

Discussion on Marine Seismic Noise

Mu Shusheng¹, Lu Jun², He Bo², Ye Qing³

¹(CNPC Orient Corp Acquisition Technology Support Department, Zhuozhou 072750, P.R.China)

²(Earth Science of Northeast Petroleum University, Daqing 163318, P.R.China)

³(The Great Wall Drilling Logging Company Engineering Company Limited, Panjin 124000, P.R.China)

Abstract

With the world economy and the continuous improvement of science and technology, the demand for oil is facing increasingly serious situation grow with each passing day, the energy in the world and petroleum exploration are facing more and more challenges. With the gradual shrinking of seismic exploration market onshore, offshore exploration has become the main market of seismic exploration. In recent years, the discovery of oil and more than half of the natural gas from Yu Haiyang, especially in the deep sea. The deep-water oil and gas exploration has become the global exploration of oil and gas resources in the most important areas. Many cable seismic exploration has great exploration depth, the exploration of high efficiency and many advantages of higher signal-to-noise ratio data, especially in deepwater seismic exploration plays the most important role the marine environment is complex and changeable. The cable seismic data noise characteristics, starting from the multi cable seismic acquisition mode, in-depth study of the noise characteristics and noise suppression in the future Deepwater oil and gas exploration has a very far-reaching significance. In the offshore seismic exploration, how to accurately identify and effectively suppress multiple wave is a difficult problem facing long-term field of seismic exploration. The sea cable data multiples of serious, effective wave energy greatly reduces the interference, the resolution of data collection, analysis speed to follow-up, migration and geological interpretation has brought great difficulties. Based on the multiple wave of sea cable in seismic data, respectively, using anisotropic Radon transform and SRME technology to suppress multiple waves, the anisotropy of the Radon transform on the big shift from deep water multiple removal effect, SRME method of near offset multiples energy suppression effect is good. The advantages in the final synthesis of the two approaches proposed in this paper, using Radon transform and anisotropic SRME combined with the suppression of multiple waves of the ocean, the treatment effect is significant, greatly improved the signal to noise ratio of the data acquisition.

Keywords - Marine seismic exploration, Noise processing, Noise characteristics

I. MAJOR SOURCES OF NOISE IN THE SEA EARTHQUAKE

Although the sea surface seismic geological condition is better than the land, the marine seismic data is relatively high, but the noise is still relatively strong, the noise source is also very complex, mainly by the following

A. Water Wave Interference

Surface wave interference is similar to the land, is produced by the source, interference wave propagating along the surface, and surface wave is different the different frequency components; surface wave is a low frequency interference wave propagation along the surface, the speed is relatively low, generally with the combination of detection, with low cut filter that can suppress the waves. The interference of the sea, the speed and the direct wave is similar to or slightly lower than the direct wave; because of the sea within the group of geophone distance is smaller (usually 0.8m), combined detection can completely eliminate the wave interference; the frequency characteristics and seismic reflection wave method almost, filtering can eliminate the wave interference. The interference wave. At the beginning of excision can remove a part, the rest of the way to rely on elimination of coherent interference is removed.

B. Submarine Obstacles

Submarine obstacles are many, such as sunken ships, offshore platforms, abandoned or retention of subsea wellhead are new diffraction source, and marine seismic noise source. This interference wave only propagates in the water, and water of seismic wave energy attenuation is very small, therefore submarine obstacle of interference wave energy is strong, wide band; in the frequency domain performance for broadband; in spatial domain for wave diffraction.

C. The Noise Of Waterfowl

Under normal circumstances is no noise of waterfowl, but birds often hang on foreign bodies such as fishing nets and other, the formation of strong noise. Another is balanced cable is not good, rely on to keep the cable in a certain depth the role of waterbirds, such birds wing, water shock of the bird wing to waterfowl and connected to the cable to produce vibration and noise. About the noise, the experience of seismic acquisition supervision will discover, and according to

the technical specifications and requirements waterfowl wing angle is less than or equal to 3. Waterfowl noise in frequency domain is mainly distributed in the low frequency band, such as aquatic birds hanging a foreign body, strong low frequency disturbance.

D. Mechanical Disturbance

Mainly seismic ship hull and propeller, the noise generated by the standard cable tail is linear coherent noises and low-frequency noise. Under normal circumstances, the seismic vessel is through carefully designed, seismic trace from the hull also has a certain distance, so that the noise is weak.

E. Submarine Sounding

The submarine multiples, also known as reverberation. Seismic waves in the sea water and the two strong reflection interface between spread back and forth, in the seismic trace formed continuous motion, a marine seismic strongest interference wave. Reverberation is offshore earthquake is the most important, the most common is impact on the quality of seismic data the most serious interference wave, often make deep reflection completely submerged in reverberation among. Reverberation are mainly distributed in the shortcut, when the submarine is solid, Naruto shock will be very strong; the frequency characteristics is broadband, and the spectrum of seismic reflection wave is almost consistent.

F. Environmental Noise

Offshore wind flow, Chung, wave caused by the noise, the noise in both time and space is not the law is random noise, in the frequency domain is a white noise, infinite bandwidth. White noise is generally easier to remove.

II. CHARACTERISTICS OF THE SEA NOISE

Under normal circumstances, the seismic noise noise rules (often equated to the coherent noise and random noise (often equivalent to random noise). In marine seismic exploration, noise rules are multiples, machine noise, and the diffracted wave, master rules of noise if environmental noise. Sea noise main features:

(1) Marine seismic data, the interference rule often energy relatively strong, regular interference are also a lot of. Random disturbance is mainly wind, waves, Chung, random interference is relatively regular interference is weak, wind, wave, Chung, random disturbance influence to seismic towrope sinking depth. As long as meet the flow of the sea not and seismic towed cable vertical, current is not too strong, random noise influence on the cable will be very small. Regular interference in easy to eliminate, random noise is relatively small, so in marine seismic data signal-to-noise relative land data is generally higher than.

(2) Reverberation is marine seismic exploration in the seawater layer repeatedly reflected the total effect, also called ringing. Sometimes refers

specifically to the shallow layer in the successive arrival of multiple wave mix with each other together to form a stable sinusoidal oscillation, and does not include separate adjacent multiples of the lithology of the submarine on the energy intensity have great influence.

(3) The random noise is full frequency band, and the distribution of the regular interference and the effective wave in the frequency region is basically the same.

III. MANIFESTATION AND SUPPRESSION OF INTERFERENCE NOISE

According to the characteristics of noise interference, the interference noise of coherent noise and random noise; and according to the form, it a new name, and one by one division. Sea noise generally have the following: reflection side, swell noise, air gun self-excited or repeatedly impulse, interference from neighboring team, cable hanging net (debris) noise, platform pile driving noise, merchant ship noise, balanced cable noise and reverberation, in deep high-frequency interference, low frequency surface wave interference.

A. Surge Noise

Generally speaking, windy weather or tide will have a certain impact on the sea, then, for offshore seismic data acquisition, avoid interference will not be current, the current of cable extrusion, lifting, bending impact, the vast majority of geophone record, thereby forming a surge noise characteristic, whether or towing submarine cable this kind of work, the interference is very obvious. This kind of noise in seismic records is generally longer cycle, low frequency, the background noise is particularly evident in the later processing, indoor is difficult to deal with, to lose part of the low frequency components of effective wave. In general, in shallow water, with the wind stopped current, the impact decreases gradually, will soon disappear surge noise; the wind and waves in deep waters, after, there will be a longer duration of time has, still on the seismic data greatly Interference and influence

B. Linear Noise Suppression

Surface waves are common, affecting the prestack record quality interference. A surface wave along a wave elastic medium near the interface of communication, it is also a regular interference on land prestack seismic records with strong energy, it is distributed in prestack record in near offset on the road, a fan or broom shaped distribution, has a strong energy, low frequency, low frequency as the speed, usually a few hertz --30 Hz, speed of 100 m / s --1000 M / s. due to the dielectric dispersion and absorption attenuation, surface wave energy will decay rapidly with increasing depth and distance but at the same time, the frequency changes from high to low, the formation of "broom", namely the occurrence frequency dispersion. The

presence of surface waves, would seriously reduce the signal-to-noise ratio of data quality affects the data stack processing, especially the processing of pre stack data, such as pre stack velocity analysis and static correction. Offset, causing great difficulties, seriously affect the treatment effect. Therefore must be in prestack records across the waves to eliminate. Surface wave mostly distributed in the corners of the regular triangle region.

C. High Frequency Noise Attenuation

According to the basic characteristics of seismic data of high frequency noise can be divided into two categories: environment of high frequency noise and high frequency noise burst. High frequency noise characteristics is: the band is wider, the relative concentration of energy at a high frequency, but the total energy with respect to earthquake wave is higher; high frequency burst noise characteristics are: the frequency range is relatively narrow, energy is relatively strong and relatively concentrated in the high-frequency part, on the record have obvious time continuation, in space and time showed random distribution.

According to the seismic wave propagation theory, without considering the noise, seismic records can be viewed as the seismic wavelet and reflection coefficient of the convolution result. If the reflection coefficient for white noise, it is considered that the outer envelope of seismic wavelet amplitude spectrum for seismic amplitude spectrum envelope, the frequency of seismic wavelet is shown at the earthquake records. Because the formation is a non perfect elastic body, the formation has absorption function of seismic wavelet, the absorption is proportional to the frequency relations (attenuation and the spherical diffusion induced energy attenuation, thus changing the different) spectrum of seismic wavelet in the seismic record is as follows: with the increase of time, the frequency shifts to the lower frequency. The high frequency noise from the detector near the source and propagation distance and effective wave energy and frequency, nor with the record. Between increases and decreases. High frequency noise generally at a local scale (in single channel on the performance as the direction of time, in the multi performance for the spatial direction) memory, the frequency range of the energy attenuation characteristics and effective wave compared to have some differences. This difference between the high frequency noise and effective seismic reflection wave will make seismic records of high frequency signal to noise ratio of shallow layer was higher than in the deeper. Therefore, it can be in the time domain, frequency domain and space domain from the point of view of the statistics on the of recognition or distinction.

D. Multiple Wave

Suppressing and eliminating multiple wave methods can be classified into two categories: one is based on the difference between the effective wave and multiple wave filtering method. Based on the wave equation of prediction and subtraction, completely from the wave equation of, do not rely on any assumptions, without known underground geological structure and lithology. By using the wave equation simulation wave field or inversion of seismic data to predict multiple waves, and then subtracting it from the original seismic data, the specific application of a predictive deconvolution method, Tau-p domain deconvolution method and data driven SRME technology, Radon transform suppress multiples technology.

E. High Energy Interference

In low signal to noise than area, due to the influence of environment, construction and acceptance, in the original records exist large number of such sharp pulse, square wave, wild value some strong energy interference, which severely restricts the quality of stack and migration. Conventional negative way is tick waste road. Energetic interference frequency suppression technique is according to the multi-channel statistics, single to noise, automatic identification of seismic records in the presence of strong interference energy in different frequency band and to determine the space position of the noise, according to the defined threshold value and the attenuation coefficient, used when changing, empty be suppressed.

IV. CONCLUSION

Based on the analysis of various sources of interference caused by noise based on the seismic data acquisition, further lists and comprehensive analysis of the characteristics and identification methods of the seismic data of the most common kinds of noises. Of course, the original data acquisition process in the sea, certainly more than these, because the field and complex situation, especially some random noise, the myriads of changes but these are listed in this paper. The basic types of interference, on behalf of the sea common. Through the list and make a comprehensive analysis, the main purpose is to make the seismic data of the front-line staff can quickly identify all kinds of interference, and strive to achieve good recovery, mining, mining field data, a good data base under earthquake an exploration and development for the future. At the same time, through the analysis, provide some basis for the denoising of seismic data processing, mining noise better Suppress means, so as to achieve a better noise suppression effect.

REFERENCES

Journal Papers:

- [1] Zhao Xin. Application of prestack noise in seismic data processing, China University of Geosciences (Beijing), 2008, 5.

- [2] Chen Yedou. Processing of shallow multi channel high resolution seismic data in the Yellow Sea, Ocean University of China, 2011, 5
- [3] Liang Quanyou. Research and application of seismic data denoising method for multi cable in the sea, Jilin University, 2014, 5

Books:

- [4] Wang Runqiu. Basic course of application software for earth exploration, Petroleum Industry Press, 2013.