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NUMERICAL SIMULATION STUDY ON HYDROCARBON MIGRATION OF PALEO-RESERVOIRS IN TAZHONG OIL FIELD, TARIM BASIN, NORTHWESTERN CHINA

WENFENG TANG, GUOZHONG ZHAO, LUOBIN XU, BAOCHEN ZHANG AND WEI ZHAO

Abstract. Tazhong Oil Field located in the center of Tarim Basin is one of the greatest discoveries during the petroleum exploration in Tarim Basin. The course of many years for hydrocarbon exploration and development has proved that there existed a much larger ancient reservoir than present-day reservoir and residual oil section below present WOC is of obvious characteristics of water displacement. Study shows that after it early formed, the paleo-reservoirs had been reformed to a great extent by hydrodynamic pressure caused by compacted water flow, which had played a dominant role in the redistribution of oil and gas in the evolution process of paleo-reservoir to present one. The previous method to study secondary migration caused by hydrodynamic pressure is as follows: to draw oil and water potential energy diagrams by utilizing pressure data of exploratory wells; to judge hydrocarbon migration direction and possible accumulation position by combining them with geological conditions; thereafter, to forecast potential oil reservoirs from the macroscopic view. Application of reservoir numerical simulation technology to hydrocarbon migration by hydrodynamic pressure has its advantage whether in its mechanism or in the accurate description of oil and water distribution. This paper has first presented the existence of the paleo-reservoir, and then constructs its geological model on the basis of recognizing its configuration at different geological stages.

Key Words. hydrocarbon migration, numerical simulation, exploration orientation.

1. Introduction

Tazhong4 area in Tazhong Oil Field is a typical structural trap (FIGURE 1) with CIII oil-bearing section, its main oil-bearing bed is characterized by that present-day WOC is at -2510m below sea level and the bottom of transitional zone from oil to water is at -2610m below sea level. Residual oil saturation is obviously dominated by physical properties, i.e., the residual oil saturation in the formation where physical properties are good is lower than that where physical properties are relatively poor; and there is remaining oil-bearing interbed. This phenomenon indicates that there existed a destroyed paleo-reservoir with unitive ancient WOC (now at -2610m below sea level) in the geologic history.

The existence of ancient WOC can shed more light on studying the evolution of Tazhong Oil Field as well as its exploration orientation. (1) In the long evolution process of Tazhong Oil Field, there ever existed a paleo-reservoir which is larger than that at present. How many was the reserve? (2) The existence of residual oil indicates that the reservoir had ever undergone adjustment and reconstruction.

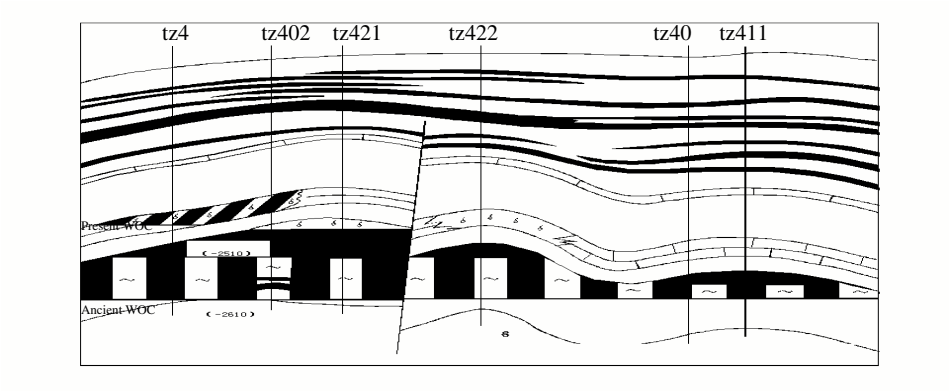

FIGURE 1. Tazhong4 area structural trap.

How about is hydrocarbon loss? Where does hydrocarbon migrate and accumulate towards then? (3) How to find secondary reservoirs scientifically? Many tough problems listed above are really urgent to tackle during exploration. This paper applies reservoir simulation technology to study hydrocarbon migration process of paleo-reservoirs, and partially answers the redistribution of oil and gas after it destroyed.

2. Hydrocarbon Migration Model

Black oil model is designed for developing the oil field. It is fully a new trial to utilize it to simulate large-scale hydrocarbon migration. Its simulating space and time is as much hundreds and even millions times as the general development block. Moreover, in each simulating unit fluid flow is very slow and the solved variables may have approached to tolerant errors, so the simulation requires software fast and more accuracy. Therefore, parallel VIP simulator is employed to perform calculations on ORIGIN2K parallel computer.

The modeling consists of two parts. First, a section model is designed to study the mechanism of migration as well as to analyze the relation between hydrodynamic gradient and the amount of migration followed by determining a reasonable distribution of hydrodynamic field in this district. Then it is to set up a 3D numerical modeling of the whole area and to predict spatial distribution of secondary reservoirs on the basis of matching the proven reservoirs.

2.1. The Section Model. The section model of Tazhong Oil Field is set up which is 41km long, vertically including CII and CIII oil-bearing sections and can be used to study both plane and vertical migration. The model has 8 modeling layers with each layer of 25m in effective thickness. WOC is at -2610m (the ancient WOC). There is a water injection well on one side to simulate hydrodynamic pressure and on the other side it is open boundary. The fluid inflow and outflow varies with pressure.

2.2. 3D Simulation Model. In order to find locations where there may exist potential secondary reservoirs and hydrocarbon may accumulate again, we design a large work area model which contains 32 exploratory wells in Tazhong zone. Simulating area is 106km(EW)$\times$ 74km(NS)=7844km^2 . According to the integrated