

Chapter I Strata Classification and Comparison

On the basis of previous study, the drilling strata of Mid-Luzon Basin are classified top-down as Quaternary System BAMAN Formation, Pliocene Series TARLAC Formation, Upper Miocene Series MORIONES1 Formation, Middle Miocene Series MORIONES2 Formation, Lower Miocene Series MORIONES3 Formation, and Oligocene Series AKSITERO Formation, as shown in Fig.1-1. Biostratigraphy (marine facies biological fossil), lithologic stratum (lithologic feature, sedimentary feature, electrical characteristics and seismic reflection characteristics) of the drilling well in the working area, and other measures are used to classify and compare these strata.

Section I Biostratigraphy Classification and Comparison

A total number of 13 exploratory wells have been drilled in this working area. Through analyzing the current data, it is found out that these strata are abundant in marine facies biological fossil foraminifer and calcareous nannofossil.

There are two species of foraminifer, which are planktonic foraminifer and benthic foraminifer. In the study of marine facies strata, planktonic foraminifer is mainly used to classify and compare them. At present, there are two zoning schemes: proposed in 1969 and summarized in 1979, by using planktonic foraminifer biological events and combinations, Blow classified the Oligocene Series-Holocene Series into 23 fossil zones and the Paleocene Series-Eocene Series into 17 fossil zones. This scheme has been widely used in the classification of foraminifer biostratigraphy and the comparison of intercontinental stratum. Bolli (1985) proposed the zoning method according to their species and provided the corresponding relationship between the fossil zone classified according to the species and the fossil zone classified by Blow.

Calcareous nannofossil zone is divided according to the events of calcareous ultra microorganism. Martini (1971) proposed the standard Cenozoic calcareous

nannofossil biozone suitable for the near-shore shallow continental shelf areas from tropical zone to temperate zone. He classified the Paleogene System into NP1 to NP25 zones and totally 25 biozones, the Neogene System-Quaternary System into NN1 to NN21 zones and totally 21 biozones. Bukry (1973) proposed the low latitude area calcareous nannofossil biostratigraphic zone, which is suitable for low altitude area ocean zone. Okada and Bukry (1980) further classified Paleogene System into CP1 to CP19 zones and Neogene System-Quaternary System into CN1 to CN15 zones. In the zoning scheme proposed by Martini (1971), most of it adopts fossil end present surface, which is suitable for the analysis of drilling samples with debris samples as the majority.

Northern continental shelf at South Sea of China is the most developed and typical area for Neogene System marine sedimentary in the world. The paleontologists of China made thorough study of foraminifer and calcareous nannoplankton in this area. Foraminifer and calcareous nannoplankton have been widely used in the study of Neogene System biostratigraphy in this area. Good results were achieved, and successive reports of research results include Duan Weiwu, Huang Yongxiang, 1991; Huang Lvsheng and Zhong Bizhen, 1992; Qin Guoquan, 1996; Xu Yulin, 1996; Zhu Youhua and Chen Fang, 2007, etc. Intercontinental biostratigraphy comparison can be conducted to planktonic foraminifer and calcareous nannofossil. The era of drilling strata in Mid-Luzon Basin is similar to that of northern continental shelf at South Sea of China. Therefore, the biostratigraphy of Mid-Luzon Basin and northern continental shelf at South Sea of China can be compared by using planktonic foraminifer and calcareous nannofossil. Please refer to Table 1-1 and Fig.1-1 for details.

Only 9 wells in Mid-Luzon Basin have biostratigraphy data. In the absence of fossil identification table of all wells, these strata can only be determined on the basis of the available data, and problems existed in the data can be analyzed.

Section II Lithological Strata Classification and Comparison

1. Well Victoria-2

(1) Pliocene Series (Plei)

The depth of this well varies from 0 to 828m, and the apparent thickness is 828m. Unconformable contact with the underlying strata.

Lithologic feature: three different lithologic combinations can be seen from top to down. From 0 to 216m, it is sandstone and mudstone interbedded strata. From 216 to 557m, it is grayish-green, gray thick mudstone and thin siltstone. From 557 to 828m, it is gray sandy conglomerate, sandstone and grayish-green mudstone interbedded strata. Its upper is gray sandstone, siltstone and gray mudstone interbedded strata.

Sedimentary feature: the sedimentation of this stratum is mainly manifested as fluvial sediment feature, meandering river subfacies.

Electrical characteristics: the maximum value of natural potential is -73.3mv, minimum value is -79.7mv, and average value is -77.7mv. The fluctuation of natural potential is small, in oval and column shape. The bottom is in funnel shape, medium low negative anomaly, micro-serrated. The maximum value of natural gamma is 41.1API, the minimum value is 25.6API, and the average value is 33.9API, and the fluctuation is small. The paleontology stratification of these strata is at 993m. However, from the surface to 828m, it all belongs to fluvial sediments with variegated clastic rocks as the majority. Well log shows medium and low amplitude serrated, and the seismic line shows medium to high amplitude medium-high frequency medium continuous reflection. It shows obvious truncated relation or disconformable relation with the underlying strata. Therefore, it is more reasonable to place the bottom boundary of Pliocene Series at 828m.

(2) Pliocene Series (Plio)

The depth of this well varies from 828 to 1344m, and the apparent thickness is 516m. Conformable contact with the underlying strata.

Lithologic feature: the rock strata in this group can be classified into three sections. From 828 to 918m, the lower part is grayish-green, gray mudstone with thin gray siltstone, and the upper part is gray siltstone and gray mudstone interbedded strata. From 918 to 1264m, it is thin gray siltstone and thick gray calcareous mudstone interbedded strata, occasionally with thin limestone. From 1264 to 1344m, the lower

part is thick gray calcilutite, and the upper part is mudstone gray grayish-green siltstone. Mudstone is occasionally contained with fine lignite and pyrite inclusion, a few firestone, and very little planktonic foraminifer and benthic foraminifer.

Sedimentary feature: the sedimentation of this stratum is mainly manifested as marine sediment feature. The upper section and lower section are manifested as littoral sediment, while the medium section as neritic sediment.

Electrical characteristics: the maximum value of natural potential is 20.4mv, minimum value is -79.7mv, and average value is -22.5mv. The fluctuation of natural potential is big, in oval and box shape. The bottom is in funnel shape, medium low negative anomaly, micro-serrated. The maximum value of natural gamma is 49.5API, minimum value is 29.2API, and average value is 38.4API, and the fluctuation is small.

The paleontology stratification of these strata places the bottom boundary of Pliocene Series at 1344m. From 828m to 1344m, it mainly is gray clastic rock and belongs to coastal neritic sediment. Well log shows medium and high amplitude serrated. In seismic section, the upper part of these strata above this interface shows medium-weak amplitude medium-high frequency weak continuous reflection, and the lower part shows weak amplitude low frequency blank reflection. Truncated and progradational configuration can be seen near the anticlinal nucleus below this interface. Therefore, it is logical to place the bottom boundary of Pliocene Series at 1344m.

(3) Upper Miocene Series (LM)

The depth of this well varies from 1344 to 2606m, and the apparent thickness is 1262m. Conformable contact with the underlying strata.

Lithologic feature: the rock strata in this group can be classified into five sections. From 1344 to 1568m, the lower part is gray, grayish-green mudstone and gray sandstone interbedded strata; the medium part is gray sandstone with thin gray, grayish-green mudstone; the upper part is gray sandy conglomerate with thin siltstone, mudstone. From 1568 to 1875m, it is thick gray mudstone and thin siltstone, sandstone interbedded strata. From 1875 to 2272m, it is gray siltstone with gray,

grayish-green mudstone. From 2272 to 2433m, it is gray siltstone, sandstone with grayish-green mudstone. The mudstone is occasionally contained with benthic and planktonic foraminifer. From 2433 to 2606m, it is thick gray sandstone, siltstone with thin gray mudstone and limestone. Sandstone has the characteristics of gray to dark gray, poor sort, a little firestone, commonly contained with a large number of clastic rock limestone inclusion, small amount of planktonic foraminifer. For limestone, the upper part is muddy limestone, silty to very fine, white, light yellow, containing with organic clastic, commonly seen with large amount of encrusting alga, occasionally with coral and shell fragments, and benthic foraminifer.

Sedimentary feature: the upper part of this stratum is delta sediment, and the lower part is marine sediment.

Electrical characteristics: the maximum value of natural potential is 19.2mv, minimum value is -17.9mv, and average value is -0.6mv. The upper part is low negative anomaly, and the middle part is low positive anomaly. The fluctuation of natural potential is small. It shows the basic value, serrated, local in oval shape and barrel type, and bottom in bell shape. The maximum value of natural gamma is 55.0API, minimum value is 33.7API, and average value is 44.1API, and the fluctuation is small.

The paleontology stratification of these strata places the bottom boundary of Upper Miocene Series at 2795m. However, from 1344m to 2606m, top to down it is littoral facies and delta facies, the configuration of seawater is third level sequence cycle deepening at first and shallowing later. The lower part well log shows low amplitude serrated shape, and the upper part shows the combination of funnel shape and bell shape. At the upper and lower parts of the seismic section, it shows low amplitude low frequency weak continuous reflection, the upper parts shows medium and high amplitude high frequency medium continuous reflection, and progradational configuration can be seen at both wings of the anticline. Therefore, the bottom boundary of Upper Miocene Series should be placed at 2606m.

(4) Middle Miocene Series (MM)

The depth of this well varies from 2606 to 3530m, and the apparent thickness is

924m. Conformable contact with the underlying strata.

Lithologic feature: the rock strata in this group can be classified into two sections. From 2606 to 3338m, it is thick gray siltstone, sandstone with gray mudstone and brownish yellow limestone. From 3338 to 3530m, it is dark gray siltstone and mudstone interbedded strata, occasionally with planktonic foraminifer.