Modeling of well-seismic structure

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Abstract. The characteristics of the fault system are analyzed by using the 3D method and the combination of well-seismic and break-point method. The structural model is established by using the combination of logging and seismic data, to guide the adjustment of oilfield development. The results show that the fault combination, fault orientation and Extension Direction are obviously different from those before, and the large structure pattern of the study area has not changed, a structural model based on the combination of logging and seismic data, which is faithful to the well point data and retains the relative trend of seismic data, is better than the model based on logging data, it's more like an underground structure.

1. Introduction
The application of drilling break point data to two-dimensional artificial composite faults has some limitations, and the description of the head and tail changes of large faults and the shape of small faults is not accurate enough, especially, the strike and tendency of isolated breakpoint controlled faults and well-to-well faults can not be confirmed. Only using seismic data to study structure is lack of combination with well data, the description of large fault section occurrence is random, and some small faults which are controlled by well breakpoints and have no obvious seismic reflection characteristics will be missed. For this reason, we have carried out the research on the modeling technology of the well-earthquake combined structure, the research on the 3D fault combination and the method of the well-earthquake combined structure combination, and explored the new thinking and method of the well-earthquake combined structure modeling, so as to greatly improve the precision of the structure description, to guide the adjustment of oilfield development.

2. Fracture system study

2.1. Breakpoint reduction method
The original breakpoints are grouped together in the 3D to show whether or not the breakpoints of the same fault are in a trend plane and are realigned as the case may be. Take the a # fault as an example: the a # fault is composed of seven breakpoints, one of which is obviously not in a trend plane with the other six breakpoints in the space of the breakpoint, the distance from this point to the a # fault is about 500m, and the analysis confirms that the point does not belong to the a # fault, verified and classified as Fault B. At the same time, in the undefined breakpoints of 2D fault combination, 4 points fall into the trend plane of a fault, and these 4 points are classified as a fault.

A total of 275 fault points were studied in the study area. The original fault points were rearranged by 3D method, and a total of 259 fault points were rearranged. Taking the distribution of the top surface faults as an example, the whole strike of the faults of the two-dimensional and 3D assemblages
is similar, both of them are nw, the local faults of the three-dimensional assemblages are nw, and the length of the faults varies.

2.2. A method for locating the breakpoint of well-seismic connection

Taking geostatistics theory as the core, introducing the seismic data control through the traditional geological modeling process, taking the fault as the basis of seismic interpretation, retaining the tendency and extension length of the major fault basically, and combining the ant tracing results, from the point (breakpoint), line (seismic section), plane (fault development surface), body (seismic attribute body), the spatial location of the breakpoint, fault spatial combination, fault and fault occurrence are carried out. According to the breaking point, the section occurrence and the variation of the head and tail extension of the major fault are adjusted, and the uninterpreted minor faults are searched.

The steps are as follows:

1. The purpose of calibrating synthetic records for structural study is to convert the time-depth of break-point and time-domain reservoir-group-level structures to synthetic records produced during seismic interpretation. The calibration data mainly check two points: whether the velocity trend of the preliminary composite record is consistent, whether there are abnormal wells; whether the interval velocity plane changes uniformly, whether there are abnormal velocity points [7].

2. The key to the combination of time-depth conversion and seismic data is the time-depth conversion, which unifies to the time domain, and makes the data of the two observation systems work together in one domain and check each other. The main reason is that in the stage of Structure Research, the precision of the structure trend revealed by the earthquake is higher than that of the well, so we should keep the original appearance of the seismic data. The time-depth conversion is a point-to-point conversion, and the relative error is much smaller than that of the point-to-point conversion. Therefore, the well layering, fault point and earthquake are unified into the time domain.

3. Seismic attribute extraction through the combination of seismic multi-attribute analysis and well seismic data, the information that cannot be identified by conventional methods is extracted, and the fault geometry and distribution characteristics are analyzed in detail, study the small sealing fault in detail. It is usually the well breakpoint combined with the variance body and the ant body to confirm the existence of small faults.

2.3. Research results of well-seismic combined fault

The fault research in the study area mainly focuses on four aspects: The location of well breakpoints; fault strike controlled by single well or few wells; the interpretation of small fault distance controlled by no well breakpoints; and the combination of fault space. Based on the 3D observation of fault morphology and combination mode of seismic attribute volume, the ascertainment of all well breakpoints is adjusted and the fault interpretation results are corrected. There are obvious differences between fault combination, fault orientation, Fault Extension Direction and fault made by well-seismic data only, emphasis is placed on the following aspects:

1. The number of faults has increased: 10 new faults have been interpreted using seismic data; and most long faults have been divided into several faults as compared with logging interpretation faults.

2. Compared with the faults interpreted by well point data, the extension length of the head and the tail of the faults has changed greatly: The tendency of one fault in the study area has changed, and the overlap relation of the two faults in the middle of the work area has changed.

3. Write-off of 2 faults. The log interpretation shows that the new fault exists, the well-seismic interpretation shows that the new fault does not exist in the target interval, the well break points of the fault are all above the target interval, and the stratification data of the surrounding wells have no obvious height difference, and there is no explanation in the seismic section, the interpretation will be cancelled.
2.4. Tectonic knowledge

After detailed structural interpretation and well-seismic interpretation of the study area and verification of the faults, the knowledge of fault distribution after using fine structural interpretation techniques mainly includes the following points:

(1) the large structural pattern of the study area has not changed, and it is still a monocline structure that gradually decreases from southeast to northwest, the local structural morphology has changed greatly. The faults in the middle part of the structure are many and complex because of the local high point of faults. After several decades of oilfield development, the overall structure of the oilfield has been determined fairly accurately by using single-well stratified data, which also shows that more detailed structural study can be carried out by using seismic data, the utility model can further meet the need of oilfield development adjustment and tapping potential.

(2) the local structural morphology changes, which are mainly caused by the increase of faults and the change of the cross-cutting relationship of faults;

(3) there are many faults in the area, and the fault distance is large, which are normal faults, and the strike of the faults is nw, the maximum extension length of the fault is 2.7 km, the minimum extension length is 0.2 km, the maximum fault distance is 92.0 m, the minimum fault distance is 1.2 m, and the average dip angle of the fault is about 55°. Using seismic data, the distribution of faults can be described in three dimensions from the 3D, and the strike of faults can be determined more clearly.

(4) the number of faults increases. The increase in the number of faults can be divided into two situations: first, although some wells have encountered faults while drilling, because of the great distance between these faults, it is limited to the understanding of the limitations, these breakpoints were not combined to form a fault when combined. Second, because there is no cross-well fault drilling, so no discovery, after seismic interpretation, the existence can be confirmed. For some of the fault write-off, mainly due to the original understanding of the limitations of the fault direction and combination of not grasp well.

(5) the form of the fault changes, after the well-seismic joint research, almost every fault based on the data of the well breakpoint has different degree of change in form.

(6) the combination relation of faults has changed greatly, for example, the block is considered as a fault by the data of well breakpoints, and it should be divided into two faults after the study of well-seismic and fine structure.

(7) the tendency of some faults has changed. The tendency of the faults interpreted according to the well breakpoint data is ne. After the well-earthquake combined interpretation, the faults are divided into four faults, and one of them has changed, as opposed to what we thought we were.

3. Structural modeling

Because the relative structure depth trend of the underground reflection interface revealed by seismic data is accurate and credible, the relative structure depth trend of the seismic data should be preserved while the well point data is faithful in the construction of the structural model. Taking the depth domain level transformed by seismic interpretation as the trend surface, the structural level which is faithful to the well point layering data and retains the trend of seismic interpretation level between wells is obtained. The flow chart is as follows:

3.1. seismic interpretation of structural layers in time domain;

3.2. Velocity Field of reservoir group level is established by using synthetic records;

3.3. time-depth conversion to seismic interpretation of structural layers in depth domain;

3.4. using the seismic structural planes in depth domain as the trend constraint, the structural planes of each oil-bearing formation are generated by using the well stratification data;
3.5. The top structures of each sand-bearing formation are obtained by using the thickness planes of the sand-bearing formation, which are constrained by the seismic structural planes; the strata are of layered structure, the variation of formation thickness is small, so the seismic horizon of the top oil formation is used as a trend constraint in the study of sandstone formation-level structures.

According to the above flow, the structural model of oil layer is established, and the grid precision is 10m 10m 0.2 m. Compared with the model established by well logging data, it is more close to the underground structure shape.

![Fig.1 Structure modeling in 3 dimension using seismic and logging data of oil layer](image)

**4. Conclusion**

4.1. There are 10 more faults developed in the top of the reservoir group than the well-point Group, and there are obvious differences in the fault combination, fault orientation and Extension Direction.

4.2. The large structure pattern of the study area has not changed, and it is still a monocline structure that decreases gradually from southeast to northwest, and the local structure shape has changed greatly. The faults in the middle part of the structure are many and complex because of the local high point of faults.

4.3. Using logging and seismic data to establish structural model, which is faithful to well point data and retains the relative trend of seismic data, is closer to the underground structure than the model established by logging data.

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