

Application of Cloud Transformation Technology in Predicting Reservoir Property

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Abstract: Large and extensive area of thin reservoir in Songliao basin, these reservoirs' physical parameters' relationships are not linear, nor the function can be expressed. Most of the relationships of parameters are distributed by kinds of cloud shapes. If the cloud model is applied to the thin reservoir prediction, which can maximum reduce the fitting error between the two functions, especially between the two functions without linear and parabolic conventional relations, etc. The Cloud Transformation technology for reservoir porosity, permeability and other physical parameters prediction provides a scientific and effective method, also has a practical significance to the exploration and evaluation in oilfield.

Key words: Reservoir prediction; Songliao basin; Cloud transformation; seismic inversion

I. INTRODUCTION

Cloud is used to describe a qualitative concept and its model is uncertain conversion between numeric representation, in other word cloud model is the transformation between qualitative quantitative uncertainty model.

Cloud transformation is produced in the progress of the application of cloud model research development, mainly applied to two kinds of data conversion. This kind of transformation is different from the previously direct linear and quadratic function, as shown in figure 1, when the data is 1 to 7400, value 2, the corresponding data purple double arrow lines, including the scope of so much possibility, when using the linear or quadratic function, in general, the area of the red arrow value is without considering. While double arrow lines, including value 2 ranging of the whole data are taken into account in the cloud transform. Treat the possible value as a probability distribution, thus the approach is obviously more scientific.

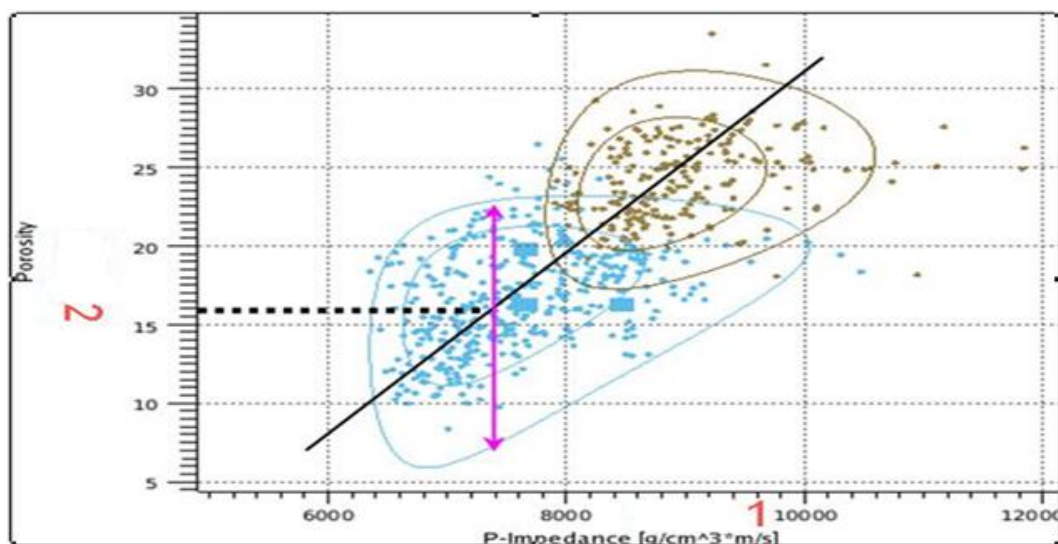


Figure 1. The relationship of two data
(Data1: wave impedance, Data2: porosity, blue: mud, dark yellow: sand)

II. DEVELOPMENTS AT HOME AND ABROAD UPDATES

In data Mining and Know ledge Discovery (DMKD) research. People mainly focus on the research of data mining algorithm, but the uncertainty, quantitative qualitative transformation and some other basic research is less. In the field of artificial intelligence, the uncertainty of knowledge and reasoning is mainly divided into the fuzziness and randomness, once a precise membership function is used to describe fuzzy set, and then in the mathematical thinking, it will not include the fuzziness, this is the uncertainty of the traditional fuzzy theory.

In order to solve this problem, professor de-yi li on the basis of traditional fuzzy set theory and probability and statistics, put forward to a qualitative quantitative uncertainty transformation model - cloud model, Based on this, cloud theory is formed through system research and development, including cloud model, virtual cloud, cloud operation, cloud transform and uncertainty reasoning. At present it has been widely used in all fields.

III. PROJECT OVERVIEW

(1) Geological survey

Mutou area is located in the Fuxin uplift belt, with a large resource potential. It conducts the exploration and evaluation of hit after 2005. Early-known reservoir which is controlled by reverse fault of lithologic has been basically finished drilling. New reservoir recognition, and the next step of the drilling direction need to implement. In this situation, the research center of jilin begin on study of "accuracy" to carry out the accurate structure interpretation and reservoir prediction, looking for slightly structure, reservoir distribution zone, etc., to carry out the oil and gas enrichment region, provide the basis for oilfield exploration and evaluation to deploy. Cloud transform technique for reservoir porosity, permeability on reservoir property prediction provides a concrete and effective method^[1].

The study area is located in the central sag Mutou area in southern Songliao basin, and the main purpose of formation is Fuyu oil layer. Fuyu reservoir is located in quantou group four. The thickness of strata is generally 100 ~ 100 meters. Provenance is given priority to with southwest Baokang stream sediment, followed by southern Huaide drainage. Its sedimentary system is based on terminal fan deposits and distributor channel. Sand body develops well. Sand reservoir is divided into four groups, 12 small layers, including 1-4 small layers for I sand group, 5-7 small layers for II sand group, 8-10 small layers for III sand group, 11, 12 small layers for IV sand group (figure 2).Main Mutou area through the analysis of known drilling oil sands for sand group, focus on 3-6 small layers^[2].

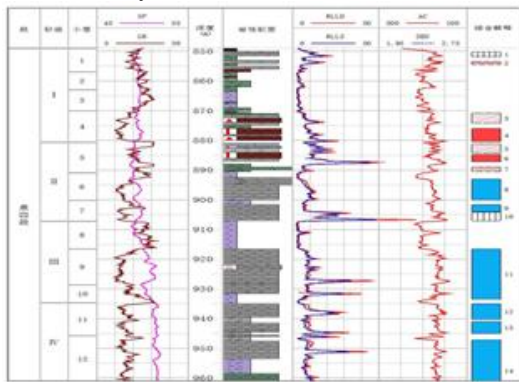


Figure 2. Fuyu oil

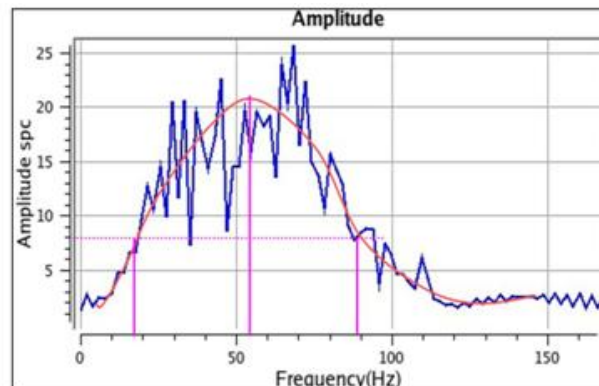


Figure:3 The frequency of seismic data analysis

(2) The geophysical data

Mutou area in fuyu reservoir is buried less than 1000 m, ϕ is more than 12%, K is greater than 1 mD. Given that most priority is original intergranular pore, pore connectivity is well. Oil-water differentiation is easy. Lithologic, fault-lithology are main oil pool style, Oil saturation is greater than 50%. Belong to the conventional petroleum.

The main frequency of seismic data in this area is 55 hz and the bandwidth is between 17 and 80 hz (Figure 3) with average stratum velocity of 2700m/s which can distinguish sandstone above a quarter of the of lambda equals 12.3 m. Moreover, one of the difficulties in the forecasting of the reservoir is the characteristics of reservoir with single sand body thin, multilayer stacked and rapid lateral variation, also, the thickness of single sand body is in 3-9 m. Therefore, the use of seismic data is difficult to directly predict the distribution of single sand layer. Through the analysis of the intersection of log curves, the wave impedance and gamma curves have some overlap in distinguishing sand shale, reservoir can be distinguished by geological statistics inversion^[3-4].

IV. THE TECHNIQUE PROCESS AND THE KEY PARAMETERS

On the basis of the achievement of the multiple reasonable equal probability of the lithologic body and p-wave impedance body, we go further to gain the reservoir attributes (porosity, saturation, etc.). In application of jason83 StatMod MC modules of software, based on setting up the relationship by the cloud transform, we get reservoir attribute body by the simulation using the lithologic body and p-wave impedance body^[5]. (1) reservoir geophysical characteristics analysis; Lithology and wave impedance, gamma ray and electrical resistivity that can better reflect reservoir, through the analysis of the intersection, the gamma curve in the study

area has good effect in distinguish between sand and shale; (2) carry out with gamma curve as the characteristic curve of geostatistics inversion, get reasonable lithology body^[6]; (3) on the basis of he application of co-simulation in lithology and porosity bodies by cloud transformation relations, we get reasonable porosity.

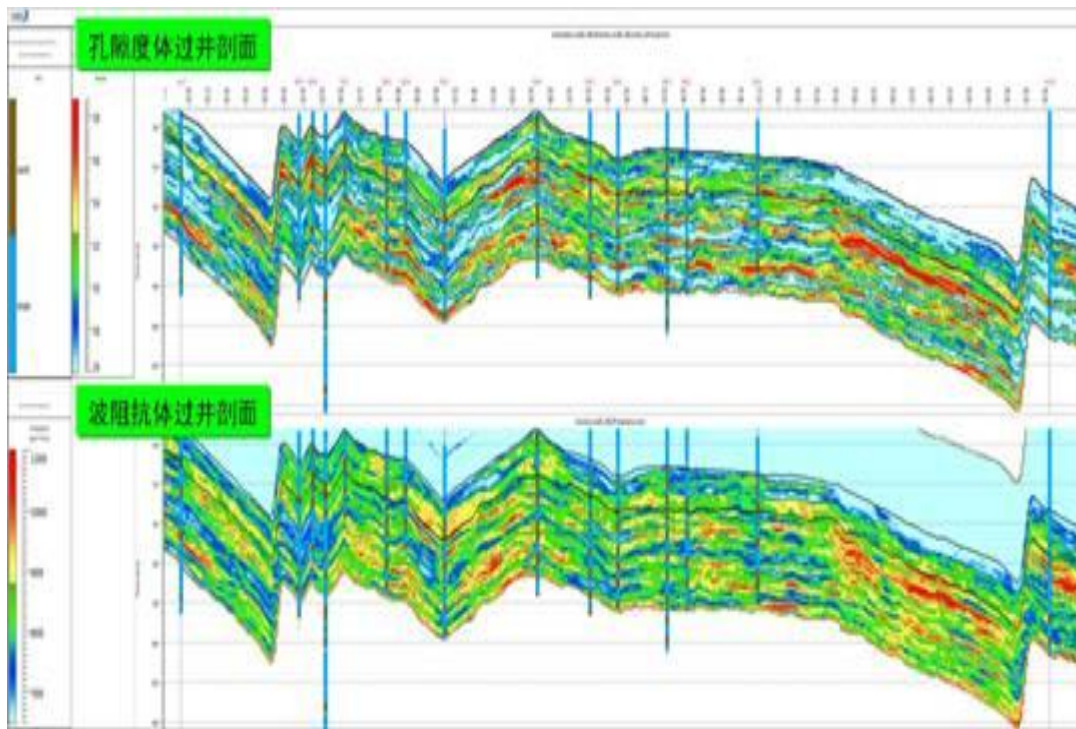


Figure 4. porosity section and wave impedance section contrast figure.

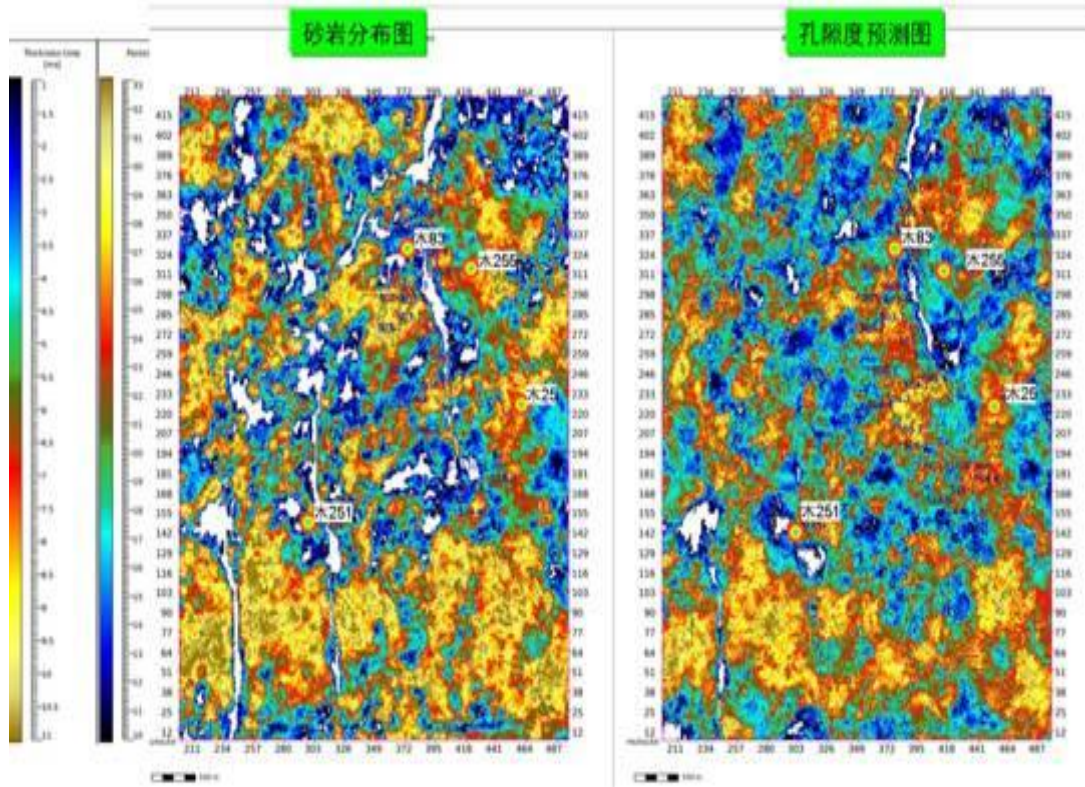


Figure 5. sandstone distribution and porosity prediction map.

V. THE APPLICATION EFFECT AND UNDERSTANDING

The application:

Based on cloud transform, the porosity simulated both in vertical and horizontal be with consistency, and more detailed than the lithologic body in line with the drilling results in more than 80% study area [7](FIG. 4, 5) . The study area is located in the fan delta front facies belt[8], with a maturity of underwater distributary channel. Reservoir physical property change is the main factor of restricting drilling capacity, through pore volume prediction, further evaluation of oil and gas enrichment blocks can guide in the oil field exploitation.

Understanding

Objective function for curve fitting fit directly influence the accuracy of the curve parameter, the size of the fitting error and computational complexity in the process of fitting. Cloud transform can minimize fitting error between two functions, especially between the two functions without linear and parabolic conventional relations, etc.

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