[PS]Depositional Evolution and Microfacies Characteristic of the Carboniferous Donghe Sandstone in Hudson Oilfield*

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Abstract

The Hudson Oilfield located in the northern uplift of Tarim Basin is the largest whole-shaped desert oilfield in China, with the Carboniferous Donghe Sandstone as the main reservoir. Combined with modern sedimentary theory, data analysis and the ancient landform characteristic of the research area, we determined that the depositional environment of the Donghe Sandstone was a wave-dominated shoreline with no barrier. Shoreface, foreshore and backshore were considered as three sedimentary subfacies of this depositional environment. Twelve major sedimentary structures observed in core from the research region were demarcated through high-resolution dipmeter logging and imaging logging data. According to these twelve major structures and other facies marks, we identified nine microfacies. Sedimentary evolution of the Donghe Sandstone can be divided into four periods. Early HST was deposited in periods 1-2, and late HST was deposited in periods 3-4. The relative sea level initially rose in the first period, when foreshore and backshore successively deposited towards land of the area (NE). Foreshore beach was made up of beach ridge and swale. It was mainly affected by water erosion and of relatively higher maturity of architecture and composition. Backshore was made up of beach dam and backshore beach, with facies distributed paralleling to the shoreline; normal and storm deposits made up backshore beach. The second period was the main rise period of relative sea level. Large size of shoreface appeared in the southwest of research area, foreshore and backshore moved towards land. At the end of the second period, the maximum flooding surface occurred and shoreface distribution range reached its peak. The shore facies had a zonal distribution along the ancient coast zone. The third period was the initial descent period of the relative sea level, sedimentary facies began to migrate seaward (SW); the fourth period was the main decline period of the relative sea, sedimentary facies continued a seaward migration, at the same time erosion happened in the original side towards land, and erosion area appeared in the northeast and southeast. At the end of the fourth period, falling range of sea level reached the maximum and distribution range of shoreface, foreshore and backshore decreased. Sedimentary facies reached the maximum degree of migration towards the sea, while erosion range reached the maximum in the study area. Only part of the Donghe Sandstone remained in the western part of the research area.

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Abstract

Hudson Oilfield located in the northern uplift of tarim basin is the largest whole-shaped desert oilfield in China, with a main reservoir of the carboniferous donghe sandstone. Combined with modern sedimentary theory, data analysis and ancient landform characteristics of research area, determine that the depositional environment of the donghe sandstone is wave-dominates shoreline deposits with no barrier. Shoreface, foreshore and backshore were considered as three sedimentary subfacies of this depositional environment. Twelve major sedimentary structures observed from core of research region were demarcated through high resolution dipmeter logging and imaging logging data. According to these twelve major structures and other facies marks, identify thirteen microfacies.

Sedimentary evolution of donghe sandstone can be divided into four periods. Early HST deposits in period 1-2, and late HST deposits in period 3-4.

Introduction

Hudson oilfield situates in Shaya country of Akesu, Xinjiang province. Tarim River extends along the north of Hudson oilfield and has 20 km distance from Hudson village. Hudson oilfield locates in Hudson structure belt ofManjar Depression and its tectonic framework is heritance sag since the early Paleozoic. Manjar Depression is the sedimentary center of the whole basin in late Ordovician, Silurian, and Devonian. HD structure belt is a low amplitude anticlinal structural belt developed in a Nose-like uplift, which extends from Lunnan low uplift in Tabei uplift(Figure. 1). It's a typical inner-sag uplift and has a favorable accumulation conditions.

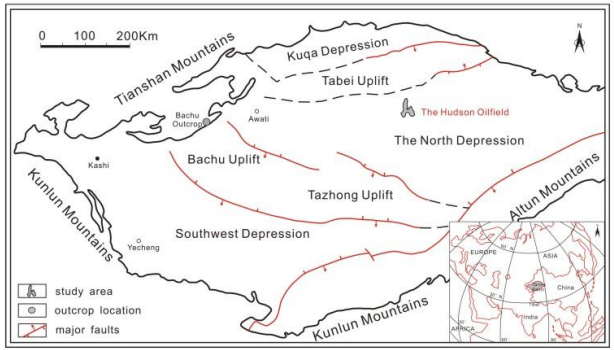

Figure 1. Location of Hudson Oilfield in Tarim Basin

The Carboniferous stratum has an unconformity contact with the overlying Permian formation and the underlying Silurian stratum. The strata deposits from bottom to top is Donghe sandstone section, Breccia section, middle mudstone section, standard limestone, upper mudstone, sandy mudstone and limestone section, respectively. Donghe sandstone is littoral deposition with high textural and compositional maturity. Donghe sandstone section deposits like a belt along the coastline and presents the trend of onlapping and thickness reduction from north-west to south-east. The natural potential curve and natural gamma curve of Donghe sandstone presents a micro gear box with a value of 12 to 20 mv and 27- 45 API, respectively; Deep resistivity curve shows like a step from top to bottom and its value is 0.3-5Ωm; Acoustic time difference curve appears a wave shape and its value is 65-75 mu s/ft.

Microfacies Types and Characteristics

Combined with modern sedimentary theory, data analysis and ancient landform characteristics of research area, determine that the depositional environment of the donghe sandstone is wave-dominates shoreline deposits with no barrier. According to landform characteristics,

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Environment		Microfacies Types	Hydrodynamic Condition	Lithology	Bedding Structure	Granularity
Wave-dominated Littoral Facies	Transition Zone	Under-transition Mud	Swell	Pelitic siltstone Silty mudstone	Horizontal bedding Massive bedding	Sand and mud interbeded
		Stormy Sandstone	Storm Wave	Fine sandstone	Hummocky cross bedding	
	Shoreface	Lower Shoreface Sand	Lift Wave	Siltstone Fine sandstone	Parallel bedding	Granularity coarsens Rolling, Jumping, Suspending
		Longshore Bar	Break Wave	Medium-fine sandstone	Wedge cross bedding Tabular cross bedding	
		Longshore Trough		Fine sandstone	Wave-formed ripple	
		Rip Channal	Rip Current	Fine sandstone	Trough cross bedding Low angle cross bedding	
		Upper Shoreface Sand	Breaking Wave	Fine-medium sandstone	Trough cross bedding Parallel bedding	
	Foreshore	Coastal Sand	Surf Wave	Medium sandstone Gravel	Swash cross bedding	Double jumping overall
		Trough		Fine sandstone	Parallel bedding	
	Backshore	Beach Dam	Storm Wave	Medium-fine sandstone	Parallel bedding	Well sorted and rounding
		Backbeach-rut			Low angle cross bedding Trough cross bedding	
		Beach Ridge		Ostracum Debris	Huge cross bedding	
	Aeolian Dunes	Dune	Wind	Medium-fine sandstone	High angle huge trough cross bedding	Well sorted and rounding

Figure 2. Microfacies Characteristics of Hudson Oilfield

hydrodynamic conditions and sediment characteristics, the coastal zone is divided into transition zone, shoreface, foreshore, backshore and coastal dunes, and further divided into 13 kinds of microfacies(Figure. 2).

Transition zone

Under-transition mud Mud-based or siltstone-based depositions develop with obvious bioturbated texture.

Shoreface

The shoreface environment is defined as the area low tide mark to fairweather water base. The deposits are strongly affected by wave movements, where the depth is limited. From the wave base to the land, water body's energy is increasingly stronger, the sediments are finer grained and bioturbation lessens. Shoreface environment could be subdivided into five microfacies: lower shoreface sand, longshore bar, longshore trough, upper shoreface sand and rip channel.

Foreshore

Foreshore is an oblique environment with little topographic relief located between mean high-water line and mean low-water line. Based on the features of the sedimentary, foreshore is divided into two micro-facies as coastal sand and rut.

Backshore

Backshore locates between lower bound of aeolian dune and average high tide line, and is only submerged under water during super storm surge and extra high tide, so it is affected by wave and weak water flow, belonging to supratidal zone. Backshore environment includes three microfices: beach dam/ backbeach-rut and beach ridge, all of which parallels shoreline.

Aeolian Dune

Aeolian dunes are long-ridged or crescent sand bars modified by wind, which have the width of 10km on average.

Sedimentary Evolution Characteristics

Carboniferous Donghe sandstone in Hudson oilfield is only characteristiced by high stand systems tract, with the top denudated. Deposition has experienced four periods, among them, early HST deposits in Period 1-2, and the late HST deposits in Period 3-4.

The relative sea level initially rose in the first period, when foreshore and backshore successively deposited towards land of the area (NE).

Transgression of smaller scales makes onlap to the coastal zone. Because in this stage the Hudson region located on the edge of the basin, only short marginal facies deposits. Onlap deposition appears from southwest to northeast in Hudson area, and the coastline gradually moves back to the northeast.

Foreshore beach was made up of beach ridge and swale. It was mainly affected by water erosion and of relatively higher maturity of architecture and compositional. Backshore was made up of beach dam and backshore beach, facies distributed paralleling to the shoreline; normal and storm deposits make up backshore beach.

The second period was the main rise period of relative sea level. Large size of shoreface appeared in the southwest of research area, foreshore and backshore moved towards land. End of the second period, the maximum flooding surface occurred and shoreface distribution range reached

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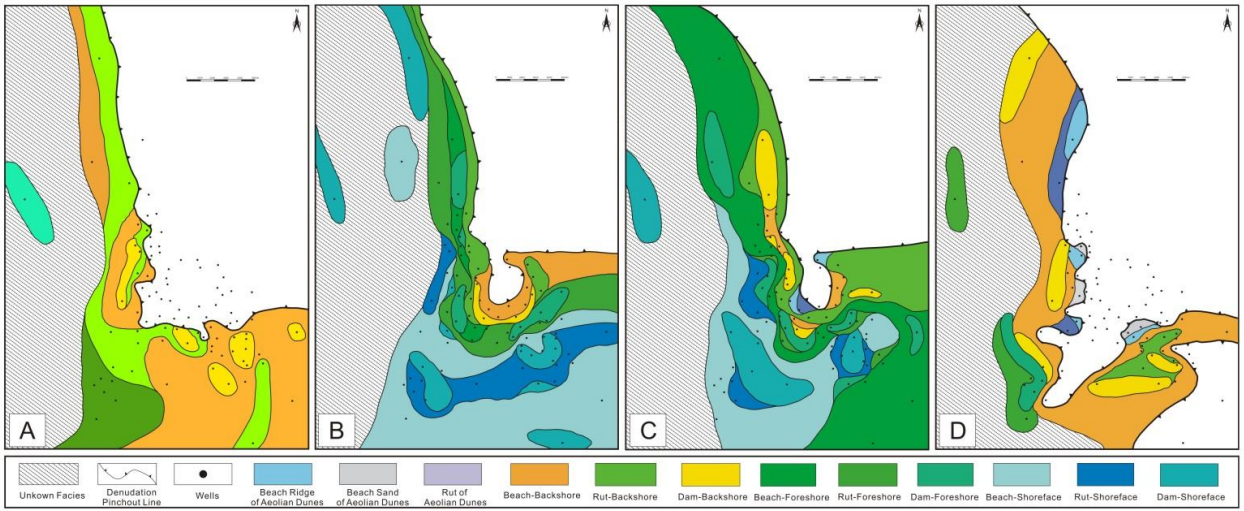

A. Period 1 (The relative sea level initially rose) B. Period 2 (The main rise period of relative sea level) C. Period 3 (The initially descent period of the relative sea level) D. Period 4 (The main decline period of relative sea level)

Figure 3. Sedimentary Evolution Characteristics of Hudson Oilfiled

to the prograding subsequence，whose top was partly eroded ,with a smaller thickness than the Subsequence I. The change characteristics of thickness resembled Subsequence I horizontally, with the sedimentary thickness of the northwest well area big, and east well area small.

The fourth stage is the main falling stage of relative sea level, when the sedimentary facies belt continually to migrate seaward, together with the erosion landward. The erosion areas can be found in northeast and southeast of the research area. The end of the fourth stage is when the falling range of the sea level reached the maximum , the distribution range of shoreface, foreshore and backshore decreased, the extent of migration seaward of sedimentary facies belt reached the peak and the erosion areas of the research area reached the maximum with only a part of remainder of Donghe sandstone in the west of the research area(Figure. 3).

Conclusions

(1) Carboniferous Donghe sandstone in Hudson Oilfield develops a sedimentary system of wave-dominated littoral deposition with no barrier. The main types of facies which are in wide ranges in this area are Transitional Zone, Shoreface, Forshore, Backshore, and Aeolian Dunes.

(2) Carboniferous Donghe sandstone of Hudson oilfield mainly develops HST deposits. Sea level transgresses from southwest to northeast during Period 1−2 of early HST and coastal belt presents the character of overlap. Shoreface deposits is largest as the sea level reaches its peak. During Period 3−4 of late HST, sea level retrogrades to southwest and sedimentary facies migrate to the same direction. At the end of HST, the distribution of facies belt in study area reaches its minimum and the erosion scope is largest.