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The Method of Recovering the Burial History

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Abstract: The recovery of basin burial history is a vital content in the process of resource evaluation of petroleum basins; therefore the researchers of basin pay attention to it widely. The method of recovering the burial history has two: direct method and inversion method. Direct method is the simulation process of burying in all ages, such as deposition rate method in the overpressure technology; Inversion method is recovering the burial history From now on to the ancient, such as back-stripping technology. Both the direct method and inversion method are the principle of sedimentary compaction and porosity change.

Keywords: Burial History, The method of recovering, the direct method, the inversion method.

INTRODUCTION

Burial history refers to the change of the buried depth of the one basin sedimentary unit or a unit (sequence or strata) from the beginning of depositing to today or a certain geological period, including sedimentary discontinuity, denudation and geological events etc. Sediment have a number of roles during burial happening , including compaction, drainage, change of porosity, mineral transformation, the original mineral dissolution; Compaction drainage, porosity change and the characteristics of irreversible compaction can help us restore the denudation thickness quantitative and reconstruction of burial history [1].

THE METHOD OF RECOVERING THE BURIAL HISTORY

Deposition rate method is referring to the recovery of geohistory in all ages, such as deposition rate method. According to the thickness of strata, the porosity and porosity of the original get the original thickness of strata. According to the original thickness and the corresponding settlement time, get the sedimentation rate of the formation. At this point, the geologic history can press forward (in all ages) reconstruction, from the bottom the original thickness of strata, strata according to the sedimentation rate with time settling down, and be reduced porosity depth curve of formation thickness. The downside of this approach is: due to the stratigraphic sedimentation rate in the form of settling down, don't follow constant so when evolutionary computation to today, the simulation of the recovery do not tally with the actual thickness of the formation of strata thickness. Leading to recount must adjust parameters, until it is in line with the error.

The direct method

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The inversion method

The back stripping technology process of Inversion as follows: according to the law of conservation of mass, with the increase of buried depth, formation thickness decreases, but the frame thickness of strata is the same. The basin known single-well hierarchical data as the foundation, according to the geological time stripping step by step, until all finished peeling (Fig-1), it needs to be considered heavy backlog, complex lithology, denudation and other geological. The

thickness of the frame is hypothesis formation porosity becoming zero formation thickness. Visible, compared with the method of sedimentation rate, back stripping technology by the inversion (By the present back) geohistory reconstruction. In geologic results of simulation, its actual data is completely with in accordance with the present situation. No need to recalculate the adjustment parameters, there is no error problem, namely, there is no above shortcomings that settlement rate method.

CONCRETE CALCULATION PROCESS OF BACK STRIPPING METHOD

Back stripping method is also called the inversion method, the main idea is in the conditions of skeleton formation thickness unchanged (except fault and denudation), starting from the present situation of current basin layer layered on the mainland, according to the geological age anew to the old formation stripping step by step, to resume the ancient thickness of sedimentary formation at the end of each era, and then establish a columnar section of single well development of the formation. Back stripping method is based on the principle of stratigraphic framework remaining the same. Formation skeleton unchanged principle refers to with the increasing of formation burial depth, the thickness of the sediments is reduced, but the frame thickness of sedimentary layer (rock) (assuming that the porosity is zero thickness of sedimentary layer (rock) always remains the same, namely the compaction is the result of the formation porosity decrease and not make the cross-sectional area of the stratigraphic column. In general, the calculation of stripping technology mainly includes the skeleton formation thickness, formation of initial thickness and formation thickness in various geological period. Therefore, back to the process of strip is a basic on the above three aspects. (1) according to the heavy backlog of firm principle and its assumptions, application of the study area are measured porosity - depth curve relationship, and the buried depth data, respectively, to calculate the thickness of the formation of the skeleton; (2) calculated by the above, the thickness of the frame, and then combined with porosity - depth curve, calculated assuming that the thickness of the layer around the buried deeply zero namely initial thickness of strata; (3) the formation (except the structural)In keeping its skeleton under the constant thickness, since nowadays the embedded depth of stratum status, according to the geological time peeled off one by one, until all the stratigraphic peeling [2].

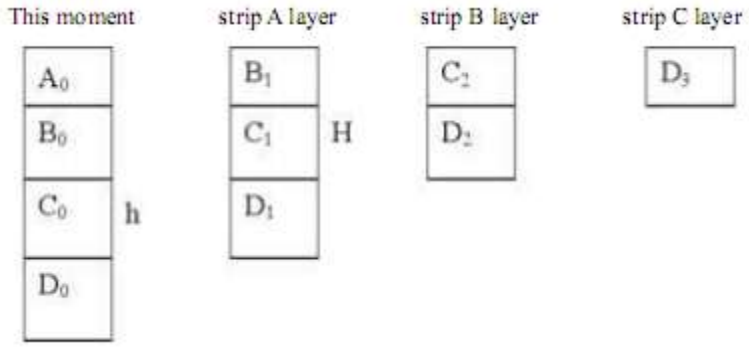

Fig-1: Back stripping method to calculate the ancient strata thickness

The general understanding to strata compaction process

Clastic rock section is mainly composed of argillaceous rock, sand and small amounts of carbonate, salt, etc. These rock diagenesis process difference is very big, compaction is also different in all the position of the diagenesis.

Argillaceous rock diagenesis is mainly compaction, its volume can lose more than half in the compaction process. Rock volume loss is mainly characterized by the decrease of the thickness of strata, so the thickness of argillaceous rock in the process of diagenetic change are considerable. In the context of the present study results, in general, argillaceous rock compacting process is very regular. In shallow argillaceous rock porosity usually with depth in the form of index decrease .

$$\phi = \phi_0 e^{-cz} \qquad (2\text{-}1)$$

ΦandΦ0, respectively, the porosity of the surface sediment depth z, c is constant. These parameters is different depending on the area, the horizon. On type shows that in the depth and the logarithm of porosity of axis of coordinate system, the relationship between the two linear (Fig-2). Buried to a certain depth, porosity changing with depth, often deviated from the trend. At this time, the porosity remains the same with depth, or decreases with depth beyond the normal section for low rate . Generally called normal compaction that reduce the interval of shallow strata porosity regularly, and lower porosity deviates from the normal trend of interval is called abnormal compaction or under compaction period. The formula that the porosity changes with depth is Basin Mod index method in software, it is suitable for the layers that high clay content, sedimentation rate faster.

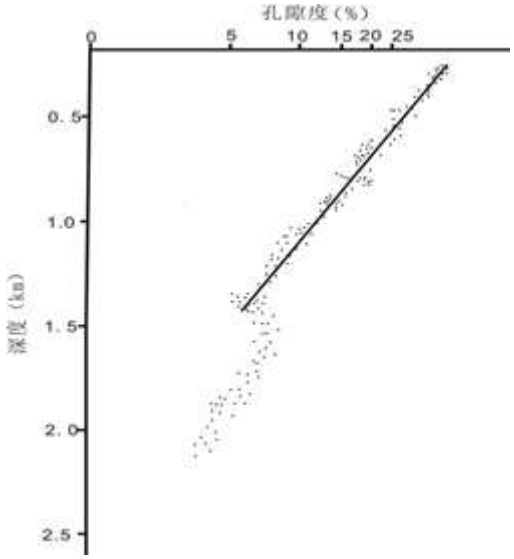

Fig-2: Argillaceous rock compaction curve

The effects of compaction to Sandy strata pressure in the process of diagenetic is smaller that argillaceous rock. But according to Athy, sandstone porosity for compaction and pressolution effects can be reduced by 13% [3]. This amount for thick layer thickness is larger. Falvey argue that sandstone under the effect of compaction pores can also be used along with the change of depth and argillaceous rock similar relation [4].

$$\frac{1}{\phi} = \frac{1}{\phi_0} + KZ \qquad (2\text{-}2)$$

Falvey think the formula (2-2) is a universal equation. For mudstone: Φ0 = 0.7, K = 2.4 / (km), for the typical sandstone: Φ0 = 0.4, K = 1.2; For the typical silty sandstone: Φ0= 0. 53, K = 2.18 / (km). This method is reciprocal what has been referred to the Basin Mod software, this method is used to the rock that lower clay content, slower sedimentation rate.

The carbonate diagenesis is more complex. Before it is generally believed that the carbonate diagenesis on very early, so basically not suffer from compaction. But in recent years, many people put forward the objection to that, think carbonate can withstand quite a degree of compaction. Even some people think that as long as it contains more than 2% of the argillaceous substances, the compaction process of carbonate rocks can and argillaceous rock compacting process is very similar. Falvey think (2-2) can also be used to represent compaction process of carbonate rocks, only the selection of specific parameters are difficult.

To the diagenesis of high salt rocks, general less researching . When gypsum dewatering into anhydrite, due to out water structure, its quality and volume are subject to change. In addition, the plasticity of halite is bigger, density is small, with the increase of buried depth, it is easy to happening soft flow effect in a larger overlying load and high temperature, which tend to occur the change unevenly of the formation thickness.

The basic formula of strata compaction correction

People have put forward a calculation of rock volume changes due to compaction formula early:

$$V_0(1-\phi_0) = v(1-\phi) \qquad (2\text{-}3)$$

v0 and v respectively is the rock volume of before and after compaction .(2-3) on both sides are skeleton volume of the rock before and after compaction. Suppose rocks skeleton volume does not change during the process of compaction, the skeleton volume should be equal before and after compaction. This formula has been widely used, but rock porosity is a continuous function of the depth , and using (2-3) can only take a formation average calculation, error is bigger. In recent years, with the deepening of the rocks on the compaction law research, people started using integral method to calculate formation compaction thickness. Falvey *et al.* proposed method is more practical [4]. Falvey also think rock formations its skeleton particles without loss in the compaction process, also not be compressed, and formation thickness changes before and after compaction is only the change of the pore space. , in other words, the volume of all its skeleton is not changing in the same formation of any depth(strata thickness changing with depth is). This volume can be calculated used to following type:

$$Z_s = \int_0^{Z_0} (1-\phi(Z))d_Z \qquad (2\text{-}4)$$

Zs is thickness that all the skeleton concentrate, also known as the formation of pure thickness; Z0 is the buried depth of strata sedimentary mordecai industry. For a particular depth underground strata:

$$Z_s = \int_{Z_1}^{Z_2} (1-\phi(Z))d_Z \qquad (2\text{-}5)$$

Z1 and Z2, respectively the buried depth of the top and bottom boundary. Two type of Φ(z) is the function

that porosity of formation with depth change. Generally speaking, different lithology of strata, this relationship is different. For argillaceous rock, (2-1) can be substituted into (2-4) or (2-5), transform then get:

$$Z_s = Z_0 + \frac{\phi_0}{c}(e^{-cZ_0} - 1) \qquad (2\text{-}6)$$

and

$$Z_s = Z_2 - Z_1 + \frac{\phi_0}{c}(e^{-cz_2} - e^{-cZ_1}) \qquad (2\text{-}7)$$

Because c is positive value, Zs is always less than (Z2-Z1) or Z0.

For sandstone, (2-2) can be substituted into (2-4) and (2-5):

$$Z_s = Z_0 - \frac{1}{K} Ln \frac{\frac{1}{\phi_0} + KZ_0}{\frac{1}{\phi_0}} \qquad (2\text{-}8)$$

and

$$Z_s = Z_2 - Z_1 - \frac{1}{k} Ln \frac{\frac{1}{\phi_0} + KZ_2}{\frac{1}{\phi_0} + KZ_1} \qquad (2\text{-}9)$$

And get the pure thickness of formation, can use the same formula getting the layer thickness of different depth (2-7) :

$$Z_4 = Z_3 + Z_s - \frac{\phi_0}{c}(e^{-cZ_4} - e^{-cZ_3}) \qquad (2\text{-}10)$$

By(2-9):

$$Z_4 = Z_3 + Z_s + \frac{1}{K} Ln \frac{\frac{1}{\phi_0} + KZ_4}{\frac{1}{\phi_0} + KZ_3} \qquad (2\text{-}11)$$

Z3 and Z4 of two type express top and bottom boundary of formation system. Before calculation, it needs to determine the burial depth Z3 of the top boundary of formation in a geological time and then calculate the Z4. Two type on both sides have Z4 that can not be expressed, therefore can only use iterative method to solve, this method is more cumbersome, but using a computer is very fast and convenient. So by iteration method can calculate all the burial depth of the strata in any geological time.

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