

Analysis of the Source System of Nantun Group in Huhehu Depression of Hailar Basin

Yue Li ^{1,*}, Junhui Li ², Qi Wang ², Bingyang Lv ² and Guannan Zhang ³

¹ Northeast Petroleum University, Earth Sciences Institute, Daqing 163318, China

² Exploration and Development Research Institute, Daqing Oilfield Company Limited, Daqing 163712, China

³ Operation team of The NO.2 Oil Production Plant, Daqing Oilfield Company Limited, Daqing 163000, China

*Corresponding author e-mail: 418828568@qq.com

Abstract. Huhehu Depression will be the new battlefield in Hailar Basin in the future, while at present it's in a low exploration level. The study about the source system of Nantun group is little, so fine depiction of the source system would be significant to sedimentary system reconstruction, the reservoir distribution and prediction of favorable area. In this paper, it comprehensive uses of many methods such as ancient landform, light and heavy mineral combination, seismic reflection characteristics, to do detailed study about the source system of Nantun group in different views and different levels. The results show that the source system in Huhehu Depression is from the east of Xilinbeir bulge and the west of Bayan Mountain uplift, which is surrounded by basin. The slope belt is the main source, and the southern bulge is the secondary source. The distribution of source system determines the distribution of sedimentary system and the regularity of the distribution of sand body.

1. Introduction

The analysis of the sediment source is the very important content in analysis of sediment basin, which goes by reproduction of sedimentary basin evolution and recovering palaeoenvironment, its main methods is the composition of the terrestrial fragmental components and combination of heavy minerals. They are under the control of clastic rock handling distance and the types of rocks in the parent rock area. Sandstone is the main rock types of terrestrial clastic rock. The clastic material mainly contains the mechanical crushing of the mother rock, which reflects the important signs of the sediment source. The analysis of source system is significant to determine the location of sediment source, character, sediment transport path, and the sedimentary pattern of the whole basin, and prediction of sand body in basin.

This paper is in use of ancient landform, light and heavy minerals, seismic reflection characteristics, thickness of sandstone and percent content of sandstone, to do detailed study about ancient source system of Nantun group in Huhehu Depression in different angle and different levels. It has theoretical and practical significance to the destruction of sedimentary system and the further exploration of oil and gas in this area.

2. Geology

Huhehu Depression is in the southeast of Hailar basin, which is the secondary structure unit in Hailar basin. It spread from north to east, which is next to east of Selim Bell bulge, the west of Bayan Mountain uplift, the north is connected to Emmini Depressin, the south border is extended outside the



country and connected to Mongolia. The depression represents dustpan-like sag which is faulting in east and overlapping in west. Its square is 2500km^2 . The structure can be divided into three tectonic units: actic region, gentle slope belt, excavated zone (fig.1). Sedimentary formation mainly composed of cretaceous, which divides from top to bottom is: lower Cretaceous Tongbomiaao Formation, Nantun Formation, Damoguai River Formation, Yimin Formation and upper Cretaceous Qingyuangang Formation. Nantun Formation is the mainly oil layer system, its rock association from top to bottom is: Nantun Formation section one and Nantun Formation section two. Nantun Formation section one is mainly composed of dark grey mudstone, grey siltstone and gray, mixed sand conglomerate interbedded and there are grey coarse sandstone. Nantun Formation section two mainly contains a set of grey siltstone and thick black mudstone, grey conglomerate, grey-white packsand, black coal seam in some regions^[1-3].

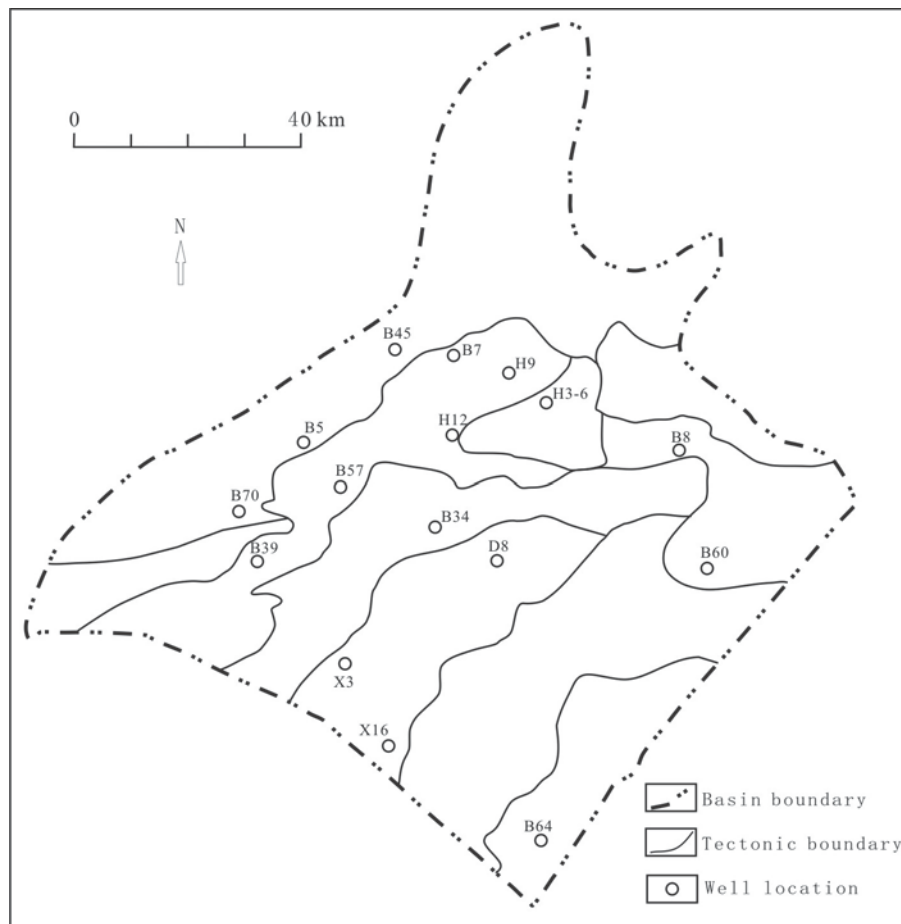


Figure 1. The location of the study area and the division of structural elements

3. Analysis of Combination of Syndepositional Fault

Different combination of syndepositional faults have different structure paleogeomorphology thus determine migration and distribution of source system, the space fabric of the depositional system. Therefore, to analysis combination of syndepositional fault in basin can help us to analysis the main sedimentation center, drawing out the path of source in basin, in order to provide macro direction of source analysis ^[4-5].

The parallel fault-order and sedimentary fracture combination system develops north-east direction which is in the northwestern gentle slope. It forms a multistage fault slope, comes to being the path of the multistage flow of sediment to the depression center, which can indicate the direction of the source. The development of a main fracture in the northwest slope and a parallel-associated secondary fracture, which formed the brush fracture system, the direction of source advanced from uplift of the main fracture to the lake basin. The area where the brush diverges can form a lower location of the structure easily, and they usually associate with thick “amputation of horn” sand body, therefore to control the local secondary depositional center; two groups of the same direction of the steep slope provide the main path to the migration of sediment source, they are low structure when they are in the fracture zone of synsedimentary faults, and they are usually in the injection position of the largest water system. The inside angle in the south forked fracture system corresponding to low structure location. The thick broken angle sand body controls the direction of source and distribution of sand body obviously (fig.2).

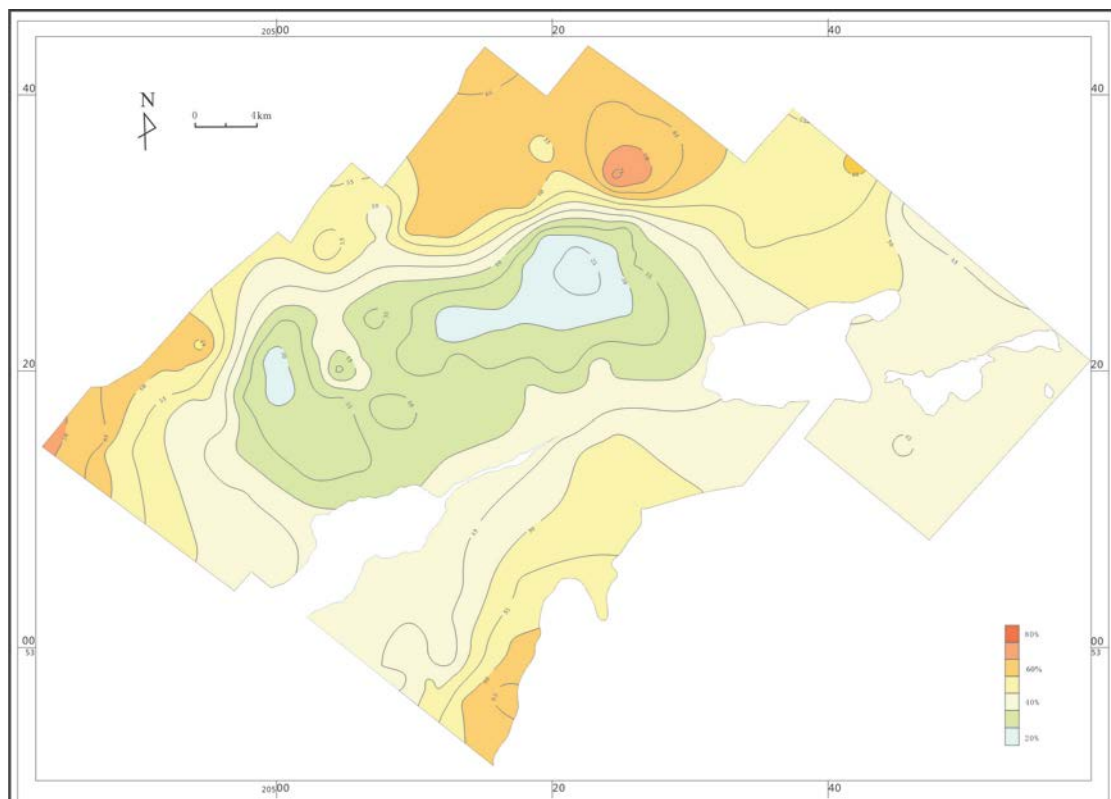


Figure 2.The characteristics of the pattern of fracture zone and the distribution of sand body

4. Analysis of Paleogeomorphologic Features

The paleogeomorphology has important control effect on the spread of sedimentary system. Through the analysis of paleogeomorphology, it can be determined that the spread pattern of upheaval and chase. By this way, we can confirm the source direction of the basin and the location of the source area. On the basis of construction grid interpretation and sequence stratigraphic structure in Huhehu sag, our research has been applied the settlement and stripping analysis technique and finally restore the early palaeogeomorphology of Nantun formation in Huhehu sag. We can see the changing process between the hollow and upheaval during this time visually. This study lays a solid foundation for the analysis of the source [6-9].

As a whole, the paleogeomorphologic features of the Nantun sedimentary period in Huhehu sag shows the tectonic characteristics of three hollows and two upheavals. The eastern Xlinbell bulge and the western Bayanshan uplift distribute surround the Huhehu sag. These two uplifts are the important source area of Huhehu sag during the Nantun sedimentary period. The distribution pattern of the hollow and upheaval in this depression is very evident. Sediment has been carried from the provenance to the low-lying district through valleys. By the recovery of Nantun group paleogeomorphology characteristic analysis, we think that the main source direction is the gentle slope and the steep slope. The southern uplift is the secondary source direction (fig.3).

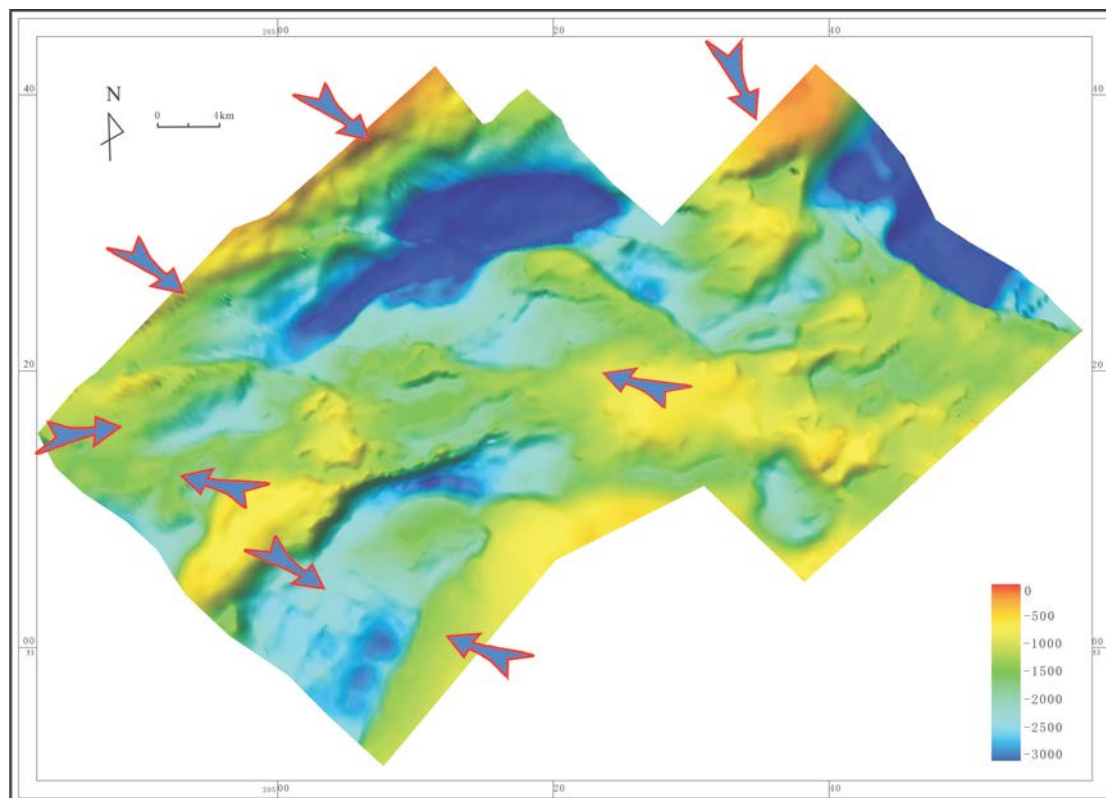


Figure 3. The palaeogeomorphology and source system analysis of Huhehu sag during Nantun period

5. The Distribution Pattern of Sedimentary System

Our research mainly used the data of core, logging and seismic progradation reflection characteristics. It confirms that Huhehu sag develop four kinds of sedimentary facies during Nantun period. They are fan delta, braided river delta, sublacustrine fan and lake[4~5].

During the first half of the Nantun sedimentary period, the crust was sinking accompanied by a strong pull. Lakes became big and deep. Huhehu sag mainly developed the fan delta, braided river delta and sublacustrine fan sedimentary facies. The fan delta sedimentary system was developed in the southern region of sag. The northern region of sag most developed the braided river delta sedimentary system whose fan body was very large. The subenvironment of lake mainly developed in the settlement center of sag. At the same time, because of gravity flow, the sublacustrine fan always developed in the shallow lake area.

The source direction of the second half of Nantun sedimentary period was same as the first period. Because of fractures continuous activity, the lake area expanded further. The sediment size was relatively smaller than before. Around the lake it mainly braided river delta sedimentary system and deep lake environment developed in subsags belt, near the center of sag. Because of gravity flow, the sublacustrine fan developed in the local area of deep lake and half - deep lake facies. Meanwhile, due to the characteristics of multi-cycle and volatile sedimentation, the lake were surrounded by swamp facies.

6. Results

To study ancient source system in Nantun formation of Huhehu Depression with using ancient landform, light-heavy minerals, seismic reflection characteristics, sandstone thickness and the percentage of sandstone in different levels and different angles. The results show that the source in Nantun Formation of Huhehu Depression has inheritance. The source comes from east of Xilinbeier bulge and west of Bayanshan Mountain uplift, and it gathers around the center. The gentle slope belt and the steep slope is the main source, the south of uplift is the secondary source. Nantun Formation develops four sedimentary facies including fan delta, braided river delta, sublacustrine fan and lake, which is according to core, logging, well-logging mainly and seismic reflection features, also combining with the regionally structural evolution. The north of Nantun 1 braided river delta, and south of it mainly contains of fan delta. Deep lake-half deep lake develops in some location. In Nantun 3 sedimentary period, developing braided river delta mainly, and sublacustrine fan facies in some location of deep lake area, and the marsh facies around the lake basin relatively developed at the same time.

7. References

- [1] Yang Ren-chao, Li Jin-bu, Fan Ai-ping, et al. The progress and development trend of Terrigenous sedimentary rocks and provenance analysis[J]. *Acta Sedimentologica Sinica*, 2013, (01):99-107.
- [2] Wei Ran, Li Hong-yang, Yu Bin, et al. Research Progress on provenance analysis of sedimentary basin[J]. *Lithologic Reservoirs*, 2013, (03):53-57.
- [3] Wu Lei, Xu Huai-min, Ji Han-cheng. Analysis of Paleogene sedimentary system evolution and source Bozhong sag in Bohai Bay Basin[J]. *Quaternary Geology*, 2006, (01):81-88.
- [4] Huang Chuan-yan, Wang Hua, Xiao Dunqing, et al. Sequence Patterns, Characteristics of Depositional Systems and Model of Reservoirs of Fault Steep Slope Belt of the First M

- ember of Shahejie Formation in Banqiao Sag[J].Acta Sedimentologica Sinica, 2007, 25(3):386-391.
- [5] Feng You-liang, Xu Xiu-sheng. Syndepositional Structural Slope-Break Zone Controls on Lithologic Reservoirs-A Case from Paleogene BohaiBay Basin[J]. Petroleum Exploration and Development, 2006, 33(1): 22-31.
- [6] Li Lin-lin, Guo Zhao-jie, Guan Shu-wei, et al. Characteristics of Cenozoic detrital heavy mineral assemblages and their palaeogeographic evolution in the southwestern margin of the Qaidam Basin[J]. Chinese Science: Earth Science, 2015, (06):780-798+1-6.
- [7] Lv Lin, Jiao Yang-quan, Wu Li-qun, et al. Reconstruction of provenance sedimentary system of the Paleogene Shahejie Formation in Qikou Sag, Bohai Bay Basin [J].Acta Sedimentologica Sinica,2012,(04):629-638.
- [8] Wang Hua, Bai Yun-feng, Huang Chuan-yan, et al. The Paleogene provenance system of the Dongying reconstruction and application of Qikou Sag[J]. Earth Science, 2009, (03):448-456.
- [9] Chen Jun-liang, Wu He-yong, Zhu De-feng, et al. Tectonic Evolution of the Hailar Basin and Its Potentials of Oil-Gas Exploration[J]. Chinese Jour Geol, 2007, 42(1):147-159.