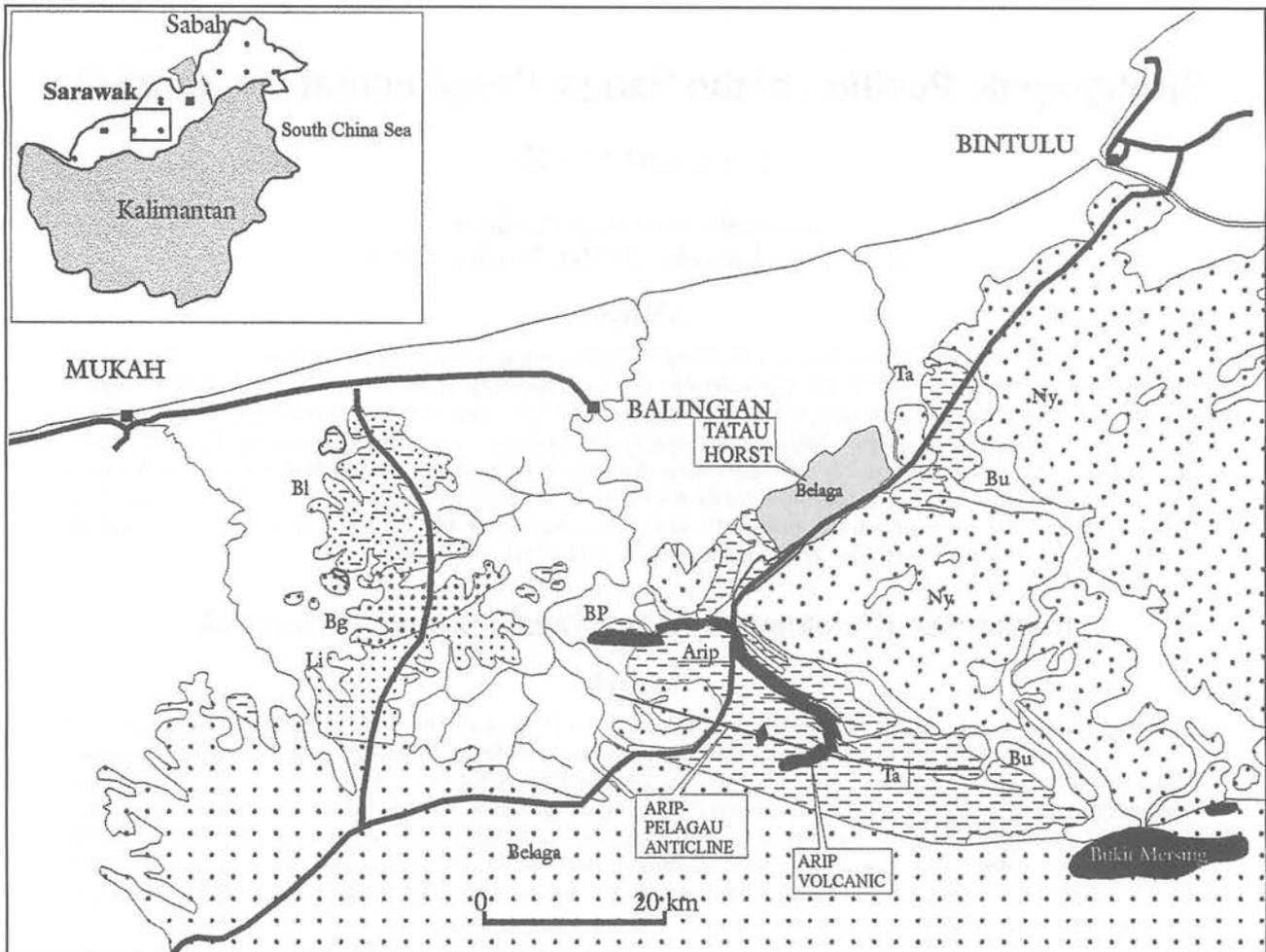


Figure 1: Map of the study area showing the location of Tatau Horst and the geology of the Mukah-Balingian-Tatau and Bintulu area. Sketch based on Yin (1992). The abbreviations used are Ta:Tatau, Bu:Buan, Bl:Balingian, Ny:Nyalau, Bg:Begrih, Li:Liang formations. Black is granodiorite at Bukit Piring (BP), andesite and rhyolite lavas at Arip and andesite at Bukit Mersing.

RESULTS OF THE SEISMIC STRATIGRAPHIC STUDY

Five regional unconformities have been recognized in this area (Figure 4). The geoseismic section (Figure 5) depicts the nature of reflection termination at the upper and lower boundaries of each of the sequences. By comparing the number of sequences preserved in this area with the proposed stratigraphic scheme of Sarawak (Mat-Zin and Tucker, 1998) in Figure 6, all the main sequences are present except Tertiary Sequence Three (T3S).

Tertiary One Sequence (T1S)

The sequence does not show any thickening in this area. The lower boundary is marked by strong reflectors that differentiate between the reflective intervals of Sequence One, and the overlying the chaotic reflectors of the Belaga formation.

T1S is internally characterised by parallel, sub-continuous, low frequency and high amplitude reflectors. Based on the seismic configuration and data from a nearby well, it is interpreted that T1S was mainly deposited in a shallow marine environment.

Tertiary Two Sequence (T2S)

The sequence shows a tremendous thickening northward. Strong reflectors mark the lower boundary with mild truncation on T1S. The upper boundary is marked by a very clear angular unconformity at the base of T4S. This means that the T3S, which is preserved in the offshore area of Balingian (Ismail, 1996), has been totally eroded in this area.

The internal character of T2S is of parallel very continues low frequency and high amplitude reflectors. It changes to shingle and clinoform towards the upper part of the preserved sequence. Based on the seismic configuration and data from nearby wells, it is interpreted that T2S was also deposited mainly in a shallow marine environment.

Tertiary Four Sequence (T4S)

Similar to T2S, the sequence shows tremendous thickening northward with divergent seismic packages, suggesting a basin fill deposition, which probably developed during T4S times. The lower boundary is marked by a strong angular unconformity and strong reflective zone and mild truncation marks the upper boundary at the base of T5S.

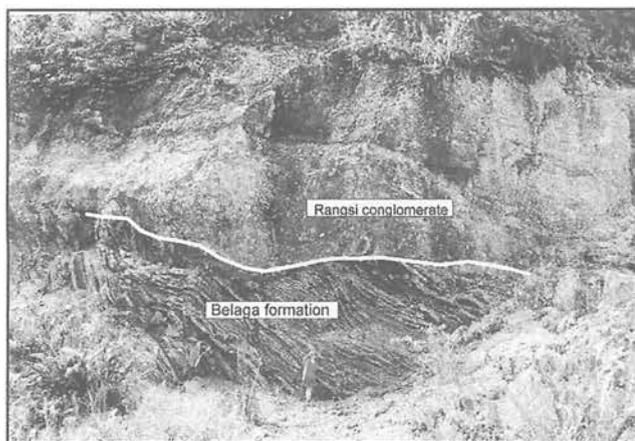


Figure 2: Photograph of Rangsi conglomerate showing the contact between what is said to be "Tatau" and Belaga formations.

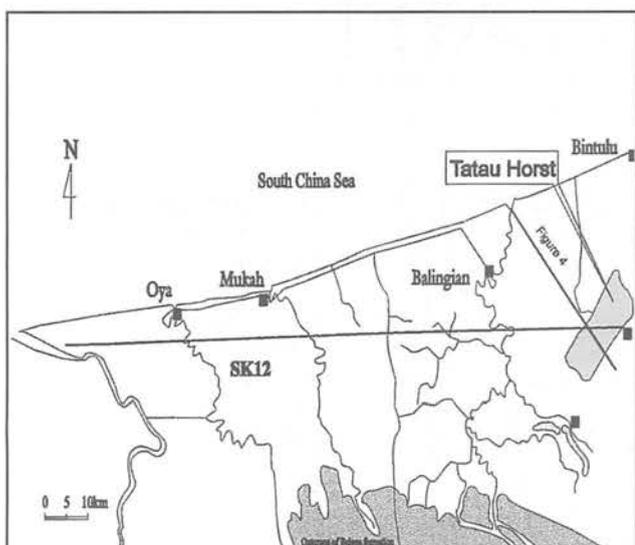


Figure 3: Map showing the orientation of seismic lines passing through the Tatau Horst area.

The internal character of T4S in the basinal area is subparallel high frequency and low amplitude reflectors. The reflectors are continuous at the basal section and become discontinuous towards the upper part of the sequence. Based on the seismic configuration and data from nearby wells, it is interpreted that T4S in the basinal area was deposited mainly in a shallow marine environment, which changed to a coastal plain environment towards the upper part of the sequence.

Rangsi Conglomerate

The base T4S unconformity can be traced landward, to obtain an anomalous reflective seismic package that extends over an area of about 4 km wide. The lower unit of the package appears to clearly truncate the underlying chaotic reflector, while the upper package with a steeper angle truncates the flatter lower package.

By comparing the seismic package that occurs at a depth of about 4 m in the northern flank of the Tatau Horst,

where the Rangsi conglomerate outcrops (Figure 2) a close appearance is observed. This similarity can be described by the presence of an angular unconformity, at the base of the Rangsi conglomerate. There are also several higher order unconformities that occur within the conglomerate unit.

Judging from this appearance on the seismic package and its close location to the outcrop of the Rangsi conglomerate, it is interpreted that the highly reflective seismic package represents the same rock unit outcrops in the Tatau Horst area, i.e. the Rangsi conglomerate (Figure 2).

Tertiary Five and Six Sequences (T5S and T6S)

These sequences thicken northward. The lower boundaries are marked by gentle onlap features and mild truncation on the upper boundaries. However, the whole part of the two sequences have been truncated by an unconformity at the base of T7S that leaves no preservation of the two sequences in the Tatau Horst area (Figure 5).

The internal characteristics of the two sequences appear to be similar. It is characterized by mainly discontinuous high frequency, high amplitude reflectors. On this basis and other evidence from nearby wells, it is interpreted that the two sequences were mainly deposited in a coastal plain environment.

STRATIGRAPHIC POSITION OF THE RANGSI CONGLOMERATE

The stratigraphic scheme by Ismail, 1996 (Figure 6) that has been adopted for this seismic stratigraphic study, allows the age determination on all the identified sequences. The stratigraphic scheme for the onshore formation by the Petronas Research and Scientific Services (PRSS), with offshore Cycle Stratigraphic Scheme (Ho, 1978), allows a more accurate correlation between the geological formation and the identified sequences in the study area (Figure 7).

By referring to the merged stratigraphic scheme (Figure 7), the T1S is equivalent to Tatau, Buan, and the lower part of Nyalau, Tanggap and Subis Limestone. The T2S is equivalent to the upper part of Nyalau, Tanggap, Subis Limestone and the lower part of Setap Shale. The T3S that may be of equivalent age to Lambir, the upper part of the Sibuti and Setap Shale formations, is totally missing in the study area.

All the identified unconformities as per Ismail (1996) can be seen to correlate very well with the unconformities in onshore formations. Nevertheless, the unconformity between the Nyalau and Buan formations (PRSS, 1991) cannot be recognized from the seismic package.

The Rangsi conglomerate that is interpreted to be situated within T4S, is of late Miocene age. It is perhaps equivalent to the Balingian formation (PRSS, 1991). In comparison to the previous interpretation (that of basal Nyalau formation) the Rangsi conglomerate is some 25 million years younger than its earlier proposed age.

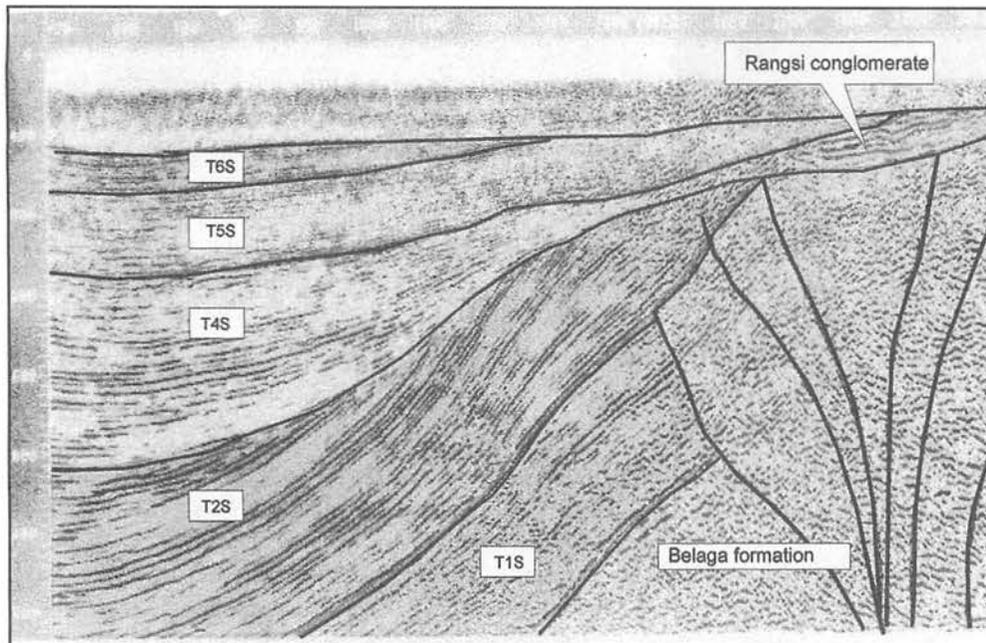


Figure 4: Seismic section passes through Rangsi conglomerate, showing the nature of reflection terminations between sequences and tectonic nature of "Tatau Horst".

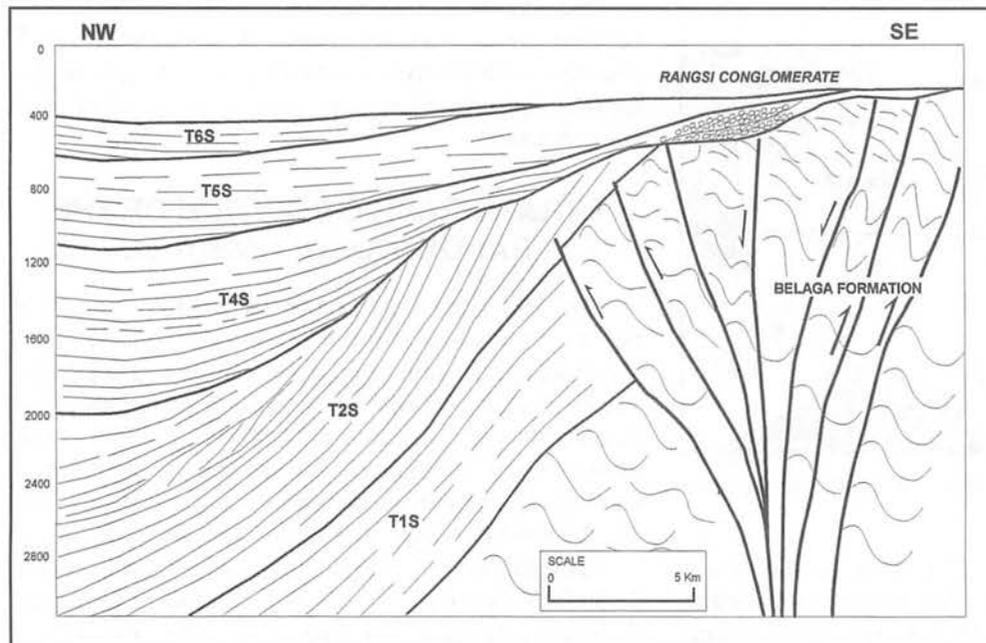


Figure 5: Geoseismic section along Tatau-Balingian area showing the nature of reflection termination and internal seismic character of every sequence. It also shows the position of Rangsi conglomerate with respect to the Tertiary sequence unit and the structural style of Tatau Horst.

TECTONIC AND SEDIMENTATION HISTORY

The NW-SE geoseismic section (Figure 5) shows the relationship between the sequences and the tectonic nature of the study area. It clearly shows that the area referred to as Tatau Horst is characterized by a positive flower structure. It is believed to have formed as a result of a highly deformed transpressional strike-slip episode that post-dated the deposition of T2S during early Miocene times. This period of tectonic unrest may represent the most active Tertiary tectonic period in the Tatau area. As a result of these movements, the whole of T1S was perhaps moved laterally, away from this area, while the southern portion of T2S was uplifted and severely eroded.

The cessation of tectonic movement during the early to middle Miocene times in the Tatau area is marked by a severe angular unconformity at the base of T4S. The basal unit of this unconformity is represented by the conglomerate unit that is known as the Rangsi conglomerate. Several episodes of tectonic movement took place that post dated the deposition of the Rangsi conglomerate, resulting in the deposition and erosion of both T5S and T6S during the Pliocene period.

CONCLUSIONS

This study concludes that the Rangsi conglomerate is of equivalent age to the Balingian formation. It forms the proximal unit of the T4S, possibly of alluvial fan or braided

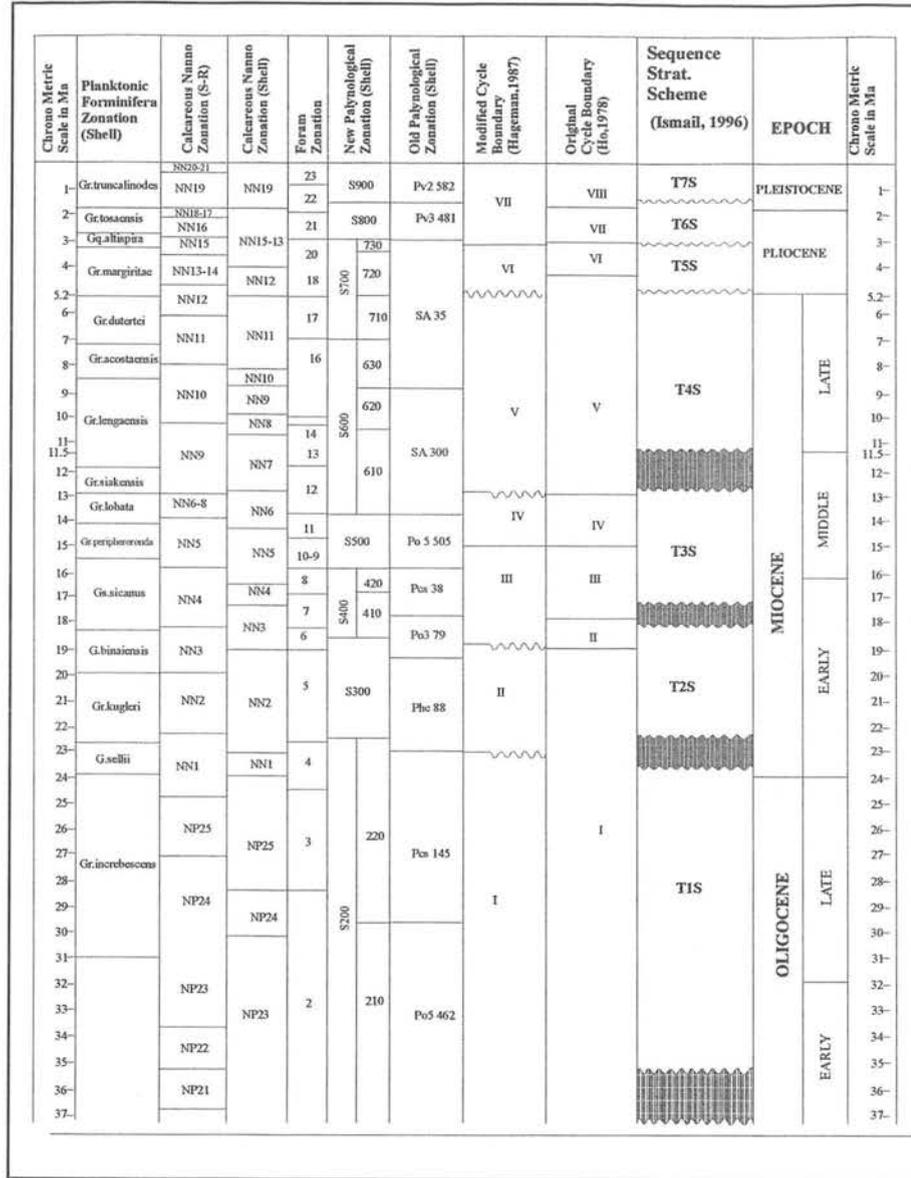


Figure 6: Composite stratigraphic table with the previous schemes used for the Sarawak Basin and the proposed Sequence Stratigraphic Scheme by Ismail, 1996.

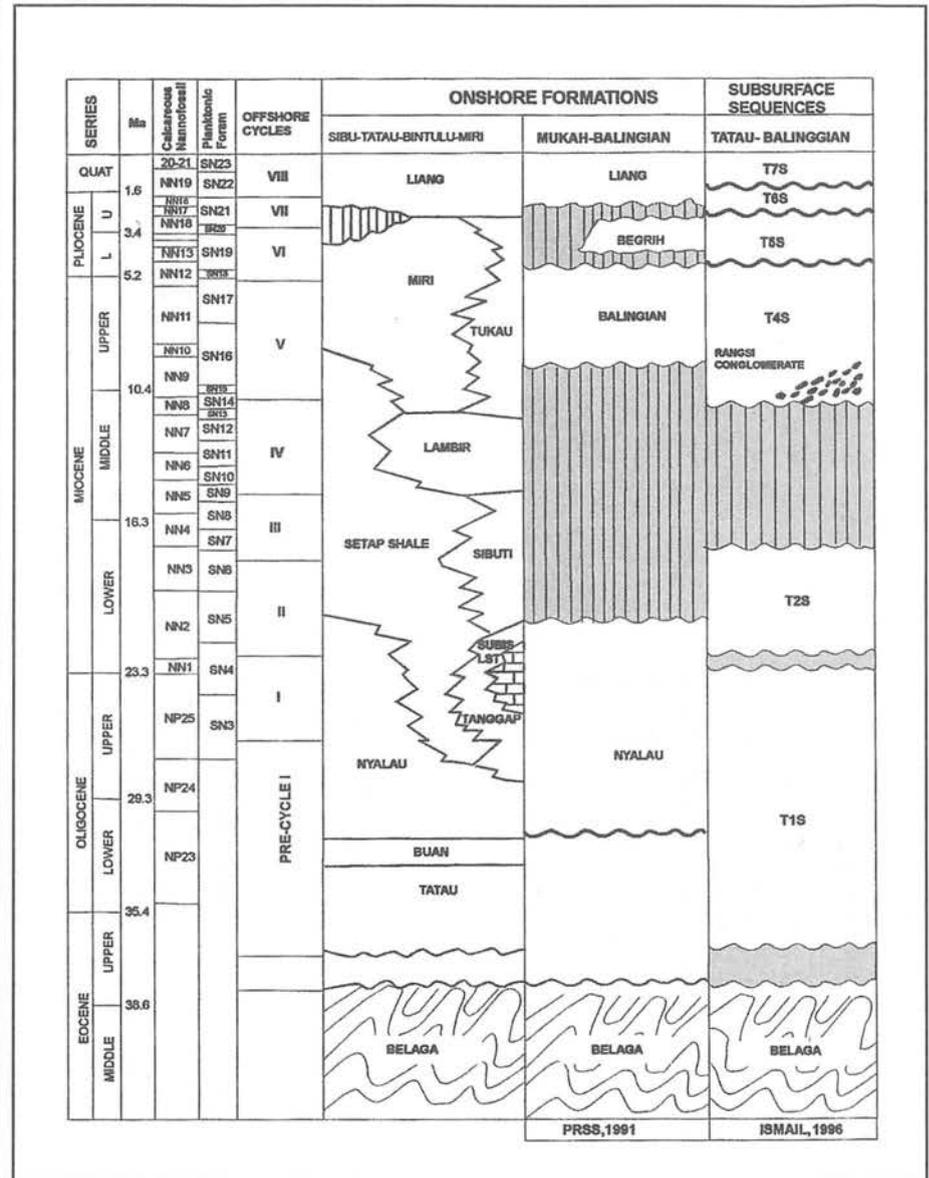


Figure 7: A combination of the stratigraphic scheme of onshore Sarawak (PRSS, 1991) and the stratigraphic scheme for Sarawak subsurface sequences (Ismail, 1996) showing the position of the Rangsi conglomerate in Sarawak's stratigraphy.

stream deposit. Therefore, this conglomerate is believed to be about 25 million years younger than previously interpreted, where it was reported to be the basal unit of the Tatau formation.

The study contributes towards better understanding of the tectonic nature and history of the study area. The area called "Tatau Horst" was not formed as a horst that is normally associated with extensional tectonics. Instead, it is formed as a result of strike-slip movement. Therefore, the term "horst" that describes the interpreted geological origin of the structure should be replaced by another name such as "Tatau Transpressional Area", which reflects the true tectonic origin of the structure.

Although it is well understood that the onshore geological formations are diachronous, this study provides an understanding of the correlation between surface geological formations and subsurface Tertiary sequences. This will contribute towards better harmony between the interpretations of field geologists and subsurface geologists who utilise different databases.

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