IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 06, Issue 03 (March. 2016), ||V1|| PP 20-22

Calculate the in-situ stress using logging data

YejunJin[1], Sijia Cao[1]
[1](*College of Earth Sciences, Northeast Petroleum University, Daqing, Heilongjiang 163318, China*)

Abstract:- In-situ stress has very important practical significance and inestimable economic significance in oil-gas exploration and exploitation. Calculating the in-situ stress by logging data is a kind of cheap and relatively accurate method. The analysis of collapse pressure and fracture pressure can determine the in-situ stress azimuth and s-wave and p-wave of sonic log data can be used to calculate the dimensions of horizontal principal stress. There are mainly five methods to calculate the dimensions of horizontal stress: Mattews& Kelly model, Eaton model, Anderson model, Newberry model and Huang model.

Keywords: *-horizontal stress,in-situ stress, logging data, the stress orientation*

I. INTRODUCTION

The last two decades, many countries have extensive in-situ stress measurement and application of research work. Li Zhiming[1] showed that the research of present in-situ stress can provide a scientific background for injection-production well pattern deployment and development plan design and in-situ stress has a strong relationship with the large area of casing damage caused by the design of hydraulic fracturing, formation sand production in the process of oil production, water injection inducing earthquake and water injection inducing formation sliding and peristalsis. Therefore, in-situ stress has very importantly practical significance and inestimably economic significance in oil-gas exploration and exploitation. In-situ stress determining by logging data is a kind of cheap method and it has been very mature, and that the calculation results are more accurate.

II. THE ORIENTATION OF THE HORIZONTAL PRINCIPAL STRESS

Horizontal principal stress direction can be achieved through the analysis of the collapse pressure and fracture pressure(fig.1). Bore collapse and formation breakdown phenomenon is a result of the combined action of in-situ stress, fluid pressure and formation fluid pressure on the borehole wall. When the stress suffered by the borehole wall is more than the rock shear strength, the phenomenon of sidewall formation collapse occurs. If the minimum effective principal stress suffered by the borehole wall in the maximum horizontal stress direction is less than zero, it will overcome the tensile strength of the rock formation and form the tensile fracture. Researches show that hole collapse occurs generally in the minimum horizontal stress direction and formation fracture occurs in the direction of the maximum horizontal stress[2,3]. In addition, their directions are perpendicular to each other. For example, figure 1 shows that the minimum horizontal stress has an azimuth of N 70°E therefore the maximum horizontal stress is orientated N 20°W.

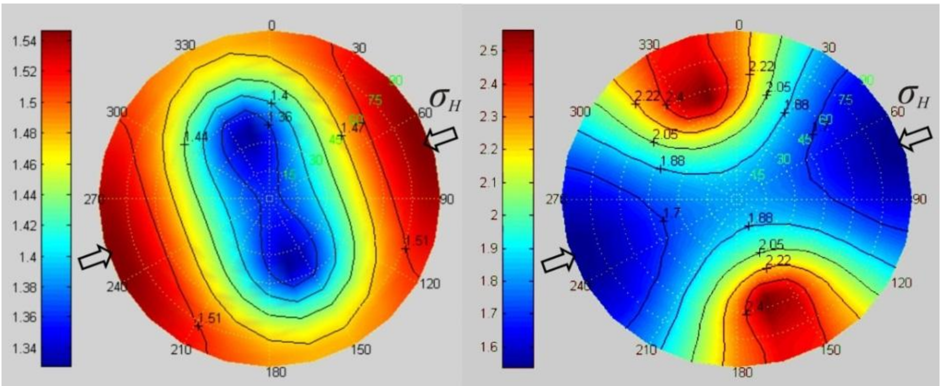

Fig.1 The collapse pressure (left) and fracture pressure (right) analysis in a certain oilfield

III. THE DIMENSIONS OF THE HORIZONTAL PRINCIPAL STRESS

There are mainly five methods to calculate the dimensions of horizontal stress: Mattews& Kelly model, Eaton model, Anderson model, Newberry model and Huang model.

3.1 Mattews& Kelly Model

In 1967, Mattews and Kelly based on Hubber and Wilis'sresearch, put forward this model with the combination of hydraulic fracturing in the process of drilling. The model shows that overburden pressure gradient is not constant with depth change, at the same time without considering the influence of Biot elastic coefficient, which is not consistent with the reality. Besides, K_i requires a lot of adjacent well fracturing data to determine, this model has not been applied extensively:

$$\sigma_h = K_i(\sigma_v - P_w) + P_w \quad (1)$$

Where σ_h is the minimum horizontal stress, MPa; K_i is the skeleton stress coefficient, non-dimensional; σ_v is the vertical stress, MPa; P_w is the pore pressure, MPa.

3.2 Eaton Model

In 1969, Eaton put forward that overburden pressure gradient is not constant but a function of depth, pointed out overburden pressure gradient can be obtained by density logging data, and crystallized K_i as $\mu/(1-\mu)$. This method is mature and commonly used in engineering, but it also doesn't consider the effect of Biot elastic coefficient. For low porosity, poor permeability of formation the calculation error will be larger.

$$\sigma_h = \frac{\mu}{1-\mu}(\sigma_v - P_w) + P_w \quad (2)$$

Where μ is the rock poisson's ratio, non-dimensional.

3.3 Anderson Model

It was deduced by Anderson using Biot theory elastic deformation of porous media in 1973. Anderson model makes the stress calculation to a new level. The introduction of the elastic coefficient of make for further understanding of the role of the formation pore pressure.

$$\sigma_h = \frac{\mu}{1-\mu}(\sigma_v - \alpha P_w) + \alpha P_w \quad (3)$$

Where α is the Biot elastic coefficient, non-dimensional.

3.4 Newberry Mode

In 1986, Newberry revised Anderson model in view of the low permeability formation with micro cracks.

$$\sigma_h = \frac{\mu}{1-\mu}(\sigma_v - \alpha P_w) + P_w \quad (4)$$

3.5 Huang Model

Huangrongzun professor, a Chinese geologist, based on the above formula put forward this model in 1984[4], assumed that stress suffered by the underground rock is mainly composed of overburden pressure and horizontal tectonic stress, and the horizontal tectonic stress is proportional to the overburden pressure.

$$\sigma_H = \left(\frac{\mu}{1-\mu} + \beta_1\right)(\sigma_v - \alpha P_w) + \alpha P_w \quad (5)$$
$$\sigma_h = \left(\frac{\mu}{1-\mu} + \beta_1\right)(\sigma_v - \alpha P_w) + \alpha P_w (6)$$

Where σ_H is the maximum horizontal stress; β_1 is the tectonic stress coefficient in the direction of the maximum horizontal stress; β_2 is the tectonic stress coefficient in the direction of the minimum horizontal stress.

IV. APPLICATIONHUANG MODEL TO THE BZ34-24 FIELD

Above five models, because of the Huang Model either considering the influence of Biot elastic coefficient or the effect of tectonic stress, the calculation results are the most accurate in the above five model. The stress of the BZ34-24 field is carried out the calculation using the Huang model(fig.2).The BZ34-24 field, lacking of in-situ stress logging data, is in the stage of waterflooding and has the complex fracture system. It is necessary to study the stability of the faults using the stress data. Thecalculationresults ofstress are as follows:

$$\sigma_h = 0.0155 \times \mathrm{D} - 0.4249 \quad (7)$$

$$\sigma_H = 0.0213 \times \mathrm{D} - 1.9704 \quad (8)$$

Whereσ_h is the minimum horizontal stress, MPa; where $\sigma_H$isthe maximum horizontal stress, MPa; D is the depth, m.

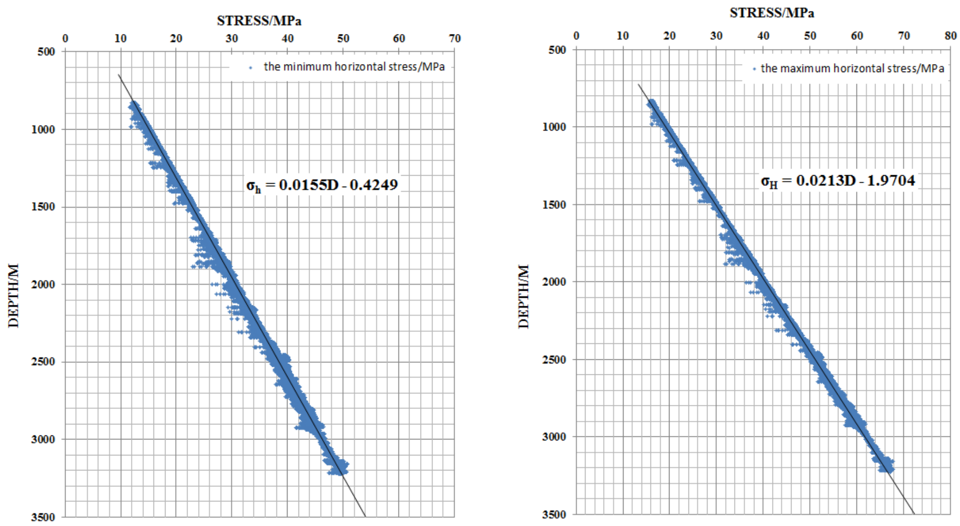

Fig.2 The profile of the minimum horizontal stress and the maximum horizontal stress

V. CONCLUSION

Horizontal principal stress direction can be to get through the analysis of the collapse pressure and fracture pressure; The first three models are uniaxial strain model and can only calculate the dimensions of the minimum horizontal principal stress, so the dimensions of the maximum horizontal principal stress is still need to be determined by other methods. The latter two models are biaxial strain model and can calculate the dimensions of both the minimum and maximum horizontal principal stress, what's more, the calculation results is more accurate than the previous two models.

VI. ACKNOWLEDGEMENTS

The authors would like to acknowledge the valuable comments and suggestions of my associates in Northeast Petroleum University. Special thanks are expressed to my senior fellow apprentice for his interesting and rewarding comments.

REFERENCES

[1] Li Zhiming. in-situ stress and oil-gas exploration and exploitation[M]. Petroleum Industry Press, 1997.
[2] White A, Hillis R. In-situ stress field and fault reactivation in the Mutineer and Exeter Fields, Australian North West Shelf[J]. Exploration Geophysics, 2004,35(3):217-223.
[3] Yaghoubi A A, Zeinali M. Determination of magnitude and orientation of the in-situ stress from borehole breakout and effect of pore pressure on borehole stability — Case study in CheshmehKhush oil field of Iran[J]. Journal of Petroleum Science and Engineering, 2009,67(3-4):116-126.
[4] Huang Rongzun. Discussion on formation fracture pressure prediction model[J]. Journal of east China petroleum institute, 1984(04):335-347.