METHOD FOR RECOGNITION OF MAGNETIC ANOMALIES BASED ON HYDROCARBON SEEPAGE THEORY

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1. INTRODUCTION

Developing an economical and effective technique to determining the prospecting oil and gas reservoir acts an important supporting role in energy reserving. In the 1920s, the relationship between the hydrocarbon concentration and oil-gas reservoirs was advanced. After a long time study, the hydrocarbon seepage theory was introduced. According to the theory, hydrocarbon seepage can result in a series of near-surface alteration. In the meantime, the geophysical and the geochemical methods of detecting hydrocarbon seepage to determine the prospective region of oil-gas field have great developed recently. The common feature of these methods is that both kinds of method are based on based on the hydrocarbon seepage theory, which measures the geophysical or the geochemical response to determining the oil and gas area.

Above all the geophysical methods, magnetic method is an economical and effective one. Some Scientists pointed out that magnetic mineral would form in near-surface alteration zone as oil-gas seepage moved up along the micro-fractures, so the magnetic anomaly caused by the alteration zone could be identified. Major progress has been made for recognizing the hydrocarbon-induced magnetic anomalies. Foote et al., introduced “Magnetic Bright Spot” (“MBS”) method after the research on the oil fields in Oklahoma and Colorado in 1996 which showed good relationship between magnetic anomalies and oil-gas regions [1]. T.Y. Hao et al., also used the “MBS” method and combined it with remote sensing method to pick 6 magnetic anomalies relative to hydrocarbon seepage in Bohai Bay basin in 2000, which showed that 4 of 6 anomalies were known as oil-gas field, and the other two had been proved productive oil-gas field by later prospecting [2]. Especially, one of the two

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anomalies ‘Miaoxi anomaly’ showed great correlation with the PL19-3 oil-gas field discovered later in Bohai Bay basin, China.

Picking and reinforcing magnetic signals from alteration zone is a promising technique of predicting oil-gas prospective area. Especially the method of distinguishing the attribute of the alteration zone plays a key role in the geophysical methods. So we proposed a comprehensive interactive recognition method based on both potential-field and image processing techniques which is combined with forward modeling result of igneous rock and other geologic information to reduce the ambiguity interpretation of the oil-gas seepage anomalies. In addition, the seismic pattern recognition method was also employed. And the method was tested and verified in the practical data processing of the South China Sea.

2. THE PICKING METHODS FOR MAGNETIC ANOMALY RELATIVE TO HYDROCARBON SEEPAGE

We employed multiple methods which were “interpolation cutting” “matched filtering” “wavelet analysis” “upward continuation” “total gradient modulus” to distinguish “MBS” from the regional magnetic anomalies, so that we could eliminate the regional anomalies caused by the basement, and compared these methods with the geologic information to get the most reasonable result. Judging by the analysis result of the local anomalies with selecting the amplitude range, the total gradient modulus methods and forward modeling of the igneous rock, we could eliminate effect caused by igneous rock and human activity in order to pick “MBS” relative to the hydrocarbon seepage.

3. IMAGE PROCESSING METHODS

Image processing methods can be applied to potential field interpretation so as to make it easier for visual interpretation and geological understanding. As the denser survey lines and the higher quality gridding algorithm developed, the “MBS” recognition and extraction method based on the image processing and analyzing technique also got to be improved. It expands the numeric values to spatial relative points, lines and polygons so as to use the spatial distribution feature of the datum thoroughly.

Different field–source anomalies can be identified not only by the amplitude or the frequency, but also the textural contrast image. When there is no major difference in the amplitude or the frequency, it is difficult to

distinguish the two anomalies by traditional methods. Therefore, the textural difference of anomalies is on the table. Firstly, we deal with preprocessed magnetic data by image processing methods that include high-definition image display based on the histogram-equalization method and target extraction and recognition based on the image processing and analyzing. The two methods explore the spatial distribution and correlation of the magnetic data. Then referencing the drilling and geologic information and the rock physical attributes we analyze the target anomalies to pick the "MBS" caused by the hydrocarbon seepage.

4. SEISMIC PATTERN RECOGNITION METHOD

Spatial variation of the rock and fluid property in the reservoir causes the changes of seismic attributes that is reflection waveforms, amplitude, frequency, phase and energy. In order to predict hydrocarbon-bearing reservoir in a finer scale, we can synthesize seismic and well-logging data by single attribute analysis, multi-attribute linear regression and artificial network method. Comparing such seismic method prediction with the "MBS" results, we could evaluate the 'MBS' method and avoid multi-solution.

5. A STUDY CASE IN THE SOUTH CHINA SEA

The result based on the aeromagnetic data of the South China Sea dealt with "MBS' recognition processing shows some prospective regions for oil-gas field. Compared with the drilling and seismic information, the result is good. We also designed a program with an interactive interface which integrated the potential-field data processing with image processing method so as to be easier to compare and analyze multiple datum. It overlays one residual magnetic anomalies diagram with oil-gas tectonics, faults, drilling holes, trap structures, bioherms and gravity anomalies and remote sensing information after relocation, removes anomalies resulted from the igneous rock and human activity. Comparing with the remote sensing anomalies of different period time and integrating all the gradients and results, we predict the grade of the oil-gas potentiality. It is believed that picking "MBS" of alteration zone due to hydrocarbon seepage is a possible and effective way to discover prospective oil-gas field.

6. REFERENCES

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