NOISE ANALYSIS IN SEISMIC DATA ACQUISITION

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INTRODUCTION

In seismic reflection method, which is by far the most widely used geophysical technique, the structure of sub-surface formations is mapped by measuring the times required for a seismic wave (pulse), generated in the earth by a near-surface explosion of dynamites, mechanical impact, or vibration to return to the surface after reflection from interfaces between formations having different physical properties. The reflections are recorded by detecting instruments responsive to ground motion. Much of the undesired ground motion is associated with the shot and might result from waves that have traveled along the earth's surface or that have been scattered or diffracted by surface or sub-surface irregularities.

A major impetus for the development of new energy sources and new field techniques in reflection recording has been the necessity for eliminating or suppressing spurious seismic signals from ground motion not associated with reflections. Such signals are generally referred to as noise[1]. It is the extraneous or irrelevant part of signals and may be inherent in the instrument. It may result from magnetic storms and other transient disturbance fields in the earth and the atmosphere. It may be related to geologic or topographic features in the terrain.

Noise conceals useful information and has always been the most troublesome problem in seismic prospecting. In some areas it still poses more of a challenge than can be met at the present state of the art.

TYPES OF NOISE

The principal types of noise associated with land shooting are surface and near-surface waves (coherent noise), scattered or incoherent noise, and multiple reflections[1,3].

Moreover, the exploration seismologist cannot discriminate against ambient noise such as man-made noise, traffic noise, industrial machines, tractors' noise, farmers' noise and of course workers' noise[1]. All these need to be taken into consideration in order to enhance desired reflections.

LAYOUT DESIGN

This is aimed at eliminating unwanted signals or noise of both the random and coherent types. Since noise cannot adequately be treated by data processing, it must therefore be measured and compensated for during data acquisition. This is achieved by proper arrangement of geophones and shot points[2]. The geophones are simple tranducers, which convert sound signals to electrical analogue and are principally ground velocity sensitive.

Various methods are employed in the field layouts. They include split-dip and common-depth point shooting, spread types and the array techniques.

The rules for array design[3] are often to

i) Determine the maximum size which can be permitted without discriminating against events with the maximum anticipated dip, and

ii) Distribute as many geophones as field economy will permit more-or-less uniformly over an area a little less than the maximum size permitted, maintaining all geophone plants and elevations as nearly constant as possible even if this requires severe distortion of the layout.

PROCEDURES FOR SUPPRESSING THE NOISE

Here, emphasis is laid on various methods of suppressing different types of seismic noise; such as surface and near-surface waves (coherent noise) scattered or incoherent noise, multiple reflections and ambient noise.

a. Suppressing the surface and near-surface waves (coherent noise)

Because the frequencies of the waves are much lower than those for reflections, low-cut filter could be introduced into the amplifier circuits to eliminate interference. Also, groups of series-connected geophones could be laid out over distances corresponding to one or more wavelengths of the ground roll. Such an arrangement would result in suppression of the horizontally traveling ground roll and enhancement of vertically traveling reflections.

b. Suppressing scattered or incoherent noise

Addition of signals containing incoherent noise should result in some cancellation of the noise, and the more signals are added the more complete the cancellation to be expected. The multiplicity factor N is the product of the number of source elements s and the number of receiver units r from which signals are added. The cancellation effect is directly proportional to . To obtain the greatest suppression of incoherent noise one would therefore use as many shots and as many receivers (geophones per trace) as possible.

C. Suppressing noise due to multiple reflections

Elimination of the surface multiples is best accomplished by proper application of common-depth-point shooting. Often there is a distinct frequency change between the primary and multiple reflections because of differences in the materials through which the respective waves travel as well as differences in path lengths. In such cases, it may be possible to discriminate between the two by means of frequency filtering. This helps to remove undesired signals (collectively referred to as noise) from the record, leaving ideally only primary reflections having geological meaning.

d. Suppressing the ambient noise
It is quite obvious that a group of N geophones, spaced apart, provides an improvement of the reflection signal relative to the noise. If the noise is indeed different (uncorrelated) from geophone to geophone, then for the improvement of the signal-to-noise ration.

i. There is no point placing geophone closer than the correlated distance of the dominant type (and dominant frequency) of noise; to do this would waste time and money.
ii. To maximize the signal-to-noise ratio, the number N of geophones should be large.
iii. If the number N is to be large, and the geophones have a minimum useful spacing, it follows that the best arrangement is real.

For the suppression of ambient noise, therefore, the rule for the layout of a group is simple; the bigger, the better.

4. CONCLUSION

It is obvious that noise has always been the most troublesome problem in seismic prospecting and a major impetus for the development of new energy sources and new field techniques has been aimed at its elimination or suppression.

It has been demonstrated in this paper that for the suppression of ambient noise (noise that is there in the absence of the shot) of whatever type, the rule for the layout of a group is simple; the bigger, the better. This implies that to maximize the signal-to-noise ratio, the number N of geophones should be large. Also, the group dimensions must be large and that the best arrangement is real.

It was also shown that for the suppression of surface and near-surface waves (coherent noise) groups of series connected geophones could be laid out over distances corresponding to one or more wavelengths of the noise. Moreover, since the frequencies of waves are usually much lower than those for reflections, low-cut filters can be introduced into the amplifier circuits to eliminate the interference from this source. For suppressing incoherent noise, one would use as many shots and as many receivers (geophone trace) as possible. For noise due to multiple reflections, since there is a distinct frequency change between the primary and multiple reflections, discrimination between the two is possible by means of frequency filtering. Elimination of surface multiples is best accomplished by proper application of common-depth-point shooting.

The conduction done will reduce expenses and time, notwithstanding, the quality of results achieved is still very good.

REFERENCES

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