Application of 3D seismic data fine processing technology in District 31, Qinan coal mine

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Abstract: In order to further find out the geological condition of District 31, Qinan coal mine, according to the characteristics of mining area data and geological tasks, the techniques of pre-stack noise, deconvolution and prestack time migration were applied, and the 3d seismic original data collected before the mining area were processed again. The results of two fault interpretations: 152 faults were basically the same, 6 faults were revised, 60 faults were newly discovered, and 6 faults were negated; According to the classification and statistical comparison of fault reliability, there were 115 reliable faults in the first interpretation and 195 in the second interpretation, which increased by 80. The results show that the signal to noise ratio and resolution of 3D seismic data were improved, the breakpoint is clearer and the fault interpretation is more reasonable and reliable. Fine processing can improve the utilization rate of the original data of 3D seismic exploration, save the acquisition cost, improve the economic benefit, and provide reliable basic data for the development and utilization of coal resources.

1. Introduction
The Qinan jingtian in Huaibei mining group is located in the southwest of the Su-nan syncline. It is an arc monocline structure with a trend of approximately north-south to east-west, and a tendency of east-north protruding to the southwest. The dip angle of the mine interior is slightly steeper in the north, generally 20º~30º. The central and eastern parts are relatively slow, generally 7º~15º, and the structure is relatively developed. Since 1956, the mining area to find coal as the target, find coal, census, detailed investigation, fine investigation four stages of geological work. From 2002 to 2006, three dimensional seismic exploration was carried out in some mining areas and good geological results were obtained. In recent years, following the safe and efficient mining, the precision of geological exploration task in the mining area is getting higher and higher. Therefore, the secondary fine processing and interpretation work was carried out in some mining areas and good geological results were obtained. In the coal field[1-2], Migration imaging technique is one of the three techniques of seismic data processing and the core of seismic data processing. With the rapid development of computer, the research of migration theory can be put into practice in real time[3-6]. Since 2010, migration techniques and prestack migration have been necessary in data processing in the coal field[2]. The first three-dimensional seismic data of District 31 in jingtian were studied. Firstly, the original seismic data of the mining area are analyzed, and the fine processing process is determined according to the characteristics of the data and the new geological task. The new technique is applied to the key techniques of deconvolution and pre-stack noise and migration imaging. The successful application of the secondary fine processing technology can provide a technical reference for other mining areas in the well field.
2. Geological generalization
The District 31 is located in the east of jingtian, and the stratum is a monocline structure. The strike of the stratum is close to NW, inclined to NE, and the dip Angle is 6°~18°, with an average of 13°. The strata developed from bottom to top into carboniferous taiyuan formation(C3), Permian(P), Tertiary(R), Quaternary(Q). The 3d seismic interpretation zone contains 8 layers of minable coal seams, which are 32, 61, 62, 63, 71, 72, 9 and 10 coal seams from top to bottom. The main coal seams in the region are 32 and 72. 32 coal seam survey area can be mined, the coal thickness 0.6-3.8 m, generally 2.1-2.7 m; The 72 coal seam survey area can be mined, the coal thickness is 0.8 - 4.4m, generally 2.4-2.7 m, mainly in the middle thickness coal seam. Among them, the number of boreholes controlled to no. 10 coal seam in the survey area is small and the degree of borehole control is insufficient. The drilling data shows that the thickness of no. 10 coal seam is 1.3-2.9 m, generally 2.1-2.5 m.

3. Key technologies for fine processing of 3D seismic data
The 3D seismic data collected in this process was completed in 2007. The field construction parameters were: the well depth was 10-12 m, the dose was 2.0 kg, and the observation system adopted 8 lines and 8 guns with 48 intermediate excitation, covering 24 times, sampling rate was 1.0 ms, line spacing was 40 m, and channel spacing was 10 m. The data, based on the original track from the original 3d seismic data processing, and analyzing the characteristics of the data, the charge in order to protect image processing for the principle, high signal-to-noise ratio, high resolution and high precision processing, and many experiments, determined the processing flow, key processing steps in applying new technology, new methods for secondary fine processing.

3.1. Fine definition of spatial attributes
The definition of spatial attribute is the basis of indoor processing, the first step, and the premise to ensure the correctness of subsequent interpretation. When defining, it is necessary to compare the distribution map of the gun and the actual material map to verify whether the positions of detection points and gun points correspond to each other. After the definition, check the chart of coverage times. If the coverage times are abnormal, check the shift report carefully to find the reason and avoid definition errors. Finally, the first arrival of the pickup is used to check the position of the gun detection point. If the alignment is correct, the first arrival wave of the pickup will be corrected to a straight line after linear nmo correction to exclude the errors of the shift reporting. After several position corrections, the spatial attribute is defined. Then complete all the pretreatment work, do static correction processing.

3.2. Stack forward noise technology
Seismic records in the exploration area have good features, high signal-to-noise ratio and high resolution, and the reflection in phase axis of main coal seams in the area has prominent features, strong energy and good continuity. (1) most of the terrain in the exploration area is relatively flat, and the height difference is generally within 2m. Hui river in northeast from northwest to southeast through the exploration area, 206 national road and Xie Hui xinhe across the district, village populated exploration area, canals, detector and shot point in these places cannot normal arrangement, need to change observation system, to collect the raw data of low signal noise ratio(SNR). (2) due to the complexity of the surface conditions, the shallow excitation layer is unstable, resulting in some single gun surface wave interference, the resolution of the target layer decreased. These low SNR data processing are the difficulties in this region.

The analysis of the typical single gun noise shows that the surface wave is the main interference wave and is relatively developed. The surface wave has the characteristics of strong amplitude and low apparent velocity, and the frequency and reflected wave overlap at the low frequency end. It follows the three “highs” processing principle. After comparison by various methods, after the amplitude recovery processing with relative amplitude preservation, the three-dimensional vertebral filtering method is used to suppress the opposite wave(figure 1). The method is based on the transformation principle of shot-point line and detection point line observation system, and a conical filter is designed in the three-dimensional frequency-space(FKK) domain to suppress surface waves effectively. As can be seen from
figure 1, the surface wave is effectively suppressed, and the energy of the near-path reflection in-phase axis of the coal seam within 700 ms is enhanced and clearly visible, so that the reflection in-phase axis of the coal seam remains intact and the resolution of the single gun is improved.

3.3. Surface-consistent deconvolution
Deconvolution is one of the three processing techniques. There are many commonly used deconvolution methods, such as pulse single path deconvolution, pulse multi path deconvolution, predictive deconvolution, adaptive deconvolution, surface consistent deconvolution, etc. After a large number of tests and comparisons, surface consistency prediction deconvolution was selected. This method is based on the idea that seismic wavelet can be decomposed into multiple components such as common shot, common receiving point, common offset, common reflection point, etc. It can not only compress seismic wavelet, but also further eliminate the influence of changes in surface conditions on the amplitude and phase characteristics of seismic wave, and suppress multiple waves. Since deconvolution will reduce the signal to noise ratio while improving the resolution, the resolution can be improved while ensuring the signal to noise ratio. After comparative analysis, the final selected processing parameters are: prediction step length =10 ms, operator length =150 m (figure 2). As can be seen from figure 2, after surface consistency prediction deconvolution (figure 2b), the main frequency band moves to the direction of high frequency, and the wave group features are more obvious. The frequency band is widened, the seismic wavelet is compressed, and the longitudinal resolution of seismic data is improved.
3.4. Prestack time migration technique

The prestack time migration method eliminates the assumption that the input data is zero offset, avoids the distortion caused by the NMO correction stack, and obtains a better result than the poststack time migration. In order to describe the fault features of the region more accurately and improve the resolution of the data, the kirchhoff diffraction integral method was used to deal with the pre-stack time migration technique. In the process, the correctness of the migration velocity field is judged by the comprehensive inspection of the common reflection point trace set, migration section and root mean square velocity field of the target line. In this paper, the velocity field of root mean square(RMS) was optimized through the method of iteration of prestack time migration and velocity analysis by adopting the method of picking up velocity errors in the lateral upper layer and the longitudinal layer, and the iterative processing of three times of prestack migration and velocity analysis was carried out in this process. Finally, all the CRP trace sets were leveled to ensure the quality of migration results. figure 3 shows the pre-stack time migration profile of the mining area. It can be seen from figure 3 that the profile resolution is high, the wave group characteristics of each coal seam are obvious, the in-phase axis continuity is good, and the stratification is clear. The breakpoint is clear, the sectional features are carefully delineated and the fault interpretation is reliable.

4. Comparison between the two treatments and the fault interpretation

4.1. Two treatment effects

The newly processed data body takes amplitude preserving and fidelity as the core to ensure the relative relation of amplitude energy on the seismic section, so that the change of coal seam structure has a good correspondence with the seismic emission wave(figure 4). The new data protects the low frequencies, broadens the effective frequency band, and improves the main frequency and energy intensity. In terms of the response of the lower coal group, the new data body is much better than the old data. Compared with the original 3d seismic exploration data, the newly processed 3D seismic exploration time profile has a smoother reflection wave, better continuity and clearer hierarchy, and the signal-to-noise ratio is improved compared with the original profile.
4.2. Fault interpretation
The structure in the mining area is simple with 2 tectonic folds. There are 13 faults with a drop of 8-30 m. The first 3D seismic treatment and interpretation results: a total of 172 faults were interpreted, 5 original faults were revised, 167 faults were found, and 34 isolated breakpoints were explained. Classification by fault reliability: 115 faults were reliable, 57 were more reliable.

After the second fine processing, 218 combined faults were interpreted. The fault of this interpretation is rated according to the standard rating of the “code for coal coal-bed methane seismic exploration”, fault is made on the breakpoint on the 40 m×80 m grid profile of the data body: reliable fault, relatively reliable fault, and poorly controlled fault. The grading statistical results are shown in Table 1. The interpretation results of this fault were compared with the interpretation results of the first treatment: 152 faults were basically the same, 6 faults were revised, 60 faults were newly discovered, and 6 faults were negated.

| Interpretation  | Reliable | Relatively Reliable | Not Rated |
|----------------|----------|---------------------|-----------|
| the 2nd (strip) | 195      | 9                   | 14        |
| the 1st (strip) | 115      | 17                  | 0         |

4.3. Effect analysis
The optimized processing of pre-stack seismic data can effectively eliminate the interference of surface wave and provide a good data basis for subsequent migration imaging. Further application of surface consistency prediction deconvolution technique improves the main frequency of seismic data, expands the frequency band width of seismic data, and improves the longitudinal resolution of seismic data. During velocity analysis, the spatial distribution of velocity points is encrypted, and a relatively reliable migration velocity body is established, which guarantees the processing effect of prestack migration. By optimizing the processing parameters and flow, the characteristics of small structures are more obvious on the profile, and the identification accuracy of small structures is improved.

5. Conclusion
Key technologies such as pre-stack noise, surface consistent deconvolution, and prestack time migration were used to carry out secondary fine processing in Qinan coal mine District 31. Compared with the first treatment, the low frequency was protected, the effective frequency band was widened, and the main frequency was improved. The resolution was effectively improved. The breakpoint on the section is clear, the section details are well delineated, the interpretation accuracy is improved, and the new geological task is satisfied. There are many reasons for the improvement of the results of secondary fine processing. First, the secondary treatment is based on the first treatment. Thirdly, the treatment technology is developing continuously, and the effect improvement is inevitable. There is also an increase in verification data with mining. In a word, under the premise of good quality of 3d seismic data acquisition, secondary fine processing and secondary interpretation are carried out with ideal effect, which provides a means for geological guarantee technology of green, efficient and safe production in coal mine.

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