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Fracture Prediction Method with Narrow Azimuth Seismic Data in Tazhong District of Tarim Basin

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Abstract

In the Tazhong district of the Tarim Basin, the prediction of fractured reservoirs is of great significance to the exploration and development of oil and gas. Especially in carbonate reservoirs, the fractures, pores, and holes are the main migration channels and storage spaces for oil and gas. Their existence is one of the necessary conditions for carbonate oil and gas accumulation; the prediction of carbonate fractures has always been the focus and difficulty of research in this area. The current exploration technologies developed for fracture prediction include: shear wave exploration, P-S converted waves, multi-component earthquakes, multi-directional VSP, and longitudinal wave AVAZ. This article is based on the development characteristics, drilling logs, and seismic data of the carbonate reservoir fractures in the Paleozoic of the Tarim Basin in western China. Based on the characteristics of the prestack narrow azimuth seismic data in the Tazhong area, the author proposes to use prestack far and near deviations The displacement attribute difference method is used to predict fractures. This method provides technical support for the study of carbonate fracture prediction in areas with narrow azimuth seismic data and has important reference significance.

Keywords: Carbonate; Crack; Narrow Bearing Seismic Data.

1. Introduction

Reservoir types of carbonate fractures and caves in the Paleozoic in the Tarim Basin are diverse in type, with significant differences in size levels. According to the shape and size, the storage space can be divided into three categories: pores, pores and cracks. According to the different spatial combination characteristics of pores, caves and fractures, fracture-cavity reservoirs can be divided into four types: cave type, cave type, fracture-cavity type and fracture type [1]. Fracture is not only an important channel for oil and gas migration, but also a favorable place for oil and gas accumulation and accumulation [2]; it is an important factor for connecting multiple fractures and caves, dividing fracture and cave aggregates, and deploying development plans, and it is also the process of drilling deployment , An important basis for horizontal well orientation and trajectory design. How to effectively predict the distribution and development of underground fractures is of great significance for the seismic prediction of carbonate reservoirs. Due to the limitation of surface conditions in the Tazhong area of the Tarim Basin, most of the three-dimensional seismic acquisition is acquired with a narrow azimuth angle, and the aspect ratio of the seismic data is about 0.3. For the 3D seismic CMP gather data of this situation, the method of predicting cracks by the pre-stack longitudinal wave AVAZ technology is not suitable. In this study, based on the analysis of actual seismic data and

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forward modeling of rock physics, the method of using the difference between the far and near offset properties to detect cracks.

2. Law of Crack Response in Narrow Azimuth Seismic Attributes

2.1. Crack Detection Method for Difference of Near and Far Offset Attributes

When the azimuth range of seismic acquisition is narrow (such as the narrow azimuth seismic acquisition at sea), the azimuth anisotropy ellipse cannot be fitted within the narrow azimuth range. At this time, the pre-stack azimuthal anisotropic crack prediction technology becomes powerless under such circumstances. Therefore, it is necessary to use the pre-stack far and near offset attribute difference method to predict cracks.

The difference between the prestack far and near offset attribute difference method and the prestack azimuth anisotropy is that the method does not consider the seismic attribute change caused by the azimuth angle change, but based on the seismic attribute caused by the fracture with the offset Change the characteristics to predict the degree of fracture development. Cracks are detected by calculating the difference between the seismic properties of a large offset and the seismic properties of a small offset similar to self-excitation. As shown in Figure 1, it is actually an application of AVO technology in crack prediction. The CRP gather data after the prestack time migration not only contains the AVO information of the underground media, but also can reflect the real situation of the underground media more realistically. Therefore, it is often used for the prediction of cracks with poor pre-stack and near-offset properties. At the same time, in order to make the AVO anomalies caused by cracks more prominent, the offset of the seismic data should be large enough. This method overcomes the problem of crack prediction in the case of narrow azimuth angle to a certain extent, and provides a new idea for crack prediction under narrow azimuth angle collection.

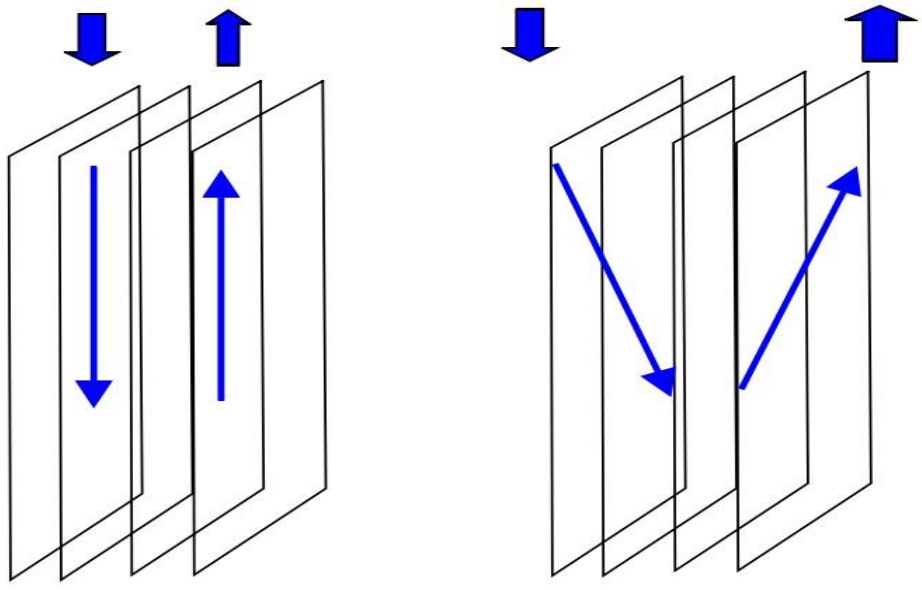

Fig. 1. Near-offset seismic waves through cracks and far-offset seismic waves through cracks

2.2. Rock Physics Forward Study on the Response Law of Cracks in Narrow Azimuth Seismic Attributes

The development of fractures in the carbonate reservoir in Tazhong is mainly controlled by structural faults. Later, with the partial transformation of secondary effects such as dissolution, dissolution fractures are developed, and structural deformation and dissolution are the main controlling factors of fractures observed today. For these kinds of cracks of various origins, first of all, according to rock physics forward modeling, the narrow-azimuth seismic data collection design in the study area is simulated, and the response law of the cracks in the narrow-azimuth seismic attributes is studied, as shown in Figure 2. For this study area, the crack trend is in the range of 50-60 degrees and 140-150 degrees, and the detection ability is weak.

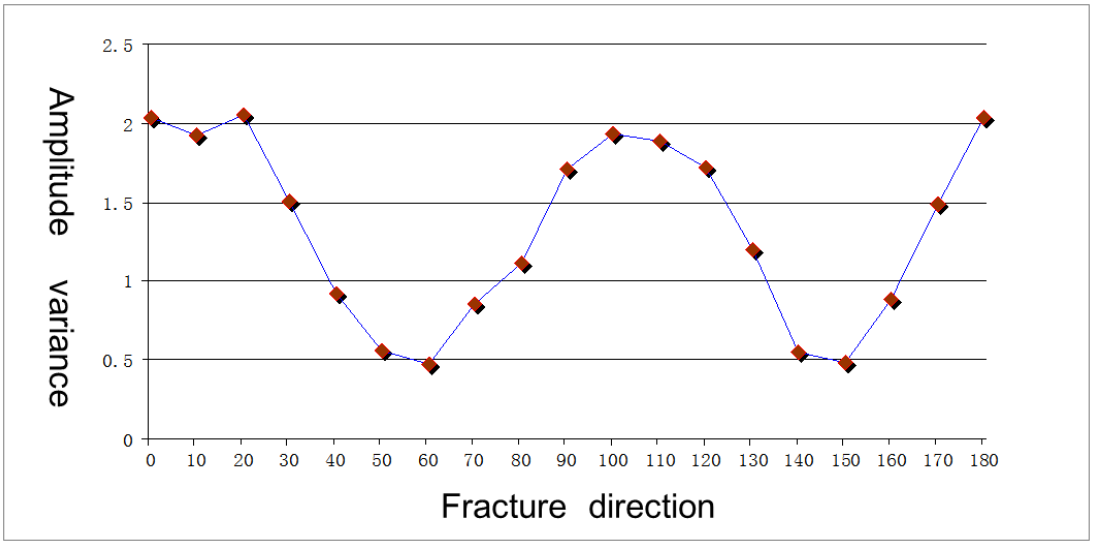

Fig. 2. The relationship between the difference of azimuth amplitude attribute and the fracture trend

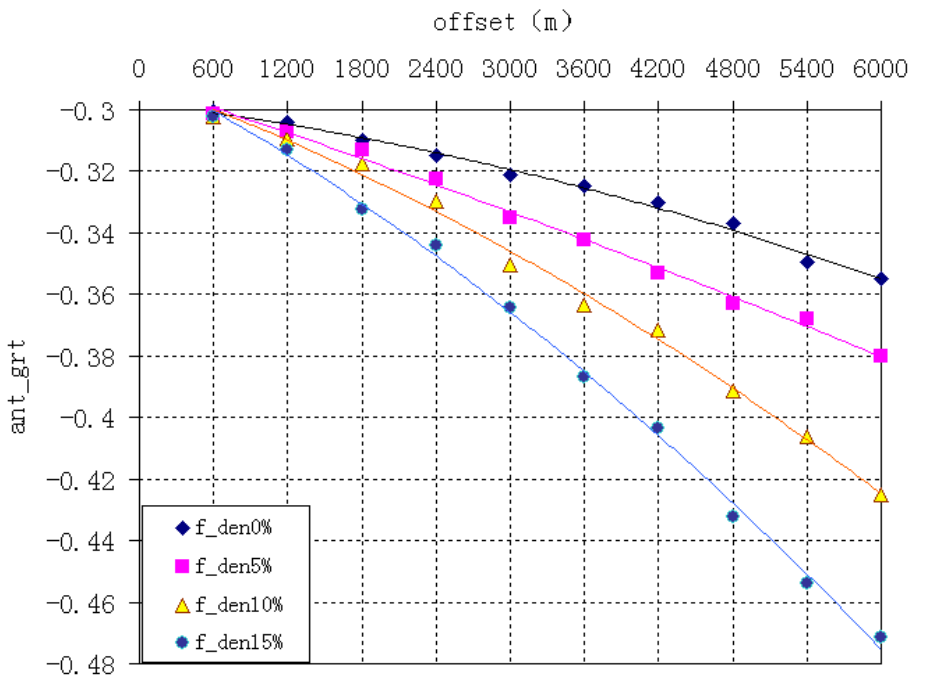

Fig. 3. Diagram of the relationship between frequency attenuation properties and offset (Different colors represent different degrees of crack development)

3. Application of Narrow Azimuth Distance Attribute Difference Method in Tazhong District

Based on the forward modeling of the above-mentioned distance and near-offset attribute difference degree and crack development degree, the actual seismic data in the study area is divided into far and near offset, attribute calculation and attribute difference analysis, and the area is developed. Research on crack prediction. The results of the crack prediction study are shown in Figure 4.

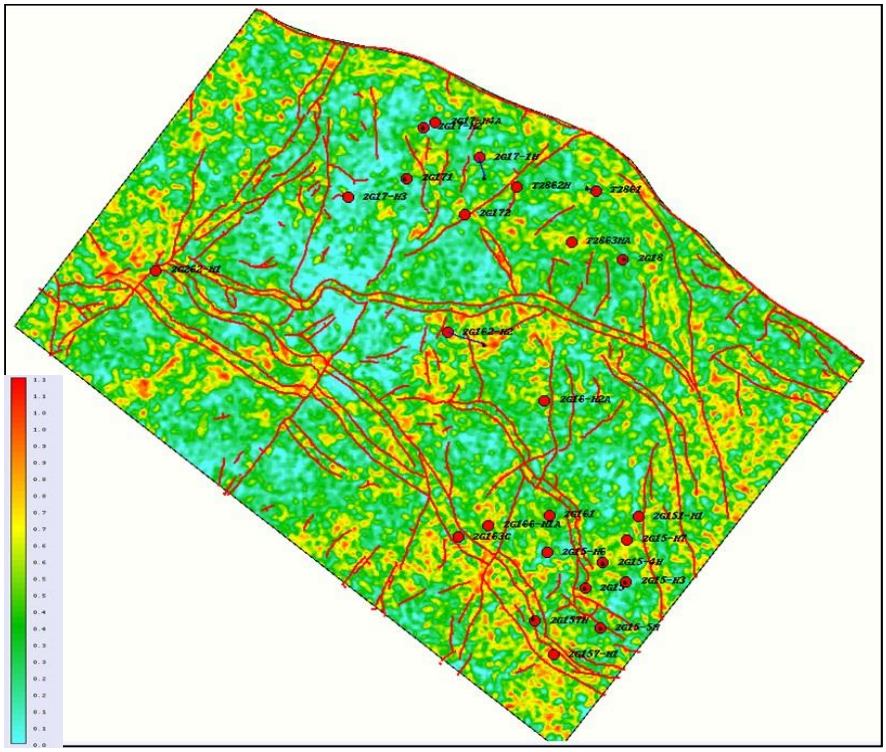

Fig. 4. Plan of crack development predicted by the difference method of far and near offset

The difference between the far and near offset attribute prediction methods predicts that the plane distribution of fractures has a better regularity and better correlation with regional faults. The fractures are mainly concentrated on both sides of the fault development site. The fracture development degree predicted by this method is compared with the fracture porosity explained by the uphole imaging logging in the study area. The fracture development degree predicted by the difference between the far and near offsets is in good agreement with the fracture porosity explained by the uphole imaging logging.

The accurate prediction of fractures has practical significance in the division of carbonate fracture-cavity aggregates and connectivity analysis. Fractures communicate with multiple pores and holes to form a connected aggregate of fractures and holes, which is an important factor for high and stable production of carbonate reservoirs. Carrying out fracture prediction research and fracture-cavity assembly connectivity analysis can provide effective technical support for exploration and development.

4. Conclusions and Suggestions

Based on the application research of crack prediction technology based on the above-mentioned narrow azimuth seismic data, the following conclusions have been made:

1. Rock physics forward simulation research shows that the geophysical response characteristics of fractured reservoirs at different offset data volumes vary greatly. As the offset increases, the frequency attenuation gradient value caused by fractures increases.

2. The effect of applying the difference between the seismic attenuation properties of far and near offsets to predict the relative density of fracture development is more obvious, and it is better consistent with well data, which is consistent with the geological understanding of fault development in this area.

3. The far and near offset seismic attribute difference method provides important technical support for the prediction of fractures in narrow azimuth seismic data, and is of great significance for the exploration and development of carbonate fracture-cave reservoirs.

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