Double Off-End Configuration in Seismic Reflection Surveys

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ABSTRACT

A method, DOUBLE OFF-END CONFIGURATION, in common depth point (CDP) reflection shooting is presented to achieve maximum possible subsurface fold coverage on land. This method can be used to obtain N-fold subsurface coverage from different ray paths with N-receiver groups.

INTRODUCTION

In 1921 Karcher, Perrine, Hasemar and Kite made the first successful seismic reflection measurements (Robinson, 1971). Since then great changes in the seismic reflection method have taken place in determining subsurface geologic structures. Mayne (1962) described the advantages of the common depth point (CDP) reflection technique over single fold coverage and discussed various possible configuration with regular moveup of spread-shot to achieve subsurface multifold coverage. paper describes and illustrates the configuration of shots and receivers to get maximum possible subsurface fold coverage on land.

PREVIOUS WORK

Single fold coverage

Single fold coverage gives continuous reflection point coverage without duplica-

tion. Raypaths from shot to receiver for reflected arrivals (for a spread of receiver groups and off-end shot configuration with two groups offset) are shown in figure 1. The rays are reflected at the subsurface depth point mid way between shot and receiver. The reflection points for receiver number 1 to 24 (R-1 to R-24) and shot at 26 (SP 26) are at positions between 13.5 and 25 (in between receivers 13 & 14 25 respectively) and under receiver relative to the surface. The coverage for this shot is from depth point 1 to 24 (Fig. 1).

By changing the spread and shot positions, continuous subsurface coverage can be obtained without any gap. The spread from R-13 to R-36 and shot at SP 38 will give continuous subsurface coverage (Fig.2). With this arrangement 24 more depth points have been added in continuation with earlier depth points. In this way continuous subsurface coverage can be obtained along a given profile.

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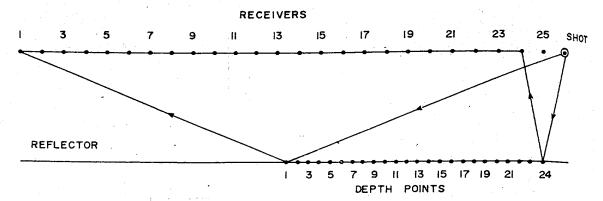


Fig. 1: Ray paths for reflected arrivals.

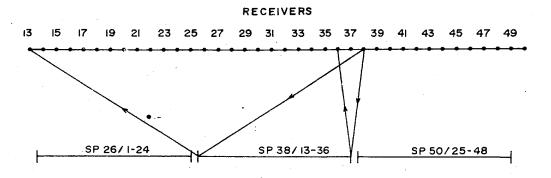


Fig. 2: Continuous subsurface coverage with single fold.

The following are the some of the rules of thumb in deciding subsurface coverage for proper spread and shot configurations:

- i) Moveup of (number of groups
 2) gives continuous subsurface coverage.
- ii) Continous coverage is achieved when shot moveup (12 positions) plus spread moveup (12 positions) equals the number of groups (24). This moveup supplies 24 new depth

points on subsurface.

- iii) For continous subsurface coverage, each receiver position is used for two consecutive shots.
- iv) There is no subsurface coverage below groups R-1 to R-13 for shot SP 26. This needs to be considered in deciding where to start a profile in order to obtain single nold subsurface coverage. It is clear that shot and spread moveum of more than 12 groups will leave.

gaps in the subsurface coverage. Similarly if the moveup is less than 12 groups there will be more than 100 per cent coverage.

Multifold coverage

The concept of multifold coverage is designed to improve the quality of data by cancelling multiple reflections and random noise (Telford et. al, 1976). Based on the concept of subsurface coverage, multifold coverage (6-fold) has been shown in figure 3. The off-end shot and spread moveup is consistently two groups. Mayne (1962) suggested the following equation for CDP multiplicity for any sequence.

groups by which the spread is advanced and S is the number of shot positions for each spread.

In above equation Mayne has not considered about different moveup of spread and shot, which is quite possible in CDP seismic reflection shooting. A modified equation for multiplicity is presented which can be used for different moveup (for example shooting through the spread and recovery shots) of spread and shot positions in seismic shooting.

$$M = NS/(n + s)$$
 2

Where (n + s) is the total moveup i.e.

RECEIVERS

3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51

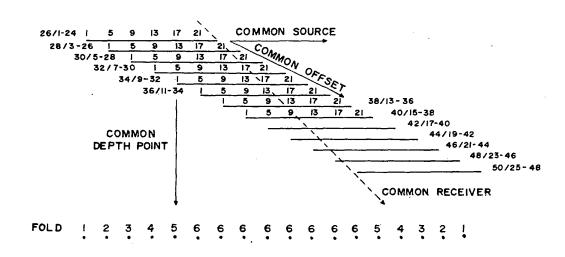


Fig. 3: Multifold subsurface coverage (six fold) for moveup of four groups (two groups moveup for shot and two groups moveup for spread).

M = NS/2n

..... 1

Where M is path multiplicity, N is the total number of receiver groups in the spread, n is the number of receiver

spread moveup plus shot moveup.

The total moveup to be shifted can be determined by choosing the CDP coverage in equation (2).

PRESENT STUDIES

In areas where there are a lot of geophysical problems such as coherent noise, complex subsurface structures etc., the tendency has been to increase the number of fold in order to get the improved picture of subsurface geological structures. In this method, it is possible to get N-fold coverage from N-number of receiver groups with different ray paths. To achieve this the total moveur must be 1 or the individual moveup of shot and spread must be 1/2 group. The half group moveup is obviously not practical on land, but can be achieved in off shore where shot and spread are under continous tow. To achieve maximum fold coverage (ex. 24 fold with 24 receiver group spread on land, different spread-shot configurations (double off-end confugration, shooting through spread and off-end configuration with various offsets) can be suggested. Of these double off-end configuration is the best one to achieve maximum possible fold coverage. Other methods are not exploring all the depth points subsurface with different angles.

Double off-end configuration

The technique Double off-end configuration (Fig.4), consist of 24 receiver spread and two shots (one at forward end and another at backward end of the spread) from both ends of the spread with one group offset. The shots and spread moveups are consistently one group. For a spread of R-1 to R-24 one shot (forward shot) will be at R-25 position and another shot (backward shot) will be at a place which is one group interval before receiver position number 1. For the next position the spread will be at R-2 to R-25 and shots will be at R-26 and R-1 positions, In this way the spread will continue from 2-25 receiver positions to 25-48 receiver positons by one group interval moveup each time. Similarly forward off-end shot will continue from 26 to 49 receiver positions and backward off-end shot will continue from 1 to 24 receiver positions by one group moveup. The multifold coverage is obvious and upto 24 fold coverage can be achieved. The 24 traces that lie in a imaginary vertical line are common to the same point

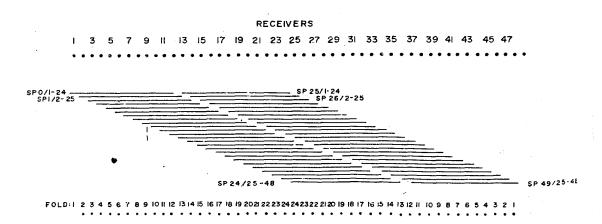


Fig. 4: Maximum possible subsurface fold coverage (double off-end configuration - 24 fold with 24 receiver groups).

on the subsurface can be seen at under 24 and 25 receiver positions. There is a taper-on and taper-off of the fold from 1 to 24 and 24 to 1 at begining (R-1 to R-24) and at end (R-25 to R-48) of shooting. The 24 fold coverage is first provided by the 12th forward off-end shot at SP 36 and 24th backward off-end shot at SP 23. 24 fold coverage will continue until the shooting stops and the taper-off commences.

In this method, for any number of profiles on a seismic line, for any offset and for any number of channels equipment, the total number of depth points, number of depth points acquiring maximum fold coverage, the first depth point and last depth point with the maximum fold on a subsurface can be found from the following simple algebric equations:

D	=	2(P - O) -1	••••	3
Κ	=	S - 2N + 1.	•••••	4
S	=	2(P - N -1)	•••••	5
Α	=	2N	•••••	6
3	Ξ	D - 2N + 1	•••••	7

Where: D is the total number or depth points on subsurface, P is the total number of pickets on a seismic line, O is the offset in terms of group interval. K is the number of depth points explored with maximum fold coverage, S is the total number of shots to be blasted on a seismic line, N is the total number of receiver groups in a spread, A is the first depth point on a subsurface with maximum fold coverage and B is the last depth point on a subsurface with maximum fold coverage.

DISCUSSION AND CONCLUSION

The method presented in this paper is based on common depth point seismic

reflection technique. Based on this technique Mayne (1962) had given a multiplicity equation to find subsurface fold coverage for any sequence of equal moveup of spread and shot. This equation does not hold good for the different moveup (ex: shooting through the spread and a series of recovery shots) of spread and shot to find fold coverage. The modified equation (2) is given in the text for equal moveup as well as for different moveup of spread and shot to determine the fold coverage.

Common depth point data are often used to compute interval as well as average velocity information. It may be desirable to shoot with, as a great degree of multiplicity as is operationally feasible (twenty four fold or more) so as to attain the greatest possible precision in the resultant velocity. To achieve above with 24 channels equipment, authors have shown a method (Double off-end configuration) to get the 24 fold coverage on subsurface. Dobrin (1976) has suggested that to get the 24 fold subsurface coverage on land, it requires 48 recorded receiver positions. However, the results of present study has clearly shown that double off-end configuration could be a potential method for achieving 24 fold coverage on subsurface with 24 number of channels equipment. The simple algebric equations have been given in the text to find out number of depth points, maximum fold coverage, first and last depth points with maximum fold coverage for any arbital parameters (ex: number of channels equipment, number of pickets on a seismic line and offset).

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