

# Thin layer logging identification method

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**Abstract.** With the development of oil and gas exploration and development, how to accurately measure and evaluate thin layer of oil and gas has become increasingly important. Some conventional methods using error is very big, often miss a lot of oil and gas layers of industrial value. Therefore, hydrocarbon scientists must develop detecting depth larger thin layer with high resolution logging instrument and must improve the vertical resolution of logging response, determine the physical parameters of thin layer, so as to comprehensively improve the effect of thin layer of oil and gas exploration.

## 1. Introduction

Thin reservoir has become a domestic and international numerous oil and gas reservoirs in the production of the main object, the logging evaluation technology is in a very important position, and because of the influence of the surrounding rock mass, the logging signal distortion, easily log readings distortion, and so on and so forth to well logging interpretation has brought great difficulties. For example, the identification difficulty of thin reservoir, the poor response of the muddy interlayer, the difficulty of distinguishing the physical properties of thin reservoir and the difficulty of determining the location of thin reservoir, and the inaccurate calculation of reservoir parameters. For the thin layer and thin layer logging data interpretation, vertical resolution can not meet the precision requirements, thin reservoir is missing.

Development of high resolution logging technology is an effective method to improve the logging resolution in practice all kinds of well logging instrument structure decided the inherent resolution of general than effective resolution, so that this gives a high resolution processing logging curve is larger.

Development of high resolution processing and interpretation techniques to achieve both depth and has a higher vertical resolution, which is a very effective method of rich vision.

## 2. thin layer logging data processing

Thin layer interpretation is to use the scientific method of mathematical physics and inversion theory, to deal with well logging curves, improve the resolving power.

### 2.1. the deconvolution.

To improve some of the old well previously recorded by a thin layer of not considering the vertical resolution, some of the data by using the inverse filtering or deconvolution method, due to the difficulty to accurately model as a linear system output filter white noise, the inverse filtering or deconvolution method is limited.



### *2.2. dual phase induction deconvolution to enhance .*

For double phase induction instrument (DPIL), able to take advantage of additional data records, to further strengthen the instrument response, improve the vertical resolution, and through the correction of surrounding rock, to enhance the thin layer resistivity.

### *2.3. increase porosity data.*

Double probe vertical resolution of the compensated neutron and density data source mainly instrument to probe distance of a function.

The use of short and long spacing (dual-spaced) detector, ability of mud cake correction and reference borehole compensated reduce borehole effects.

### *2.4. the Walsh function method .*

The method with Walsh function of traditional thin layer logging curve is also a kind of scientific evaluation method.

Solving the first kind Fredholm integral equation of the use of Walsh function principle, instrument response function, independent of the expansion coefficient  $n$ , get real physical quantities.

This method has a small amount of calculation, high precision, fast speed, good effect.

And it can clearly distinguish 0.25 m below the thin layer.

In marina south second member of the oilfield, the method of purified town oilfield in dongying sag four found oil and gas reservoir evaluation sheet, good results have been achieved.

### *2.5. alpha factor method .*

Alpha factor method is also adopted resolution there two logs to improve the vertical resolution of logging curve, the resistivity logging curve, neutron density can be high resolution processing.

Compensation density and compensated neutron can also high resolution processing, the high resolution provided by the information can be used to improve the conventional vertical resolution.

Adopt the method of alpha factor initially to the high resolution shallow resistivity logging curve for filter, make its vertical resolution can reach logging resolution level, then calculate deep resistivity curve and filtering curve, finally using differential curve to obtain high resolution.

### *2.6. spectrum analysis*

Logging signal spectrum analysis showed that the different logging signal spectrum difference is very big, especially the amplitude spectrum, power spectrum is especially striking.

By some means of Numbers, according to high resolution logging signal spectrum, the resolution of logging signal spectrum into high resolution spectrum, then put it back in the time domain can achieve the synthesis of high resolution logging curve.

### *2.7. of argillaceous interlayer out*

Some conventional logging instrument resolution will have different restrictions, logging curve can not be widely effective identification of argillaceous interlayer, sometimes will be wrong to interpret as a reservoir.

These thin interbedded often show the porosity increases, the characteristics of low resistance, high natural gamma ray value, according to these characteristics can eliminate significantly logging response characteristics of thin layer with mudstone values.

High resistance

### *2.8. thin layer identification*

Thin layer will become the main mining and manufacturing output object, but there are often mistakenly explained in the interpretation of the practice, can't even explain, especially under the influence of surrounding rock of high resistance layer formation will appear less apparent resistivity and water saturation decreases sharply increased, calculation of reserves.

In order to explain the precision instrument must improve the full use existing methods and logging data, to develop more excellent can improve the logging data processing method of vertical resolution.

### 3. thin layer model analysis

Double shell (DEL) anisotropic strata model analysis can be used to solve thin layer under the special geological environment.

Vsh sand mudstone method: sand mudstone method must first have two layer model.

It can assume that for the mudstone layer, and does not contain hydrocarbons.

It USES such as gamma ray, density, neutron curve to calculate the content of mudstone layer (VFsh).

Fixed Rsh methods: fixed Rsh method is also applied to two layer model of sand shale, can overcome the shortcoming of sand mudstone model calculation is not accurate.

In theory, when the study of formation and the ideal model ( $\Phi_1$  material  $\Phi_2$ , Sw1 material Sw2) formation in, Rsh on behalf of shale resistance value, this method is applicable.

Its advantage is that only need the Rv, Rh and phi t log.

But can only deal with ideal geological model and Rsh selected from close to the mudstone interval does not represent the sand mudstone layer resistivity model of mudstone layer.

BFV thick grain method: this method is used two layer model, different from the former two methods is two layers can be allowed to contain hydrocarbons.

Can use nuclear magnetic resonance (NMR) measured boundary of fluid volume and total porosity ratio (BFV/phi t) as the content of fine particle layer (VFfg) its limitations used in the two layers have the same porosity.

The constraints of its limitations in thick sandstone layer contains water, cause the BFV/phi t will not be able to truly reflect the content of fine particle layer.

### 4. case analysis

SeBei thin layer logging curve of gas field in qinghai province of accurate recognition more difficult. The error of the low resistivity and high resistivity recognition result in gas horizon error caused by perforation. Due to low resistance have no obvious abnormal porosity, poor consistency of natural potential, natural gamma, surrounding rock significantly affect the calculation precision of log data and reservoir parameters.

The dynamic production data for review and check it. Increasing the loose sand of SeBei gas field with multi-layer reservoir fluid identification, improve the interpretation coincidence rate of gas.

In the water cut of reservoir and interlayer water model, the first to determine the amount of liquid producing coupled with gas, water, gas water ratio and pressure and production data through fitting evaluation index of water-bearing gas reservoir.(figure 1)

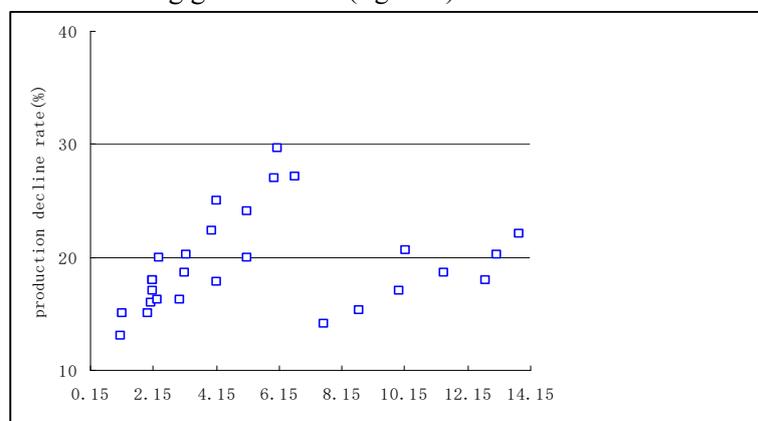


Figure 1. The relationship between water discharge and production decline

## 5. Explaining the new technology thin layer

5.1. nuclear magnetic resonance (NMR) logging is a kind of to hydrogen nuclei and plus the interaction of the magnetic field as a foundation, studies included in the natural content of hydrogen in the fluid and the occurrence of the state of the logging method.

Nuclear magnetic resonance (NMR) logging through multiple index of echo string fitting, get the T2 distribution and effective porosity, combined with core analysis data of bound water porosity T2 cutoff value to calculate irreducible water and free water porosity, estimation of formation permeability.

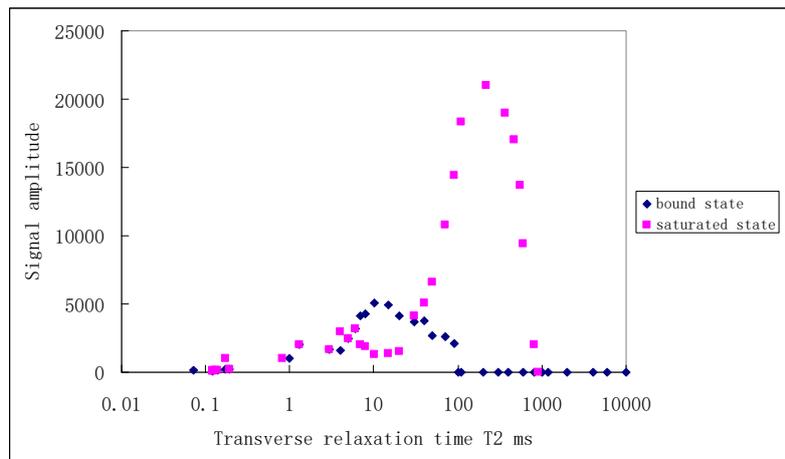


Figure 2. Fan153 core NMR

Can see from figure 2, the saturation curve has a distinct bimodal pattern, the biggest of the second peak value corresponding to the transverse relaxed time T2 for 100 ms, signal amplitude reached more than 20000, showed that free fluid seepage pore signal is stronger.

In the bound state, the second peak of the transverse relaxed time T2 value obviously moved forward, the maximum amplitude at about 10 ms, signal amplitude is controlled in 5000, only show that mainly exist in the bound state of fluids in the reservoir, mainly capillary irreducible water of micro pore, nuclear magnetic signal attenuation of the water faster, so no great influence on the judgment of the oil and gas, nuclear magnetic resonance (NMR) signal of movable fluid is not obvious.

### 5.2. the application of imaging logging evaluation in thin layer

FMI formation micro-resistivity scanning imaging logging using sensor array scan or rotating scanning measurement, along the longitudinal and circumferential borehole or radial large stratigraphic information collected, get 2 d or 3 d images of shaft wall, the sampling interval is 0.1 in, with the high density of sampling and high measuring accuracy, hole high coverage, intuitive, rich information, image clarity, analysis can provide high-precision flush zone resistivity value, can accurately identify and differentiate thin layer, can reflect the lithofacies, structure and fracture and other geological information.

For solving complex reservoir exploration and development have a significant effect, imaging logging has become the main body of geophysical well logging technology.

### 5.3. high resolution induction - digital focused induction logging .

High resolution digital is focused on the longitudinal resolution is the highest of the induction logging, suitable for the measurement of thin reservoir, but due to its relatively small transverse detection range,

limited to flushed zone and transition zone range of formation.

## 6. conclusion

To improve the resolution of the logging curve, the establishment of relatively suitable calculation model is to improve the accuracy of the thin layer interpretation is more effective way.

For thin layer reservoir logging data processing, it can be realized through the study of high resolution processing logging curve has a wide range of detection with high vertical resolution, improve the correctness of the evaluation of thin layer.

This is one of the most promising method.

## References

- [1] Yaowei, dongshenwang, MeiYingShen. Thin layer logging interpretation technology progress [J]. Journal of oil and gas field surface engineering, 2005, 24 (4) : 61 ~ 62.
- [2] zhu-wen wang, Liu Jinghua. Walsh transform in the application of logging curve stratification research [A]. Geology and prospecting, 2002, 33 (4) 6.
- [3] Flaum Cet al. Enhanced vertical resolution processing of dual detector gamma - gamma density log. The log analyst [J]. 1989, 30 (3) : 139 ~ 149.
- [4] Yuantian Zhou. Thin layer logging interpretation [J]. Journal of logging technology, 1992 (5) : 342 ~ 344.
- [5] Bao-an li, xing-shan li, liu2 xing. Walsh transform to the study of impact signal sequence feature extraction [J]. Journal of Beijing university of aeronautics and astronautics, 2003-09
- [6] Cheng Kun zhong-bin ye, Wu Wenyan etc. A thin layer of density logging calibration method and the software implementation [J]. Journal of daqing petroleum geology and development, 2008-03.
- [7] Changxue Wang Xie Shuqi, Wu jie. Soft focus of type array induction imaging logging signal [J]. Journal of jiangnan petroleum institute, 1999.
- [8] Xi-ling wu. Flow imaging logging research progress [J]. Progress in geophysics, 2002, (2) : 272 ~ 276.
- [9] Sun Xun. High resolution induction - digital focusing logging data in the analysis of characteristics of sandstone reservoir into [J]. Journal of well logging and perforation, 2006, (4) : 1 ~ 5.