

The Analysis of Sedimentary Circumstance and Geothermal Enrichment Condition of Dongying Formation in Tanggu of Tianjin

Liu Jiulong, Yang Yongjiang, Sun Baocheng, Zhang Ziliang, Linli, Li Jun, Chen Haibo

Tianjin Geothermal Exploration and Development-Designing Institute

Add: 189, Wei Guo Road He Dong District Tianjin, China

E-mail : julon0920@163.com

Keywords: the Dongying formation, sedimentary circumstance, geothermal enrichment condition, Tanggu.

ABSTRACT

On the basis of explaining the general stratigraphy of Dongying formation of Paleogene in the Tanggu District of Tianjin, the sedimentation of Dongying formation were analyzed. The Dongying formation in this area gradually emerged in the delta plain and the delta front sediment sequence. Considering the sedimentary circumstance of the Dongying formation to analyze its geothermal enrichment, it was possible to determine that the Dongying formation has good geothermal potential.

1. INTRODUCTION

As the core area of Tianjin Binhai New Area, the Tanggu area has a growing demand for green energy. As the main reservoir of the area, the Dongying formation reservoir can provide strong back-up energy and serves the economic development of the area. As a result of the Dongying formation, development of the area is only in its infancy, so the analysis of its sedimentation and enrichment conditions is of great significance to the reasonable development of Dongying geothermal resources.

2. GEOLOGICAL STRUCTURE CHARACTERISTICS OF THE STUDIED AREA

The studied area spans two grade IV tectonic units: the Beitang depression and the Banqiao depression, as shown in Figure 1. Due to the existence of Haihe fracture in the area, the present nose-like structural pattern was formed, as shown in Figure 2. This zone has a distribution that is nearly east-west. It is bordered by the Haihe fracture to the south, the Tangbei fracture to the north, and the Cangdong fracture to the west, and the eastern side extends into the sea and connects to the Xingang semi-anticline. Section inclines of the Haihe and Tangbei fractures are opposing, which leads to form an east-west stripped bed-block in their midst. Its existence affects the sedimentary distribution of part of the Paleogene strata.

3. THE SEDIMENTARY CIRCUMSTANCE OF DONGYING FORMATION

The sedimentation of the Dongying formation in this area was analyzed based on the lithology combination rule of the exploration well TR21 and its geophysical prospecting data, combined with the study results of the Dagang petroleum company.

The characteristics of the three Dongying lithological sections are as follows:

Dongying segment (1896-2044 m): This section has a thickness of 148 m, and the lithology is gray green mudstone

blended with gray green powder sandstone, with a thin upper layer composed of black shale stone.

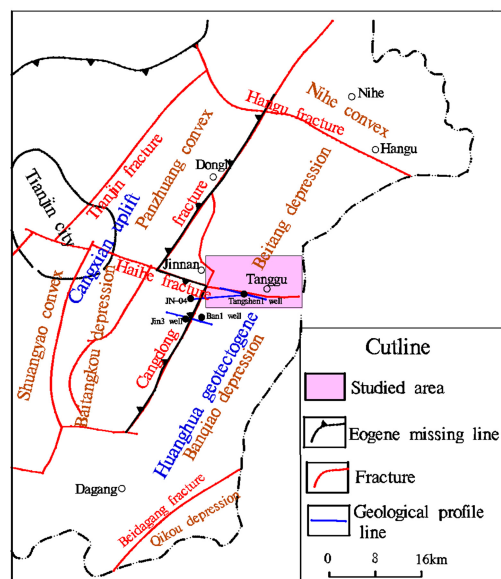


Figure1: Geological map of the Tanggu urban area

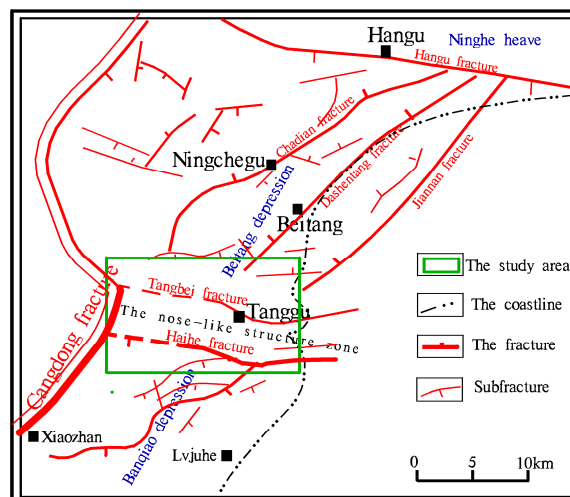


Figure 2: Geological map of the study area

Dongying segment (2044-2214 m): With a thickness of 170 m, this section has a 12-15 m thick upper part composed of middle - coarse sandstone and a lower part composed of gray green mudstone blended with gray green powder sandstone. The mudstone containing debris increased, and is

mainly composed of feldspar particles and some quartz. The feldspar has been weathered more and has poor psephicity and a 2-5 mm particle size. The segment shows the obvious anti-cycles deposition.

Dongying segment (2214-2362.98 m): This section is 148.98 m thick, with a bottom composed of gray, black, and dark brown mudstone. The upper part is the gray green powder sandstone blended with mudstone. Analysis of the core samples revealed a segment of siltstone with horizontal bedding and an average thickness 5 m. This siltstone contained debris, (particle size of ~5 mm) that had an angular - sub-angular shape and a poor degree of rounding.

The Dongying Formation deposition in this area is mainly composed of a set of terrigenous clastic sediments of mudstone and siltstone, including feldspar, quartz and a small amount of debris, as described above. With respect to the sedimentary sequence, the debris particle size becomes larger gradually from the bottom to the top. At the bottom, the segment is black and dark brown mudstone, and its upper part contains gray middle-course sandstone, green mudstone, siltstone, and increasing clastic. Its sedimentary sequence is anti-cyclic, an important feature of the delta sediments. The profile curve of the geophysical prospecting of well TR21 shown in Figure 3 reflects changes in the sedimentary sequence. Considering the low ratio of sand and mud, more indicative marine fossils, and so on, it can be seen that Dongying terrigenous clastic sediments of this area are the delta sediments controlled by rivers.

In combination with the sediment deposition characteristics of different stages in other areas, the sedimentary rock of the Dongying group in this area may further be divided into two subfacies: the delta plain subface (subdivided further into

the the bog plain, difffluence riverway, and delta difffluence depositions) and the delta front subface (subdivided further into the bayou sand-dam and far-forth sand-dam depositions).

The evolution process of the delta deposition in the Dongying formation is illustrated in Figures 4-6.

Terrigenous clastic material in this area comes mainly from the Yanshan fold belt in the north along Ninghe and Jianhe. In the west, the direction of transportation and migration is from west to east, along the direction of the ancient river and into the lake basin. As a result of the sudden weakening of the energy flow, the majority of large particulate sediment was deposited in the mouth of the river to form a sand dam, and the rest were more fine-grained material carried away in suspension by currents from the estuary, in which formed sand-dam mudstone and siltstone depositions, constituting the delta front subfacies. Farther away from the estuary, sediment grain size is finer. With the bifurcation of the tributary channel and the forward advance and cyclical fluctuations in the river and the marsh plain, tributary channel deposition occurred in the delta plain subface. Therefore, the Dongying formation emerged gradually in this area, including the delta plain and delta front depositional sequence from land to lake in the plain.

4. THE ENRICHMENT CONDITION ANALYSIS OF GEOTHERMAL LIQUID

Groundwater richness is closely related to the delta deposition. Siltstone delta deposition provides good hydrogeological conditions for the enrichment and run-off of groundwater. The bayou sand-dam and the front sheet-like sand body of the river delta in particular have good storage performances.

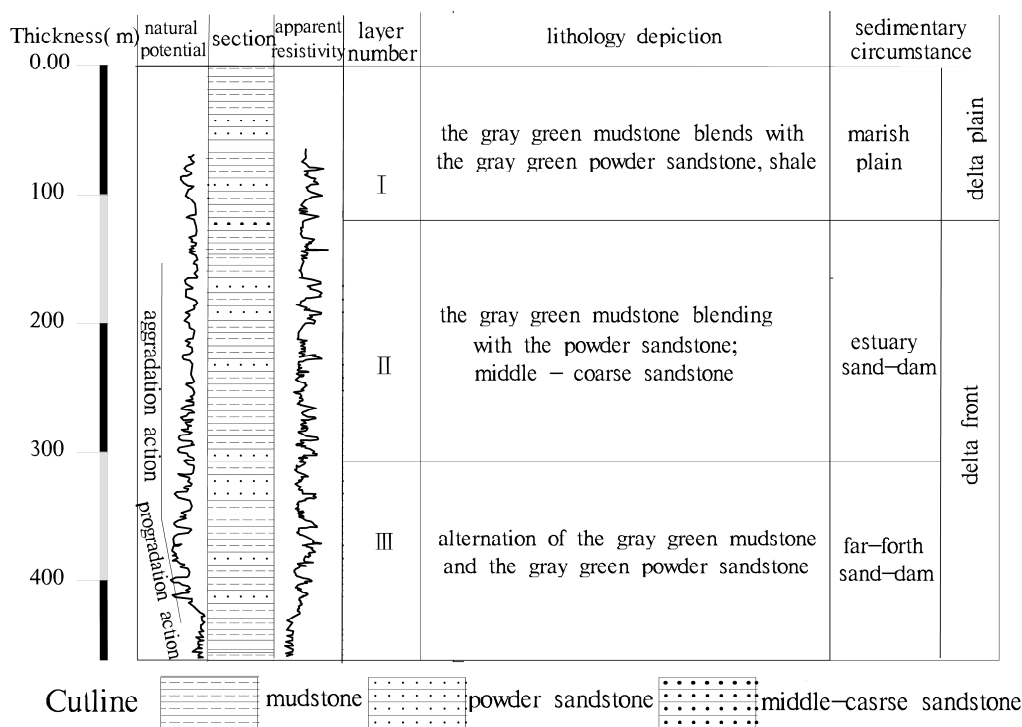


Figure 3: Dongying sedimentary faces analysis in TR21 well

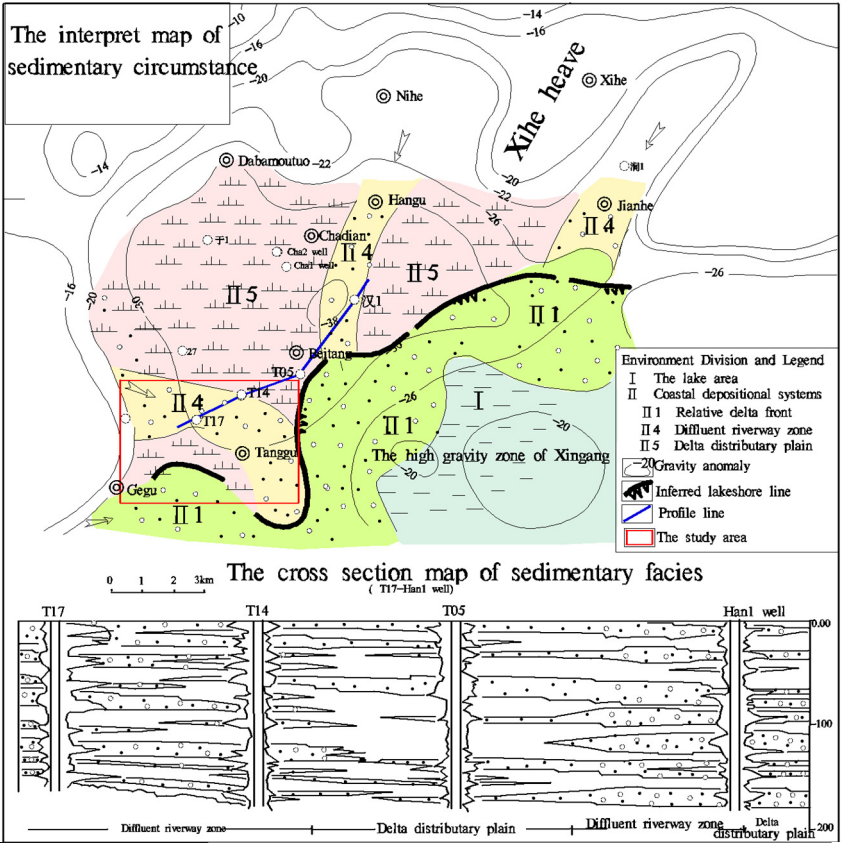


Figure 4: Analysis of Dongying sedimentary deposition in the Beitang depression

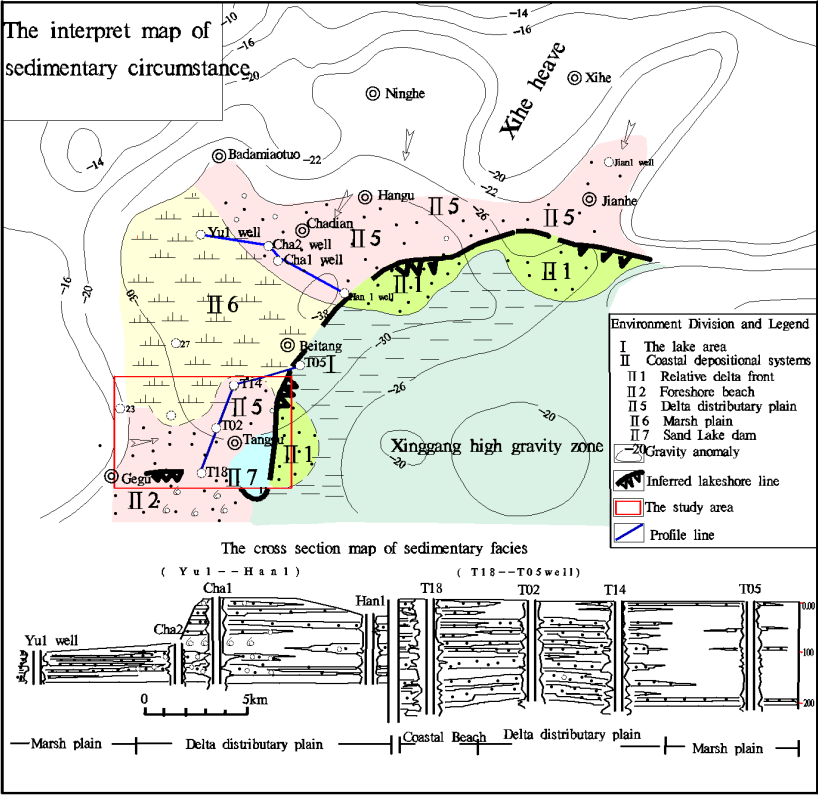


Figure 5: Analysis of Dongying sedimentary deposition in the Beitang depression

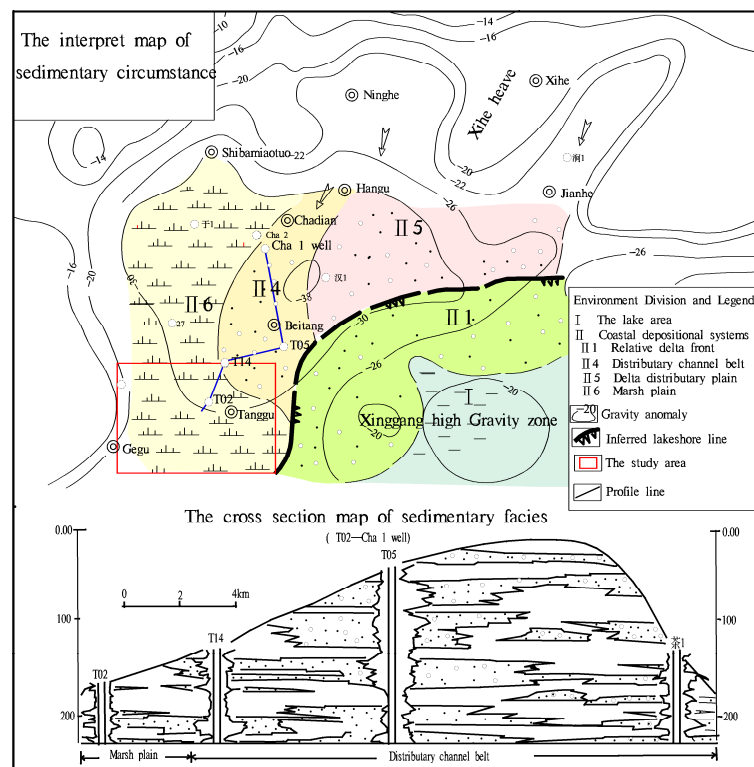


Figure 6: Analysis of the Dongying sedimentary deposition in the Beitang depression

The source area of Dongying III and DongyingII in this area was mainly in the north, and the Gugu district in the west was the secondary source area. It was the lake depositional environment east of Tanggu, however, where the river delta and marsh plain sedimentary environments were located in the Tanggu district. The area belongs to the formation process of the delta deposition and shows evidence of the transformation rule which is from the contraction to expansion from DongyingIII to DongyingI. In the Dongying III - DongyingII deposition period, mainly front delta deposition and lake sand dam deposition occurred, which favor geothermal fluid accumulation. These types of favorable deposition occurred in Hetou in the Tanggu district. To the DongyingI period, in most parts of this area, the deposition has evolved into the swamp plain. Tributary channel deposition only occurred in the northeastern region, and the relative development of sand is the favorable place for the accumulation of geothermal fluid.

5. CONCLUSION

(1) The studied area spans two tectonic units: the Beitang and Banqiao depressions. Due to the existence of the Haihe fracture in the area, it has a nose-shaped structure in the junction of two grade IV tectonic units.

(2) The sedimentary sequence of the Dongying formation was controlled by the river delta sedimentary environment in studied area. In the Dongying III - DongyingII deposition period, the depositions are mainly the front delta deposition and lake sand dam deposition. This may have favored geothermal fluid accumulation in Hetou of the Tanggu

district. In the Dongying period, in most parts of this area, the deposition evolved into the swamp plain. Only in the Northeast region was the tributary channel deposition caused by the relative development of sand. This area is a favorable place for the accumulation of geothermal fluid.

(3) The Dongying formation is a good geothermal liquid reservoir.

REFERENCES

- Geology Journal of Ministry of Geology & Mineral Resources.: Tianjin Areal Geology Note[M]. *geology press*, (1982).
- Chen Moxiang.: Geothermal of Huabei [R]. *Science Press*, (1998), 89–106.
- Tianjin Geothermal Exploration and Development-Designing Institute.: Feasibility Analysis of Prospection on Geothermal Field of Geostatic Style in Tanggu Area, (2002).
- Tianjin Geothermal Exploration and Development-Designing Institute.: General Exploration on Dongying Formation Geothermal Resource in Tanggu Area, Tianjin, (2008)
- Buatois L A,Mangano M G,Xiantao Wu,et al.: Trace fossils from Jurassic Lacustrine turbidites of the Anyao Formation(central China)and their environmental and evolutionary significance[J].*Ichnos*,4, (1996), 1-17.
- Buatois L A,Mangano M G.: The palaeoenvironmental and palaeoecological significance of the Lacustrine Mermia ichnofacies:an archetypical subaqueous nonmarine trace fossil assemblage[J].*Ichnos*, 4, (1995), 151-161.