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A New Pressure Prediction Method of Southern China Shale Reservoir

Y. Li* (BGP), Y. Zhang (BGP), R. Guo (BGP), H. Lin (BGP), W. Liu (BGP)

Summary

This new pore pressure prediction approach uses Eaton's Principle combined with the Fillippone formula for calculation. For complex surface structure in the shale gas in Southern China, its feasibility have been verified and the predicted pressure values match well with the measured data.

Introduction

For the shale gas in Southern China, reservoir pressure is an important factor that affects the deployment and production of the horizontal wells, but it has proved that the conventional methods such as Eaton’s and Fillippone’s methods do not apply to the three-dimensional pressure prediction. Then the new approach, called “Fillippone + Eaton” method, is presented which calculates the three-dimensional normal compaction velocities based on Fillippone’s formula (Fillippone, 1979) and obtain the pressure results by Eaton’s principle (Eaton, 1976). Practices in the shale gas exploration zones have proved that this combined method improves the inadequacy of the existing approaches in the parameter setting, and is applicable to the complicated geological conditions. The predicted results by this new approach fit well with the measured data.

Method

Under the geological condition of the shale gas plays in Sichuan basin, the conventional Fillippone’s method is not applicable due to the complicated underground velocities especially with the reversal of the shallow velocities, and there are no thick, homogenous mudstone intervals for the normal compaction trend (NCT) establishment for Eation’s method.

Hence, in order to achieve the three-dimensional seismic based pore pressure prediction, “Fillippone + Eaton” method first assumes the formation is normally compacted, so from the Fillippone’s fomula, the normal compaction velocities V_{normal} should satisfy:

$$P_{overburden}\frac{V_{\min}-V_{normal}}{V_{\max}-V_{\min}}=P_{hydrostatic}\Rightarrow V_{normal}=V_{\max}-\frac{P_{hydrostatic}}{P_{overburden}}(V_{\max}-V_{\min}) \, .$$

Then the pore pressure can be calculated by the Eaton’s formula with the V_{normal} above

$$P_{Eaton}=P_{overburden}-(P_{overburden}-P_{water})\left(\frac{V_{inst}}{V_{normal}}\right)^{n} \, .$$

Here n is the empirical coefficient related to the location characteristics which can be calibrated with wells.

In the application process, the calculations is entirely based on the seismic data (Velocities and densities) and involved very few parameters, and the new pore pressure prediction approach is an easy-to-use procedure on parameter setting and applicable under complex surface structure, reversed velocity and thin shale deposition cases.

Examples

A successful shale gas survey case elucidate the reliability in both well and seismic exercises:

Figure 1 are the 3D prediction result and the horizon slice through the shale reservoir. The distribution of pressure coefficients shows a upward trend of SW to NE which have been proved by the measured pressure data and reasonable from the depositional environment analysis.

Figure 2 show the predicted pore pressure of the connecting-well profile, the measured pressure coefficients at the reservoir depth of well B and C are 1.91 and 1.98, and the predicted results are 1.9 and 1.85.

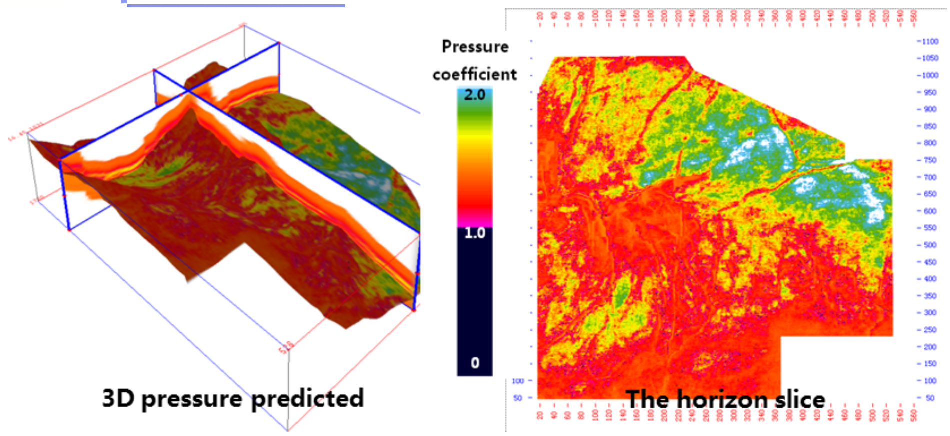

Figure 1 *The predicted 3D pore pressure and the horizon slice through the shale reservoir.*

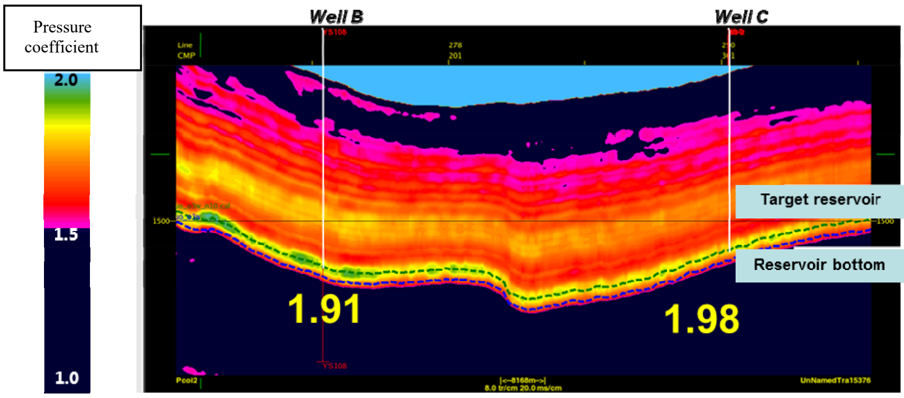

Figure 2 *The predicted pore pressure of the connecting-well profile.*

Conclusions

This new pore pressure prediction approach uses Eaton's Principle combined with the Fillippone formula for calculation. For complex surface structure in the shale gas in Southern China, its feasibility have been verified and the predicted pressure values match well with the measured data.

References

Fillippone W. R., On the prediction of abnormally pressured sedimentary rocks from seismic data. Offshore Technology Conference, 1979, 3662: 2667-2669.

Eaton B. A., Graphical method predicts geopressure worldwide. World Oil, 1976, 183: 100-104.