Revisiting The Middle Baong Sand: Basin Floor Fan Or Slope Fan In Origin?

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Introduction

The Baong Formation contains three lithology units, namely shale unit (lower part), sand unit (middle part) and another shale unit (upper parts). The middle part of Baong Formation is usually called as the Middle Baong Sand (MBS) because it was deposited between two deep-marine shale lithologies during the Middle Miocene time. The Middle Baong Sand is the first turbidite reservoir found in Indonesia (Mulhadiono et al., 1982). Two feeder systems of Baong Sand came from the Barisan Mountain (Mulhadiono et. al., 1982; Kamili & Naim, 1973, Riadhy et. al., 1998) and the Malaka Shelf (Tsukada et al., 1996, Mulhadiono & Sutomo, 1982).

Several authors had interpreted the Middle Baong Sand in Duyung Well as basin floor fan sediments (e.g. Riadhy et al., 1998). The Baong Sand in North Lho Sukon Deep was concluded to be slope fan complex (Malecek, 1994: pers. comm.), whereas in Jambuaye Utara Well was interpreted to be highstand sediments (Tsukada et al., 1996). The interpretation of this unit was merely leaned on log signatures or seismic characters without considering their presence on the regional geologic setting. The aim of this study is to investigate the depositional model of the Baong Sand within the geological setting of North Sumatra Basin.

Database

Three wells with integrated seismic-well-biostratigraphic data were utilized and seven other wells from in Malaka Shelf and the northern part of Sumateran Island (Terbang-1, Lemuru, Peudawa Rayeu-1, NSB-C1, Duyung-1, Rayeu-B2, and Jambuaye-1) were used to compliment them. Fourty seven 2D seismic sections covering shelfal area to the deeper part of North Sumatera Basin were mapped and including utilizing calcareous nannoplankton for interpreting the timing of deposition.

Regional Geology

The North Sumatera Basin can be divided in to several north-south trending sub-basins that are separated by the major faults. From the east to west of basin, there are three sub-basins which are bounded by topographic highs, namely North Lhok Sukon Deep/ NLSD, Jawa East Deep and Samalangan Deep. The southeastern end of the basin shows ramp morphology whereas the steep gradient is developed to the northern part of basin (NLSD) (Figure 1).

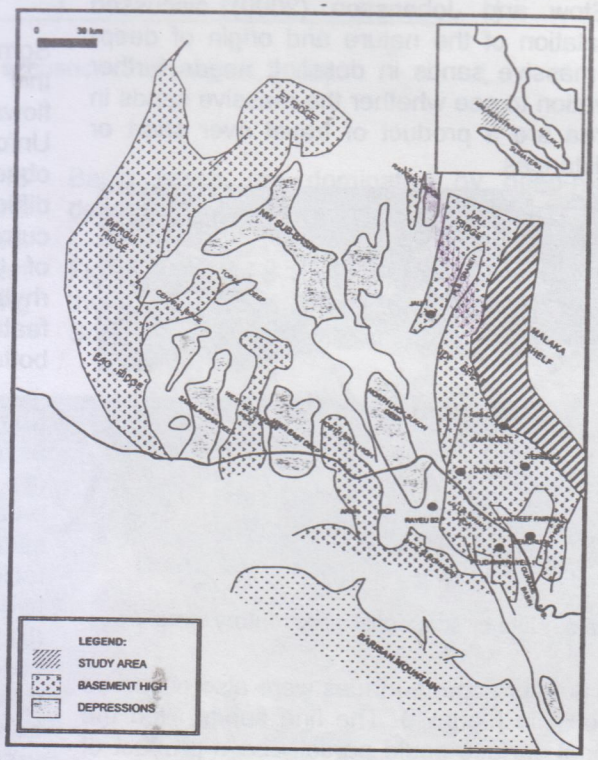


Figure 1: Location of study area (after Tsukada, 1996), offshore northern Sumatra

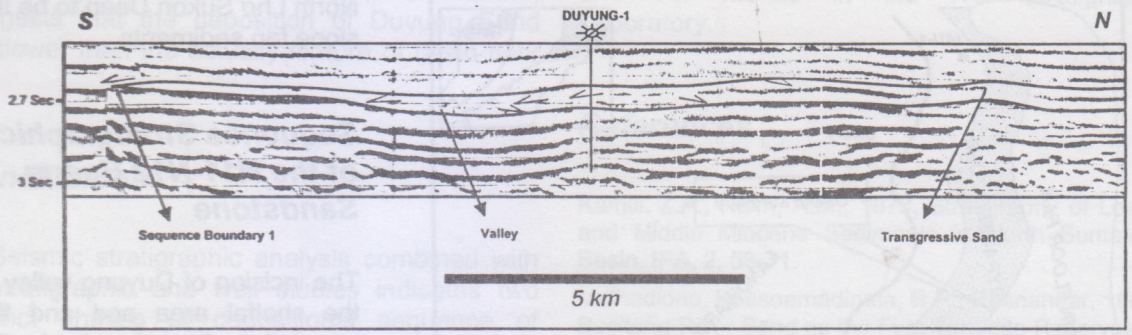


Figure 2: North-South trending seismic showing Duyung Sand which was deposited in the shelfal valley

Baong Sand Characters in western part of Malaka Shelf

On seismic lines, the Baong Sand package near Duyung-1 behaves as a continuous sheet package of parallel, high amplitude reflections that fills the valley. Onlap terminations step-out to the eastside of Malaka Shelf (Figure 2). In log profile, the Baong Sand shows blocky character with basal erosional surface on the bottom. Sphenolithus heteromorphus of NN5 and Cyclamina concelatta suggest that the Baong Sand was deposited in the uppermost of Middle Miocene time within upper bathyal of depositional environment (Figure 3). This feature implies submarine erosional process initially triggered by sea-level drop and the subsequent deposition of coarse grained above the erosional surface of Duyung valley took place during transgression.

Baong Sand in NLSD

On the reflection seismic data, the Baong Sand appears as a succession of mounded forms (convex upward) with uni-directional downlap characters and continuous to discontinuous reflection in NLSD (Figure 4). Laterally, this sediments pinches out (shale-out) to the toe of Malaka Slope. According to Shanmugam and Moiola (1991) and Shanmugam et al., (1995) it might be interpreted to be basin floor fan sediments. This basin floor fan was deposited during the lowstand stage of sea level in the NLSD (Figure 5).

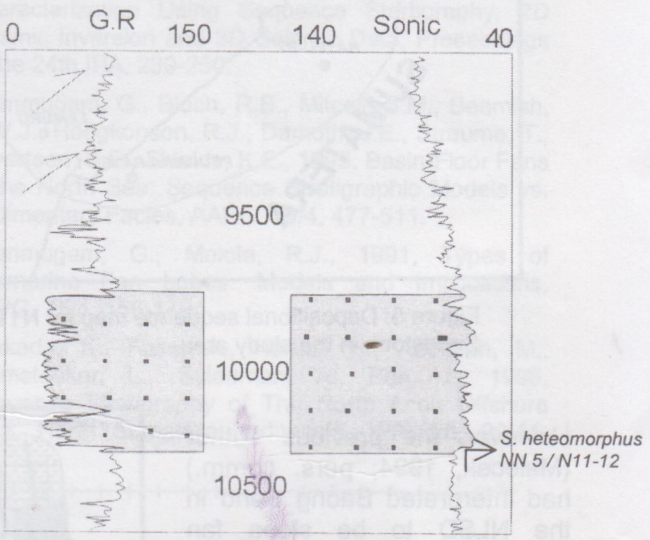


Figure 3. Duyung log motif showing sharp bottom and upper boundaries (blocky character) of Baong Sand in the shelfal valley.

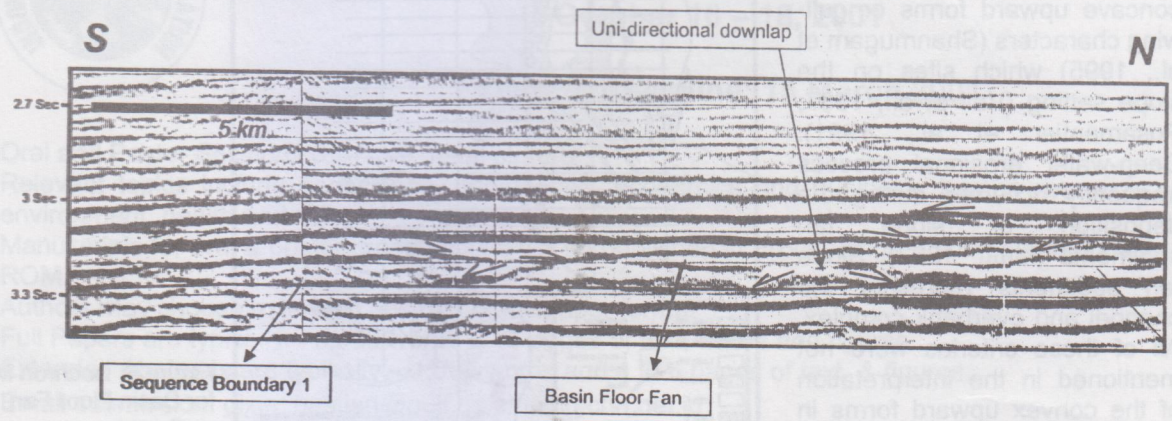


Figure 4: Seismic expression of coalescing lobes in the deeper part of North Sumatra Basin

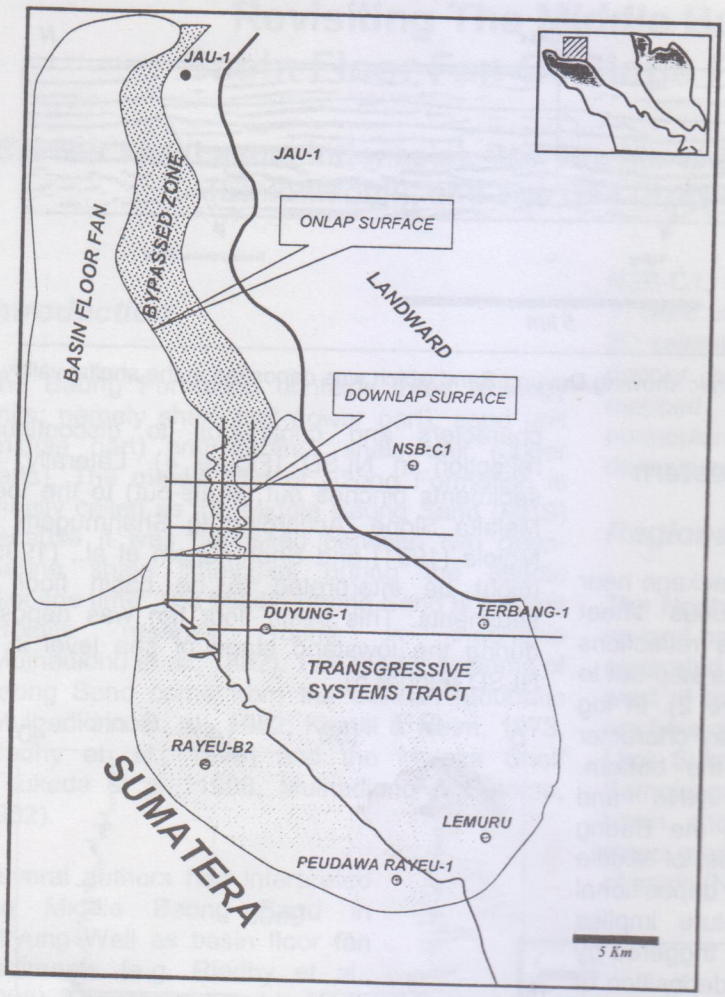


Figure 5: Depositional sequence map for N11-N12 Baong Sandstone in the study area

However, the previous author (Malecek, 1994; pers. comm.) had interpreted Baong Sand in the NLSD to be slope fan sediments (note: slope fan complex/sfc is one of the lowstand elements). Generally, the slope fan sediments exhibit concave upward forms or gull-wing characters (Shanmugam et al., 1995) which sites on the slope setting (Vail et al., 1987; Posamentier et al., 1991). Deep-water erosional process frequently occurred during the deposition of slope fan sediments (Mutti, 1992). Slope fan sediments represent the channel and overbank complex. All of these criterias were not mentioned in the interpretation of the convex upward forms in North Lho Sukon Deep to be the slope fan sediments.

Sequence Stratigraphic of the N11-N12 Baong Sandstone

The incision of Duyung valley in the shelfal area and and the correlative disconformity in the deeper part of basin (NLSD) clearly represent a type 1sequence boundary. This exhibits subtantial and widespread erosion (up to 150 meter deep, 7 km width, 10 km long) on the eastern part of Malaka Shelf and the pre-existing of Baong Sand in Duyung area (Figure 3). Erosional process delivered sediments within gravity flow mechanism bypassing the slope to basin during sea level fall (Figure 5). Gravity flow process yields successive lobes or basin floor fan unit in NLSD (Figure 6). Subsequent deposition of continuous sheet sands in shelfal area would be considered the expression of transgressive systems tract that deposited during sea level rise.

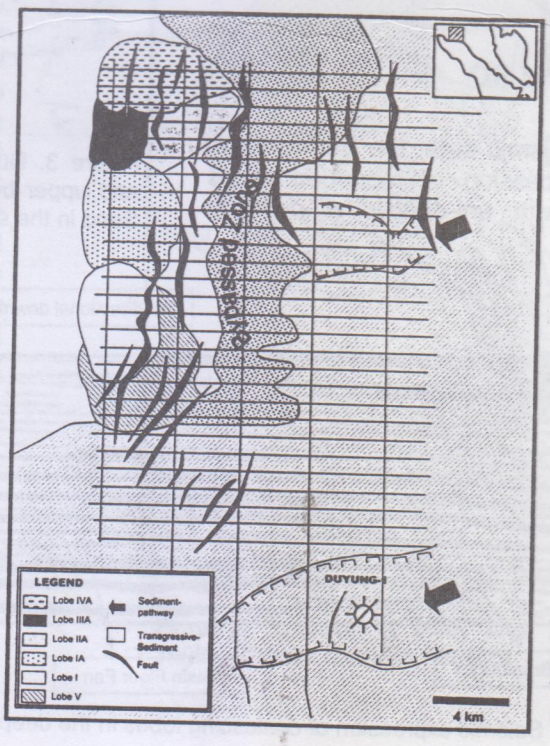


Figure 6: Isochron Map for Basin Floor Fan sediments

Cyclamina concelatta as the shelf-edge faunal assemblage (Bon, J., 1999; pers. comm.) suggests that the deposition of Duyung Sand shallower than the actually feature of basin floor fan.

Conclusions

1. Seismic stratigraphic analysis combined with biostratigraphic and well studies indicates two distinct phases of depositional sequence of Baong Sandstone in the study area (respectively from the basin to shelf): a) basin floor fan/ bff unit, b) transgressive unit.

2. The Duyung valley was accompanied by pronounced shallowing of the eastern basin margin (Malaka Shelf) and respectively incision the shelfal area. This process generated deposition of successive lobe or basin floor fan unit in the deeper part of North Sumatra Basin (NLSD). Subsequent the filling of remaining depression of Duyung

3. Sequence stratigraphic terminology for Middle Miocene of Baong Sandstone is so variously displayed. The interpretation should be considered its position in relation to the regional setting of study area.

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