Three-dimensional Geological Modeling Methods and Applications - A Gold Belt Oilfield

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Abstract. The ideas and methods of modeling are: According to each well in the simulation area geology, well logging data, combined with deposit information to geostatistics theory, establish the spatial distribution of the various geological parameters model, using interpolation techniques to predict the geological parameters for each grid block, three-dimensional geological model should include quantitative structural model, sand skeleton model, physical model and the gas-water distribution model. Currently, the three-dimensional geological modeling software more sophisticated, this study selected the Schlumberger Petrel software as a tool for research. Geological modeling generally follow the step point → surface → body. That modeling data preparation, structure modeling, and reservoir modeling with parametric modeling.

Establish A Geological Repository

There are 187 drilling modeling work area, an area 61.7km2, modeling requires basic data can be divided into three categories: point data, surface data and volume data, point data mainly wells and wells dot attribute information, mainly a variety of surface data plan and structural map, mainly seismic volume data volume data, seismic inversion data volume.

point data. All of the work area well abscissa, ordinate, make up the heart altitude, logging subdivision layer, inclined wells trajectory parameters, logs, well point attribute data, including rock, sandstone thickness, effective thickness, porosity, permeability and oil saturation.

plane data. Longitudinal stratigraphic thickness larger gold belt region, seismic interpretation provides 10 structure surface (NG, D1, D2, D3, S1S, S1Z, S1X, S31, S32, S33), hierarchical data interpolation utilizing well in the modeling process calculated data structure surface of the remaining 52; the other side is sedimentary microfacies data plan data; third surface is oil and gas reservoirs plane data distribution, which is the oil and gas area plan area. Seismic interpretation of fault data, fault and fault data includes polygon data slice.

Border and grid modeling accuracy

Different mesh types, mesh size, mesh orientation, grid scale model simulation accuracy, reliability will have a huge impact. Therefore, to ensure the accuracy of the simulation results and rationality, to determine a reasonable grid system is a prerequisite for simulation studies. Corner points of the grid is a new type of grid, which uses eight vertex coordinates irregular hexahedral describe the

spatial position of the discrete grid. Since the corner points of the grid of the grid lines can be any direction, it is possible to accurately describe the geometric shape and geological characteristics of the reservoir, especially undulating configuration changes, fault development of complex reservoirs, software Petrel grid just to meet this condition . Modeling of the grid size is determined to consider the current well spacing density, horizontal sand extending the length and width as well as the accuracy of the modeling can be calculated. The block longitudinal formation thickness larger span in between 1800m ~ 2100m area 61.761.7km2, consider computing power, integrated to determine the size of the block plane grid is 40m × 40m, the longitudinal direction of each small layer of fine timeshare thickness as small as possible to protect adequately portray the heterogeneity characteristics of sand inside, making each segment layer thickness of about 1 ~ 2m, the total number of meshes reach 187 × 217 × 764 = 3100.2 × 104, this grid resolution can be set up to meet the requirements of fine sand portray fine 3D geologic model.

Establish the structural model

Structural model reflects the reservoir space lattice, structural model and the level of fault model by model, which mainly includes three aspects: first, by interpretation of seismic and drilling tomographic data to establish fault model; second, in the fault model of control By establishing a top level at the end of each formation model; third, And other three-dimensional stratum when the mesh element model and the level of fault model based on the establishment of certain grid resolution. Subsequent reservoir property modeling and graphical visualization are carried out in accordance with the grid. PETREL optional software uses an integrated structure modeling process, about to fault modeling, level of modeling and technology as a whole stratum modeling, and during the operation of the three models in the shared data can be integrated.

Establish fault model. A series of fault model represents the spatial position of the fault, occurrence and development mode (truncated relationship) three-dimensional fault plane. Mainly based on seismic interpretation data, including fault polygons, as well as well stick a breakpoint fault data by certain mathematical interpolation, and the editing process based on the fault plane clipped the relationship between faults. Generally include the following links.

Fault modeling data preparation:

Tomographic data collection work area, including fault polygon, seismic interpretation and structural fault plane view (plan and profile) to implement each type of fault modeling work area, occurrence, development layers and cutting relationship between fault and so on.

Fault framework modeling:

The fault block structure is very complicated, does not belong on a vertical fault system, "Y" shaped fault development, reverse faults exist. When constructing a model with a first interpretation of the fault plane using seismic data to establish fault model framework, within the scope of the study area is selected to build the 80 fault fault frame, respectively, and a truncated set the connection relationship between each slice. Multiple operations, constant contact relationship fitting fault, adjust the length of the fault extending between the intersecting angle faults, fault framework model fitting final.

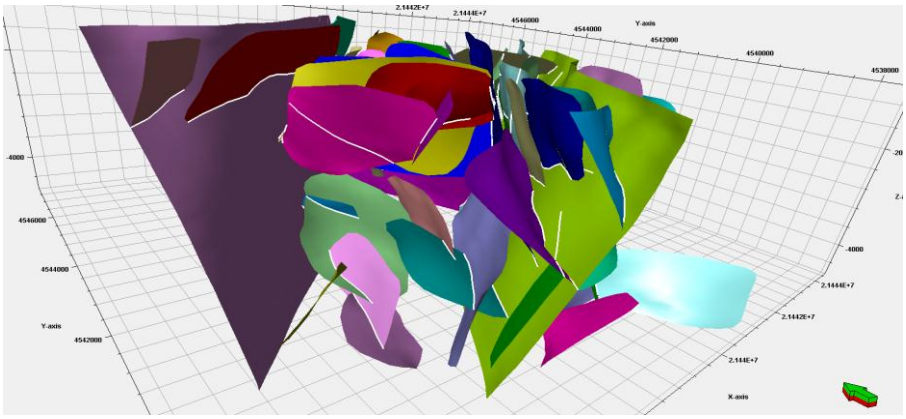

Fig. 3-1 fault framework model

Establish the level of the model. The picture shows the basic structure based on 10 seismic interpretation provided by the use of well points hierarchical data modeling work area where correction again to ensure error as small as possible. Then the structural map as a trend surface interpolation segment level data structure diagram with a well point to get the remaining 52 small layer , the algorithm is convergent algorithm selected.

Dimensional grid formation model. On the basis of the model and the level of fault model, based on the framework of the model and the level of fault model be constructed in front of the grid

Three-dimensional geological model can accurately reflect the eventual establishment of the reservoir structural framework, it can not only reflect the overall pattern of small faults and all layers, and can make accurate quantitative description of the structure of the layers of the subtle changes that can quantitatively describe the external reservoir geometry: spatial distribution and morphology of each fault combination of fault (Fig. 3-2).

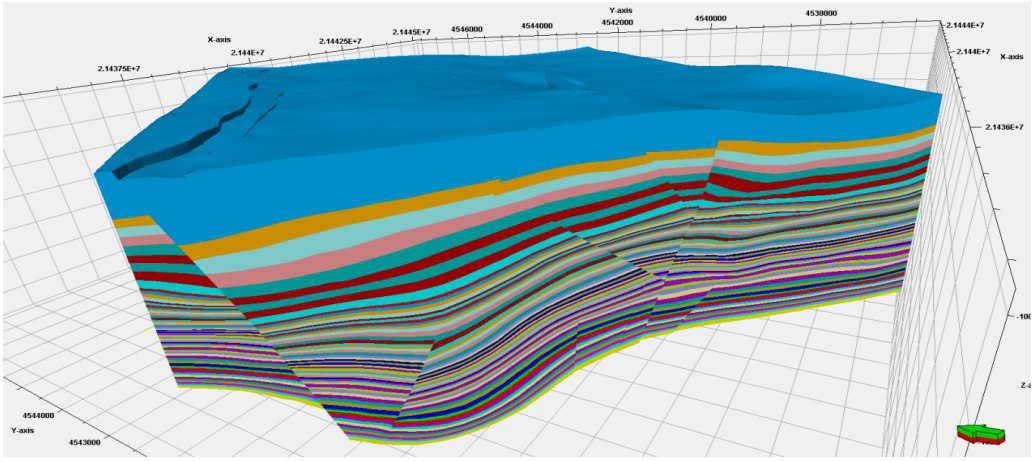

Fig. 3-2 structure model (stereoscopic display)

Establish sedimentary microfacies model

Sedimentary facies model is to establish a three-dimensional model of the flow cell or monosandbody based quantitative description of the spatial distribution of each sand form, it provides a skeleton for reservoir simulation of reservoir parameters on the background of the three-dimensional structural model. Micro-phase deposition method established model: the sedimentary microfacies based on log-phase plan to identify and fine sand on the basis of anatomy, the 52 small layer (single sand body) microfacies numerical plan to import three-dimensional geological model the algorithm uses a direct assignment method.

Build oil and gas distribution model

In the area of oil and gas distribution plan established on the basis of oil and gas distribution model, the oil and gas distribution area 61 small layer numerical modeling work area of import, using assignment algorithm, oil and gas distribution model as the basis for simulation of hydrocarbon saturation.

Establish reservoir properties of the model

Phased principle. On reservoir parameters, the traditional modeling approach mainly for the "one-step", namely direct interpolation between wells simulate reservoir parameters based on well point to establish three-dimensional distribution of reservoir parameters model. This method of single phase or micro-reservoirs for pastry-like structure. For multi-phase distribution or a complex reservoir with a reservoir structure, the one-step model will affect the accuracy of modeling. The main reason is that: ① effective reservoir parameters are mainly distributed in the reservoir sand bodies, and mudstone in the absence of effective reservoir parameters; ② different phases with different statistical characteristics of reservoir parameters. In this case, a "phased model", which first established sedimentary facies model and reservoir parameters based on the quantitative distribution of the different sedimentary facies, sub analog phase difference between wells. This multi-step stochastic simulation method is not only consistent with the geological phenomena, but also to avoid the most continuous variable model for stability / homogeneity of strict requirements.

Establish reservoir properties of the model. Establish reservoir properties of the model include the establishment of porosity, permeability and oil saturation model. The ultimate aim is to build 3D reservoir modeling parameters of the model to reflect the spatial distribution of subsurface reservoir properties. Due to the heterogeneity and anisotropy underground reservoir property distribution, the conventional deterministic modeling by a few observation points interpolation can not reflect the changes in the physical properties of space. This is because, on the one hand, the spatial distribution of reservoir parameters randomness, on the other hand, the distribution of reservoir parameters are also under control of reservoir sand bodies genetic unit, the performance is characterized by having a regionalized variables. Therefore, phased stochastic simulation method geostatistics and stochastic processes, is the best choice for a quantitative description of the physical properties of reservoir rocks spatial distribution. The property modeling using sequential Gaussian (SGS) modeling algorithm under conditions of phased, phased parametric modeling under very regular distribution of petrophysical parameters, random parameter distribution is to reduce the number and improve the modeling the degree of certainty. The degree of certainty. Phased modeling requirements characterization data field model using different statistical parameters. Each layer of each facies models need to set different parameters are: variogram, standard deviation and parameter transformation parameters.

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