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Biomarkers characteristic and sedimentary environment in Nenjiang formation from well Mao 206 of Songliao Basin

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Abstract：The Nenjiang Formation from well Mao 206 was a sort of typical lake sediment. It has comparatively high ratio of gammacerane to C30 bionorhopane,along with especially low ratio of diasteranes to conventional sterane in Qingshankou Formation,it was suggested that period should happen water body delamination event and anoxic event in old lake. It brought form of high quality hydrocarbon . Based on the study of magnetostratigraphy and zircon U-Pb ages of volcanic rock samples,the bottom age of Nenjiang Formation belong to Santonian stage.

Key words: *Songliao Basin, Cretaceous,Nenjiang Formation, Biomarkers*

The Mesozoic is an important window of time during the process of geologic evolution history,Cretaceous has occurred in a typical "greenhouse climate" as the representative of the many major global geological events,It is a major catastrophe in the history of the earth's evolution[1-2].The Cretaceous in Songliao Basin, especially late Cretaceous is the heyday of the development of the whole basin, wide lakes, the biota of lakes extremely prosperous,deposited to build a giant thick layer of sand mud clastic rock[3].

I. REGIONAL GEOLOGICAL BACKGROUND

The tectonic evolution of the Songliao basin has undergone four major stages of geological evolution, namely, the fault depression, the faulted depression, the depression and the shrinking stage, and formed a unique combination of the deposit[4].Duringthe early Upper Cretaceous,the basin Quankou Formation,Qingshakou Formation,Yaojia Formation and Nenjiang Formation were gradually expanded. It reached the peak during the deposition of Nengjiang formation.Formation of a large deep depression[5].The basin sedimentary range received a extreme development during the period of Depression stage,Fault depression on the segmentation of the isolated small basin gradually formed a unified big basin.At the same time,influenced by the ancient landform,the basin is subdivided into uultiple relatively independent tectonic stratigraphic units:central depression, northern dip-down, northeast uplift, southeast uplift, southwest uplift and west slope and so on[4].The distribution of large area lakes is derpression period's main characteristic,around the lake's Settlement Center-central depression area of annular facies.From the plane direction, the combination from the basin to the center of the lake, which is a combination of the flush plain-delta-lake.In vertical direction,two complete sedimentary filling sequences are characterized by flush plain-delta-shore shallow lake-deep lake-shore shallow lake-delta.

The deposition of the Nenjiang formation is a result of a massive invasion of the lake,especially during the sedimentary period of the first and the second stage,the sedimentary environment of semi deep lake-deep lake is formed in most areas of the basin,and in the basin are widely distributed in black mudstone, gray black mudstone,With oil shale and dolomite sedimentary assemblage.The impact of the lake is obvious, and the impact of the river is increasing after deposition of the third stage of Nenjiang formation,aubergine mudstone,greenish mudstone and shallow gray sandstone was significantly increased,they form a large set of

varicoloured sand, mudstone sedimentary combination[4].

1 The Nenjiang Formation from well Mao 206's Stratigraphic section

The well Mao 206 is located in the central depression of Songliao Basin in Gulong sag of Aonan nose structure,The geographical position is northwest 1.0 Km from Wolaquan village,which is belong to Daqinoordig.the geodetic cnates is X:5049724.5m,Y:21630437.5m.

The Nenjiang Formation from well Mao 206's description from top to bottom hierarchical is as follows:

Overlying strata:The third stage of Nenjiang Formation

-------Integrated contact--------

The second stage of Nenjiang Formation (793.4-1025.0m,Thickness is 231.6m)

(10)Brown grey siltstone. 6.25m

(9) Grey silty mudstone intercalated with charcoal grey mudstone 9.0m

(8) Charcoal grey mudstone,there is a small amount of bivalve fossils in lower part. 159.65m

(7) Grey black mudstone,a small amount of the ostracoda fossils,conchostracan fossils,bivalve fossils and fish fossils can be found. 45.26m

(6) Charcoal grey mudstone,visible ostracoda fossils,conchostracan fossils,occasionally see pyrite crystals. 2.65m

(5) Grey black mudstone intercalated with brown black oil shale,visible ostracoda,conchostracan fossils enrichment layer and a layer of 2mm thick bentonite. 3.65m

(4) Brown black oil shale intercalated with grey black mudstone. 1.1m

(3) Grey black mudstone intrecalated with brown black mudstone,visible abundant conchostracan fossils. 1.2m

(2) Brown black oil shale intercalated with grey black mudstone,visible conchostracan fossils. 0.7m

(1) Grey black mudstone,brown black oil shale at the bottom,a small amount of the ostracoda fossils,conchostracan fossils and bivalve fossils. 1.7m

-------Integrated contact--------

The first stage of Nenjiang Formation (1025.0-1126.5m,Thickness is 101.5m)

(6) Charcoal grey mudstone,visible ostracoda fossils,conchostracan fossils and bioclasts. 5.2m

(5) Large section of grey black mudstone,The bottom of the part contains ostracoda fossil-bearings bed,occasionally see traces of biological escape. 62.2m

(4) Grey mudstone,contains ostracoda fossils caliche. 1.0m

(3) Grey black mudstone intercalated with ostacoda fossil-bearings bed. 7.15m

(2) Green grey mudstone,ostracoda fossils' distribution showed a banded distribution or accumulation distribution. 11.2m

(1) At the top,there are charcoal grey mudstone and grey black mudstone intercalated with yellow grey marl.At the bottom,there are charcoal grey mudstone,grey black mudstone and blacn mudstone,visiable a lot of ostracoda fossils,conchostracan fossils and a small amout of bivalve fossils,gastropod fossils,sometimes the ostracoda output as a layer. 14.75m

-------Integrated contact--------

Underlying formation : Yaojia Formation.

The brown black shale at the bottom of well Mao 206 development and distribution stable in the whole basin,it is the first level mark of the whole basin.It is particularly worth mentioning is that at the bottom of the second stage of Nenjiang Formation at 1019.0m identified a layer of Bentonite.Through the test of Ion probe laboratory test from Institute of Geology an Geophysics Chinese Academy of Sciences,the volcano ash

(bentonite) zircon U-Pb age was 83.68 ± 0.47Ma.It provides a material basis for the analysis of isotopic zircon dating.

II. MAGNETIC STRATIGRAPHY

Magnetic stratigraphy is one of the main methods in the determination of terrestrial strata.Through the study of Late Mesozoic magnetic stratigraphy and the system testing of Pacific Ocean, the Atlantic ancient oceanic crust magnetic anomaly,combined with the biological stratigraphy and isotopic age,at present,has been gradually established and perfected the geomagnetic polarity time scale over the last 200Ma[7-8].The most obvious characteristics of geomagnetic polarity changes during the Cretaceous period,is the existence of the phenomenon of the super magnetic tape or the positive overtime in the Cretaceous period.And the key of the Cretaceous magnetic stratigraphy is to determine the starting position of the Cretaceous ultra quiet magnetic tape in the formation.And that is what is called the M_0 horizon(about 120 Ma).This is the key point of the Cretaceous strata of the sea, is also the focus of academic attention.Fang Da-jun and someone else have studied the Cretaceous poles of the Songliao basin.The results of the research show that the Nenjiang group has tested 500 samples, with positive polarity.But in the third and the forth stage of Nenjiang Formation have acquired a relatively stable and wide anti polarity zone.The reversed polarity zone of the Nenjiang formation is equivalent to the lower part of the Campanian order,it is the most obvious one between the Aptian and the Maastrichtian.

Actual measurement data show that,the secend stage of Nenjiang Formation and its underlying area are stable with positive polarity magnetic stripe.The second stage of Nenjiang Formation's oil shales above (955.45 ~ 987.95m wells) began to reverse polarity magnetic stripe with stable,the polarity layer is recognized as the M_0 layer.Contrast with GPTS[11],the geological age of the well Mao 206's Nenjiang group is equivalent to the Santonian stage.

III. BIOMARKER CHARACTERISTICS

Biological marker compound analysis technique is an important technique in the research of organic geochemistry, which plays an important role in the formation of source rocks, the maturity and evolution, the transformation of the late stage and the petroleum origin.Biomarkers due to the inheritance of the original sedimentary parent material molecular structure,so it can be used to infer depositional environment and organic matter input and maturity characteristics.The sources of the tricyclic terpane of the three sources may be some algae, which may also be related to the terrestrial higher plants[12].Through the different layers of the tricyclic terpane that the first stage and the second stage of Nenjiang Formation(Fig 1) ,the ratio of the tricyclic terpane to C_{30} hopanoid is relatively low,distributing in double peaking,its value is between 0.251-1.936.Mean value was 0.615.Each of the first stage of Nengjiang Formation and the second stange fo Nenjiang Formation had a peak,1.58(1093.14m,the first stage) and 1.94 (1000.47m,the second stage). The source rock organic matter mainly comes from the lower algae, but the influence of higher plants is smaller.

In general,the formation of the rearranged sterane is generally believed to be related to the acid catalysis of clay,the low rearranged sterane content may also indicate the anoxic reducing environment.From the top of the well Mao 206 to the bottom,The ratio of the rearranged sterane to sterane in mudstone is lower,generally less than 0.26.It is showed that the ancient lake in the sedimentary period is in a relatively strong reducing environment.

The relative content of regular sterane and hopane can reflect the contribution of higher plants and algae and bacteria in source rocks,high content of regular sterane and high regular the ratio of sterane to hopane reflects the organic matter originated from planktonic or benthic algae[12].The relative content of steranes and hopanes can reflect the contribution of higher plants and algae and bacteria in source rocks[13].The ratio of

sterane to hopane in mudstone of the first stage and the second stage of the Nengjiang Formation is little overall change,the value is between 0.052-0.322, and most of them are less than 0.25.

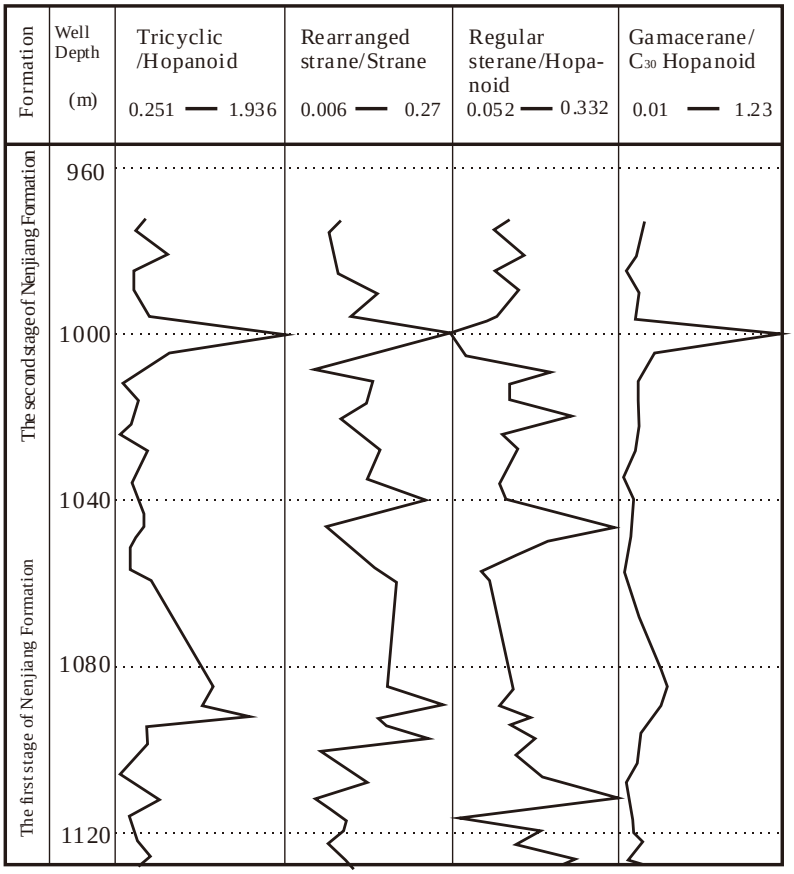

Fig.1 Geochemical characteristic parameters from Nenjiang formation from Mao 206 in the Songliao Basin

Gamma paraffin is a common biological marker,it is a kind of C_{30}-triterpane.The ratio of gamacerane to C_{30}-hopance can reflect the deposition of organic matter in water environment, high content of gammacerane indicates the stratified water environment with the halocline.The ratio of gamacerane to C_{30}-hopance in mudstone of the first stage and the second stage of the Nengjiang Formation is little overall change.At the bottom of the second stage of Nengjiang Formation there is a very high value point,1.228 (1000.47m).The second stage of Nenjiang Formation in the early stage of the deposition of ancient lakes may exist strong water stratification, may also imply that the was a hypoxia of high salinity and strong reduction environment.

IV. THE CONCLUSION

The Nenjiang formation of the 206 well is a typical lacustrine deposit..The Nengjiang Formation had the high ratio of gamacerane to C_{30}-hopanoid and the very low ratio of very low rearranged sterane to sterane,at the time of the ancient lake, there was a layer of water and anoxic events, which led to the formation of high quality hydrocarbon source rocks in Nenjiang formation.The volcano ash (bentonite) zircon U-Pb age was 83.68 ± 0.47Ma,it is further confirmed that the geological age of the Nenjiang formation is Santonian stage

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