Biostratigraphic analysis based on planktic Foraminifera from well X in North Sumatra Basin

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Abstract. There have been several studies conducted in the North Sumatra Basin, but there is a scanty information related to the age of the Formations in the basin. The aim of this study is to establish the age of the Formation. A total of 128 ditch cutting samples are used for lithostratigraphy analysis, in which 33 samples were analysed further for the Foraminifera biostratigraphy study from the well X at a depth of 6090 – 9919 feet. From the result of the analysis, 38 species from 16 genera successfully identified, as well as 5 datum species, namely FO Globigerinoides sicanus, FO Orbulina suturalis, FO Globorotalia menardii, FO Globorotalia plesiotumida and FO Globorotalia tumida. From the lithology data, three (3) lithostratigraphic unit successfully identified, namely the calcareous claystone, very fine calcareous sandstone and fine calcareous sandstone unit which is estimated to be comparable to the Baong, Keutapang and Seurula Formation. From the result of the study it’s concluded that the lithostratigraphic units found in the study area have the age range of N7-N18 or the late Early Miocene to the Late Miocene.

1. Introduction
Stratigraphy of North Sumatra Basin have been studied by many authors. The latest discussion of stratigraphy were described based on the tectono-stratigraphic stage [1-3], such as follows (1) Pre-Rift Stage (Eocene) were deposited Tampur and Meucampli Formation; (2) Horst and Graben Stage (latest Eocene to Oligocene) were deposited Bruksah and Bampo Formations; (3) Transgressive stage (Late Oligocene to Middle Miocene) were deposited Peutu and Belumai Formation; (4) Maximum transgression (Middle Miocene) were deposited Baong and Keutapang Formation; and (5) Regressive stage (Middle Miocene to Present) were deposited Seurula and Julu Rayeu Formation. Based on those data, there were no information yet regarding with the detail age.

This study is attempted to arrange the biostratigraphy of the North Sumatra Basin and establish the planktic Foraminiferal datum, which is worldwide fossils [4], that could be used as a correlation tool in this area. Those datums is needed as a correlation tool due to its reliability.

2. Methods
One hundred twenty eight (128) ditch cutting samples of the well X from 6090 to 9919 feet depth which located at North Sumatra Basin were selected for the study. Whole of the samples were...
described for lithostratigraphy units analysis and thirty three (33) samples was prepared for the biostratigraphy analysis study.

For biostratigraphy study, first of all, the samples were crushed approximately into 1cm size and soaked within H2O2 (Hydrogen Peroxide) 0.1N for 24 hours. Furthermore, each sample, using the 0.0625 mesh were washed under the rainy water for about 10-20 minutes. Furthermore samples were dry within the oven for several hours. The dry samples were meshed into several size and were ready to pick. Using the Zeiss binocular microscope in Geology Department Laboratory, planktic and benthic foraminiferal fossil specimen were picked and identified for the species name [5-8]. Furthermore the world wide planktic datum fossils were selected [4,9] and using the interval zone method the zonation could be determine [10]. The benthic Foraminiferal fossils also determine for depositional environment analysis.

3. Results

Based on the lithologic description, the lithostratigraphy unit could be proposed from the oldest to the youngest as follows (Figure 1): calcareous claystone unit, very fine calcareous sandstone and fine calcareous sandstone. The description of each unit are: calcareous claystone unit found at 9919 to 8060 feet depth, this unit characterized by light brown colour, <1/256mm, fine permeability, calcareous; the very fine calcareous sandstone unit found at 8060 to 7020 feet depth, this unit has brownish green colour, 1/16mm to 1/18mm, rounded, good permeability, calcareous. characterized; and the fine calcareous sandstone unit found at 7020 to 6090 feet depth, greyish green colour, 1/8 to1/4 mm, rounded, good permeability, calcareous.

| DEPTH (feet) | LITHOLOGY UNIT        | LITHOLOGY COLUMN | DESCRIPTION                                                   | FORMATION |
|--------------|-----------------------|------------------|---------------------------------------------------------------|-----------|
| 6090 to 7020 | Fine calcareous       |                  | Greyish green, fine sandstone size, rounded, fine sorting,    | Serula    |
|              | sandstone             |                  | calcareous cement                                             |           |
| 7020 to 8060 | Very Fine             |                  | Brownish green, very fine sandstone size, rounded, very fine   | Ketapang  |
|              | calcareous sandstone  |                  | sorting, calcareous cement                                    |           |
| 7020 to 9919 | Calcareous claystone  |                  | Light brown, claysize, calcareous cement                      | Baong     |

Figure 1. Lithostratigraphy column of Well – X.
| Fossil's name                        | 6090 | 6210 | 6330 | 6450 | 6570 | 6690 | 6810 | 6930 | 7050 | 7170 | 7290 | 7410 | 7530 | 7650 | 7770 | 7890 | 8010 |
|-------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Globigerina ampliapertura           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globigerina aperture               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globigerina brazier                 | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globigerina connecta               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globigerina falconensis             | x    |      |      |      |      | x    |      |      |      |      |      |      |      |      |      |      | x    |
| Globigerina woodi                   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globigerinoides bulloides           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | x    |
| Globigerinoides immaturus           | x    | x    | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globigerinoides primordia           | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | x    |
| Globorotalia archeomenardii         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | x    |
| Globorotalia fohsi robusta          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globorotalia limbata                |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globorotalia menardii               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | x    |
| Globorotalia miocenica              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Globorotalia plesirotumida          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | x    |
| Globorotalia tumida                 | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Orbulina bilobata                   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Orbulina suturalis                  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Praeorbulina bilobata               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| Praeorbulina transitoria            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | x    |
| Sphaeroidinella seminulina          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
Table 2. Faunal distribution of planktic Foraminifera at Well X from 8120 to 9919 feet.

| Fossil's name                  | 8120 | 8240 | 8360 | 8480 | 8600 | 8720 | 8840 | 8960 | 9080 | 9200 | 9320 | 9440 | 9560 | 9680 | 9800 | 9890 |
|--------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| *Globigerina ampliapertura*    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerina apertura*         |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerina connecta*         | x    | x    | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerina falconensis*      |      |      |      |      |      |      | x    |      |      |      |      |      |      |      |      |      |
| *Globigerina woodi*            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerinoides immaturus*    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerinoides primordius*   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerinoides sacculiferus* |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerinoides siccarus*     | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globigerinoides trilobus*     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globoquadrina baroemoensis*  |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globoquadrina venezuelana*    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Globorotalia menardii*        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Orbulina bilobata*            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Orbulina suturalis*           | x    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Praeorbulina bilobata*        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Praesorbulina transitoria*    |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| *Sphaeroidinella seminulina*   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
In the other hand, based on the foraminiferal analysis, 35 species from 8 genera were successfully identified (Table 1, 2). Furthermore, based on those faunal list were attempted to select 5 planktic Foramiferal datums, that are FO *Globigerinoides sicanus*, FO *Orbulina suturalis*, FO *Globorotalia menardii*, FO *Globorotalia plesioutumida* and FO *Globorotalia tumida* (Table 1). Using those data, 5 planktic Foraminiferal zones could be recognized, that are:

3.1. Zone 8 (Late Early Miocene), 9800 to 9560 feet depth
The base of this zone was defined by the first occurrence of *Globigerinoides sicanus* at 9800 feet depth and the top of the zone is characterized based on the first occurrence of *Orbulina suturalis* at 9560 feet depth. This zone were characterized by the present of *Globigerinoides sicanus*, *Globigerinoides immaturus*, *Globigerinoides sacculiferus* and *Globoquadrina dehiscens*.

3.2. Zone 9 – N13 (Middle Miocene), 9560 to 8360 feet depth
The base of the zone was characterized by the first occurrence of *Orbulina suturalis* at 9560 feet depth and the top of this zone is defined by the first occurrence of *Globorotalia menardii* at 8360 feet depth. This zone is characterized by the continuing presence of *Orbulina suturalis*, *Globigerinoides trilobus*, *Gs. sicanus*, *Gs. sacculiferus*, *Gs. immaturus*, *Gs. primordius*, *Gn. falconensis*, *Gq. venezuelana*, *Gq. dehiscens*, *Gs. bispheriscus*, *Globigerina woodi* and *Gn. apertura*.

3.3. Zone 17 (Middle Miocene), 8360 to 7890 feet depth
The base of this zone was defined by the first occurrence of *Globigerinoides sicanus* at 9800 feet depth and the top of the zone is characterized based on the first occurrence of *Orbulina suturalis* at 9560 feet depth. This zone were characterized by the present of *Globigerinoides sicanus*, *Globigerinoides immaturus*, *Globigerinoides sacculiferus* and *Globoquadrina dehiscens*.

3.4. Zone 18 (Middle Miocene), 9560 to 8360 feet depth
The base of this zone was defined by the first occurrence of *Globigerinoides sicanus* at 9800 feet depth and the top of the zone is characterized based on the first occurrence of *Orbulina suturalis* at 9560 feet depth. This zone were characterized by the present of *Globigerinoides sicanus*, *Globigerinoides immaturus*, *Globigerinoides sacculiferus* and *Globoquadrina dehiscens*.

Benthic Foraminifera also identified to interpret the depositional environment. Nineteen (19) benthic Foraminifera were identified. Several species which found are *Batysiphon*, *Bolvina*, *Bulimina*, *Cassidulina*, *Cibicides*, *Cyclamina calceellata*, *Dentalina filliformis*, *Dentalina subsoluta*, *Gyroidina broeckhiana*, *Gyroidina soldanii*, *Millimina*, *Pulenia*, *Pyrgo denticulae*, *Robulus thalmanni*, *Spirillina decorate*, *S. inequalis* and *Uvigerina*. Those fossils interpreted as lower slope to middle shelf environment.

Based on those data it could be interpret that calcareous claystone unit which correlate with Baong Formation has N8 to N16 in age, was deposited at slope area; the very fine calcareous sandstone which correlate with Ketapang Formation has N17 in age, was deposited at slope area and fine calcareous sandstone has N18 in age, was deposited in slope to shelf area.

4. Discussion
Baong Formation, Ketapang Formation and Seurula Formation has middle Miocene, middle to late Miocene and late Miocene to Pliocene in age, in ascending order [1]. In this study the Baong Formation has N8 to N16 in age, Ketapang has N17 in age and Seurula has N18 in age. This differences should be due to the difficulties to define the name of the Formation based on lithology data. So, it needs to study more detail to define first the name of the Formation. For the age, we proposed 5 planktic Foraminiferal datums. Within those datums 4 datums are the worldwide fossils [2], that is FO *Globigerinoides sicanus*, FO *Orbulina suturalis*, FO *Globorotalia plesioutumida* and FO
Globorotalia tumida; and one datum, that is FO Globorotalia menardii which is use in low latitude area [7].

5. Conclusion
Based on this research could be concluded:

- Thirtyfive (35) planktic Foraminiferal species from eight (8) genera and nineteen (19) benthic Foraminifera have been successfully identified.
- Five datums could be recognized, that are FO Globigerinoides sicanus, FO Orbulina suturalis, FO Globorotalia menardii, FO Globorotalia plesiotumida and FO Globorotalia tumida.
- Based on the planktic Foraminiferal data were recognized 5 zones: N8, N9 – N13, N14 – N16, N17 and N18 with corresponds with Late Early Miocene to Late Miocene or 16.4 to 5.51 Ma.
- Based from the lithostratigraphy study, three unit could be recognized that are calcareous claystone, very fine calcareous sandstone and fine calcareous sandstone which is correlable with Baong, Ketapang and Seurula Formation.

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