Using RMS Software to Modeling Multi-stage Fault Structures of Large Faults

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Abstract. With more and more attention paid to residual oil recovery at the edge of faults, the internal structure of large faults and their growth and evolution and combination patterns are more clearly understood. How to accurately depict these understandings has become the main problem. RMS software uses triangular mesh modeling, which can accurately describe the spatial shape and contact relationship of faults. It solves the problem of "Y", "l", "X" fault modeling which can not be accurately established by conventional software.

Introduction

Fine interpretation of well and earthquake combined with structural data and field geological data show that: Large faults are characterized by multi-stage activity, large faults have the geological characteristics of "plane sectional growth and vertical staged evolution"[1], the intersection mode of two faults at the stage active point of vertical faults contacts with "Y", "l" and "X" faults. Conventional modeling methods are difficult to solve these two types of modeling. It can only be achieved by the decomposition of faults and the structural modeling of layers. It is difficult to maintain the original shape of faults and the grid is not uniform.

RMS software uses triangular mesh modeling method. Fault models of arbitrary shapes can be constructed. It can accurately depict the fault location at the unit level. In order to better characterize the multi-stage development characteristics of faults, Research on single-stage characterization of large faults is carried out. The method of building complex construction model by RMS modeling software is formed. Accurately depict the intersection relationship of complex faults and faults.

Geological Characteristics

A certain area is located in the south of a placanticline anticline structure in the central depression area of a basin. There are 19 large and small faults. Six of them are characterized by multi-stage fault activity. Vertically, the fault has undergone three stages of fault series: fault depression, depression and inversion. The research horizons are distributed in Qingshankou Formation-Nenjiang Formation (T2-T06) in the depression period [2]. The main reservoirs are Sa II, Sa III and Pu I reservoirs. Vertically, it is subdivided into 72 sedimentary units. The delta distributary plain and inner front facies are the main deposits of the Pu I Formation.

Technology Roadmap

This study is based on the comprehensive analysis of geological, logging and seismic data. Firstly, through well seismic interpretation combined with fine structure interpretation. Fine matching of breakpoints, Fine interpretation of structural faults has been completed. The detailed interpretation of "plane sectional growth and vertical staged evolution" of faults is also given [3, 4]. Secondly, the vertical staging fault boundary is depicted by using modeling software. To determine the intersection relationship between staged evolution faults. Thirdly, fault model is generated by RMS software. The fault junction relationship is processed accurately. The stratification model is established by using well point stratification data and seismic interpretation horizon. The regional

structural characteristics of complex faults are accurately depicted (Fig. 1) [5].

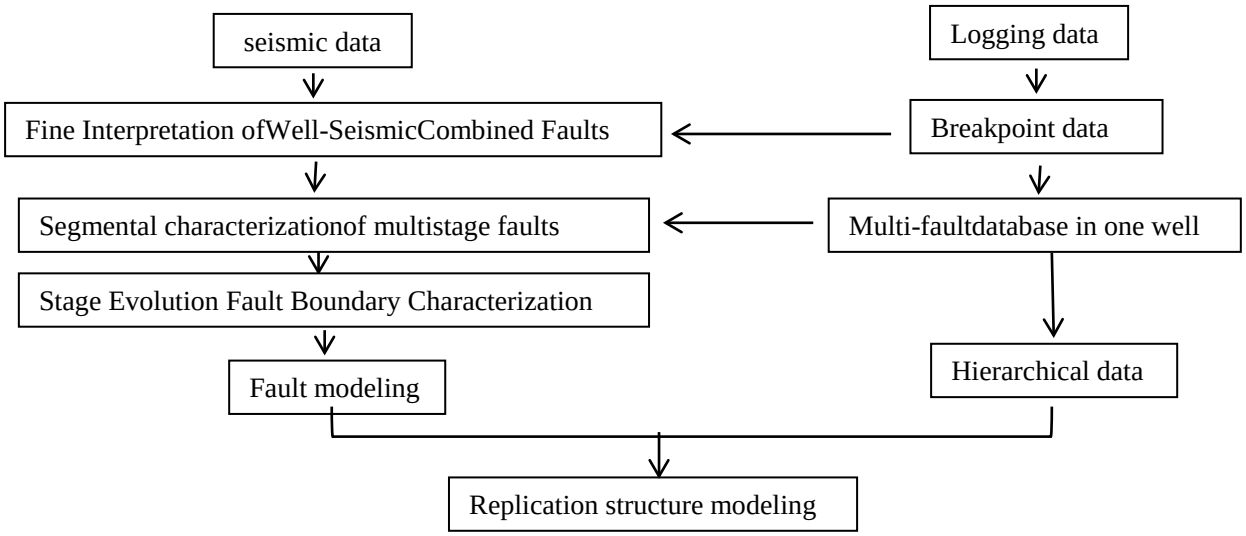


Fig. 1 technical roadmap

Fault Interpretation

There are two mechanisms of fault evolution. The first is the evolution mechanism of multi-stage tectonic movement. The second is the mechanism of fault evolution under the condition of different formation plasticity. The vertical growth evolution of faults under this mechanism can be divided into four stages. (1) In the stage of fault propagation fold (formation of lower fault system), traction fold is easy to form. (2) The formation and evolution of mudstone smear are accompanied by the vertical sectional growth stage of faults. (3) The "hard connection" stage of penetration; (4) The faults are fully connected and disconnected. According to the evolution mechanism of segment fissures, the faults are delicately depicted and the detailed interpretation of faults is completed (Fig.2).

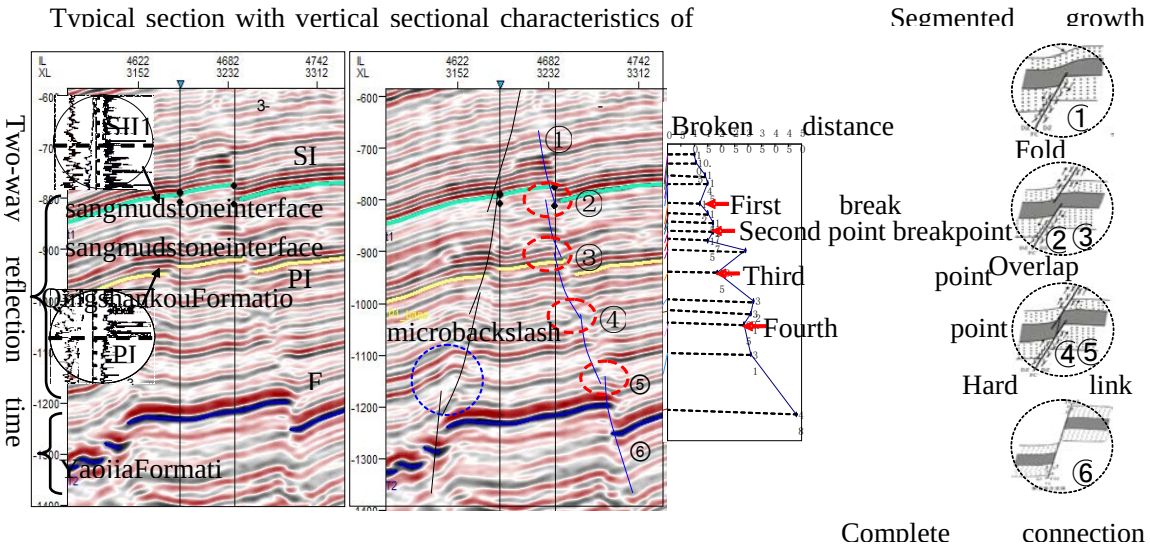


Fig. 2 Fine Interpretation of Well-Seismic Combination of Fault Evolution

3D Structural Model

Based on the results of well-seismic description, RMS software is used to carry out structural modeling research, which mainly includes fault modeling and horizon modeling [6].

Fault Plane Modeling. According to the fault description principle of well-controlled position and seismic-controlled shape, the primary fault model is established. Well breakpoints strictly control the location of corresponding sections, and seismic interpretation results guide the description of the overall contour of faults and overlap relations.

The RMS software can automatically generate the primary fault model by inputting the interpretation results of well breakpoints and depth domain faults (Fig. 3). Its spatial location and distribution pattern can well correspond to well breakpoints and interpretation results, but the overlap relationship has not been processed, and there are still some unreasonable situations in some parts, which need further quality control to form the final model.

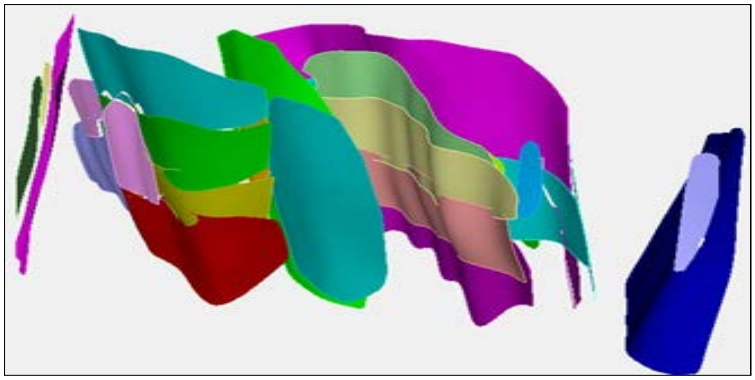
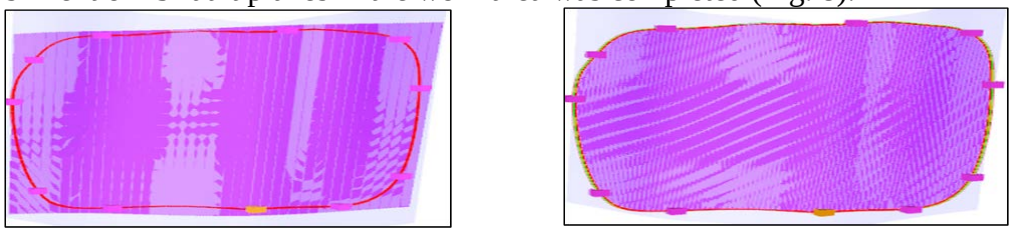


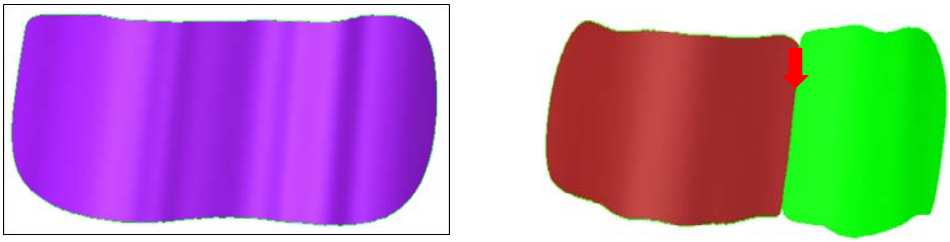
Fig. 3 Primary fault model automatically generated by RMS

Manual editing and processing are mainly in the following three aspects: First, the quality control of fault boundary. Under RMS environment, the boundary of fault plane can be edited freely, and the elliptical structure of fault can be reasonably characterized based on the depth domain results of seismic interpretation (Fig. 4). The second is the quality control of fault overlap relationship. Under RMS environment, the construction mode between faults can be dealt with freely by editing overlap connection of faults. The overlap connection divides the fault plane into several parts, each part can be cut off separately (Fig. 5). The third is to adjust the spatial shape of fault plane according to the shape of fault plane segment and vertical segment overlap (Figs. 6, 7). The establishment of 19 fault planes in the work area was completed (Fig. 8).



A.Before modification of section shape B. After modification of section shape

Fig. 4 Fault morphology and overlap relationship processing



A. before modification B. after modification

Fig. 5 Plane sectional fault effect map

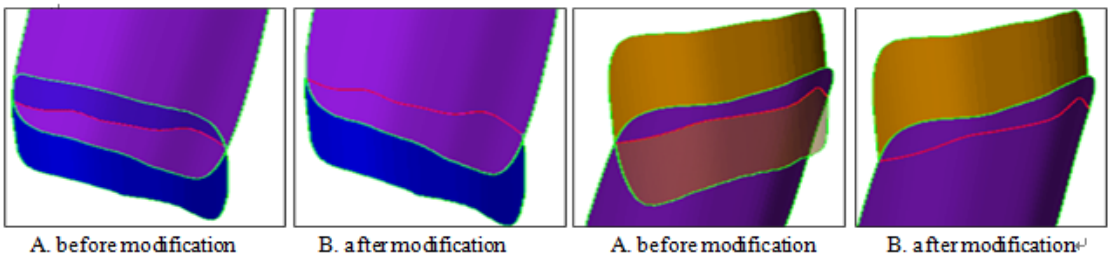


Fig. 6 Vertical parallel section adjustment

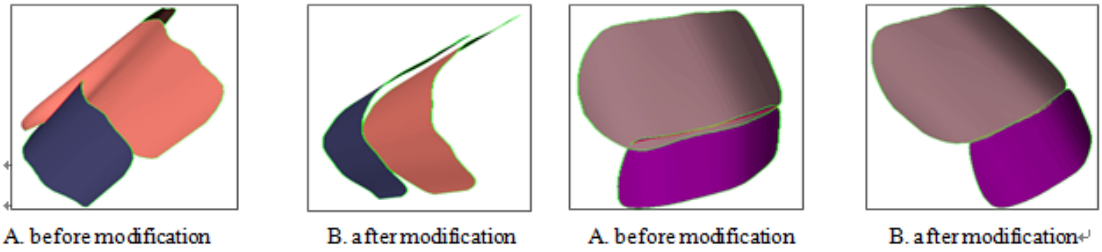


Fig.7 Adjustment of vertical connection section

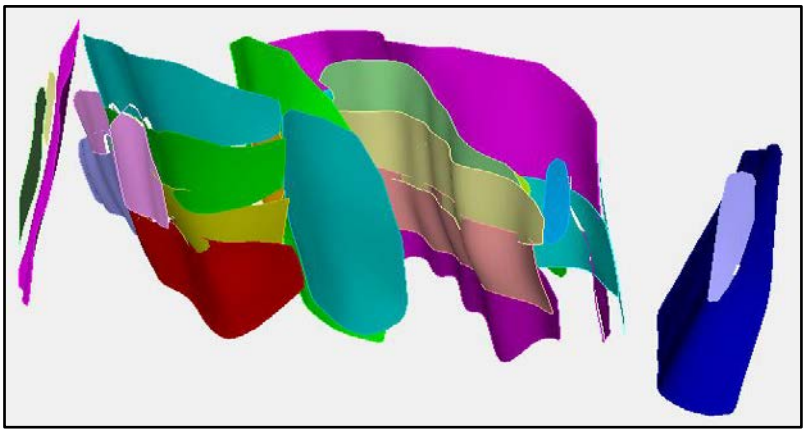


Fig. 8 Fault Effect Map

Structural Surface Modeling. The establishment of horizon model needs to be based on layered boundary data of sedimentary unit and interpretation data of seismic standard layer after depth conversion, and realized by adjusting various parameters and manual quality control. Primary models can be produced by using seismic interpretation data, unit stratified data and interlayer thickness data as inputs. Among them, seismic interpretation data provide the overall trend, which belongs to soft data. The unit hierarchical data is the basis of the spatial location of the horizon, which belongs to hard data, i.e. the horizon model is hard constrained. Interlayer thickness data is the thickness field between adjacent layers in this level model, which needs software calculation. In order to inherit the construction trend between control layer and non-control layer, it is necessary to set the credibility manually to adjust the effect of constraints (Fig. 9).

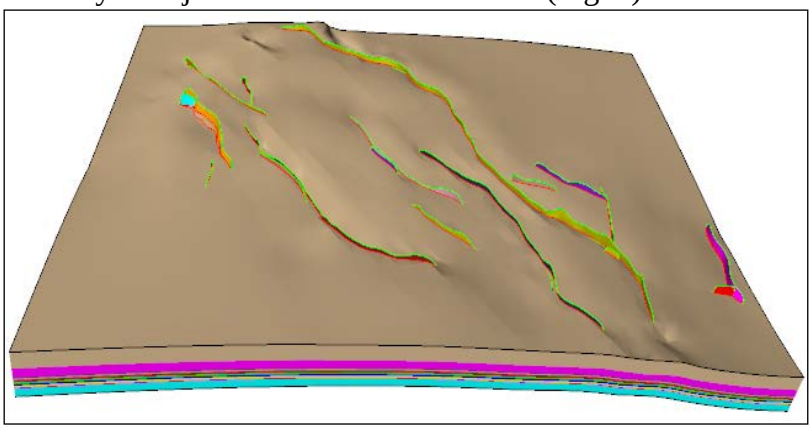


Fig.9 Sedimentary unit-level tectonic plane

Analysis of Modeling Effect

Through the analysis of the structural model after modeling, for the fault model, the fault surface is completely consistent with the seismic interpretation level, and the combination of fault surface and well breakpoint is reasonable, which meets the requirements of fault modeling. Taking 305 # fault as an example, the small faults evolved in the upper and lower stages can be clearly depicted, and the relationship between fault surface and fault is reasonable, which can be fully consistent with the geological knowledge of the previous study (Fig. 10).

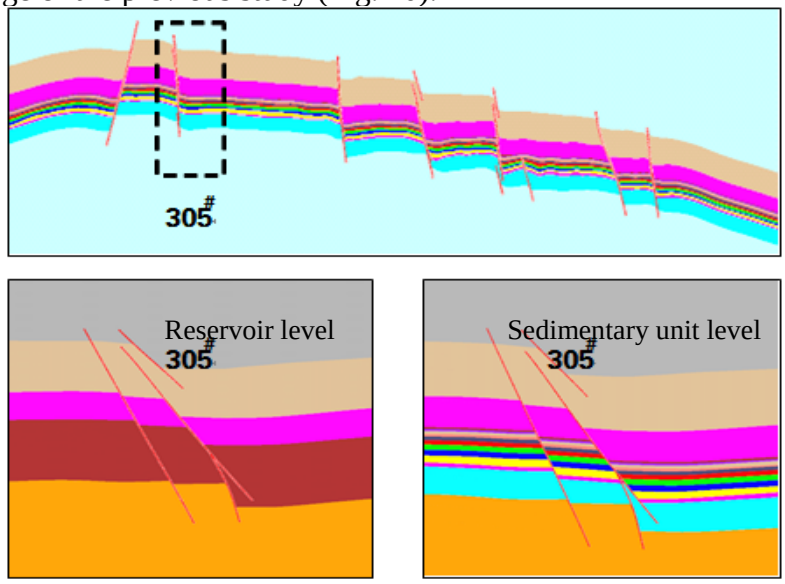


Fig. 10 Structural Model Profile

Conclusion

RMS modeling software can be used to solve the structural research with many faults and complex junction relations. However, in order to construct a reasonable fault model, it is necessary to do well well seismic matching in the early stage of application. If Petrel software is combined with RMS software, and Petrel software is used in the early stage of fault data processing, reasonable fault data can be obtained. Fault model can be generated in RMS software. Fault model processing is simple and reasonable. Simple adjustments are needed.

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