

Double Off-End Configuration in Seismic Reflection Surveys

K.S. KRISHNA AND A.K. CHAUBEY

**NATIONAL INSTITUTE OF OCEANOGRAPHY
GOA - 403 004, INDIA**

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. This 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 24 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 and under receiver 25 respectively) 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.

* Manuscript received on 12.5.86: Accepted after revision 3.10.86.

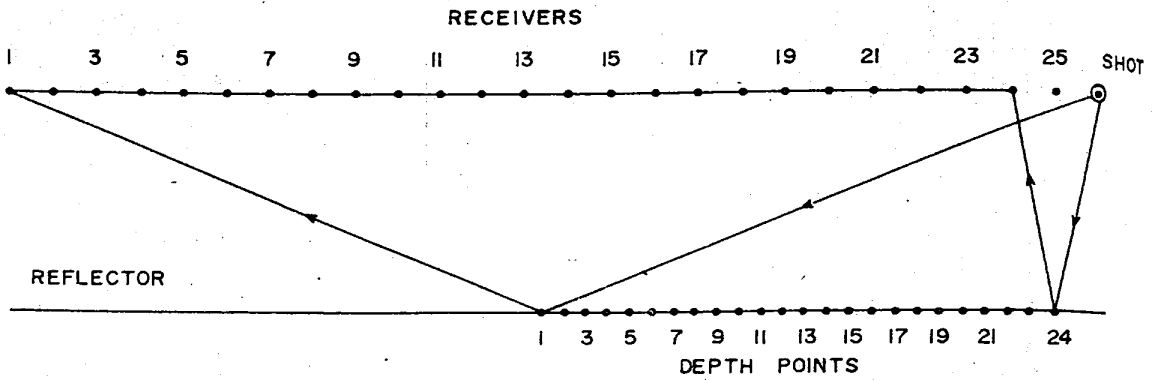


Fig. 1: Ray paths for reflected arrivals.

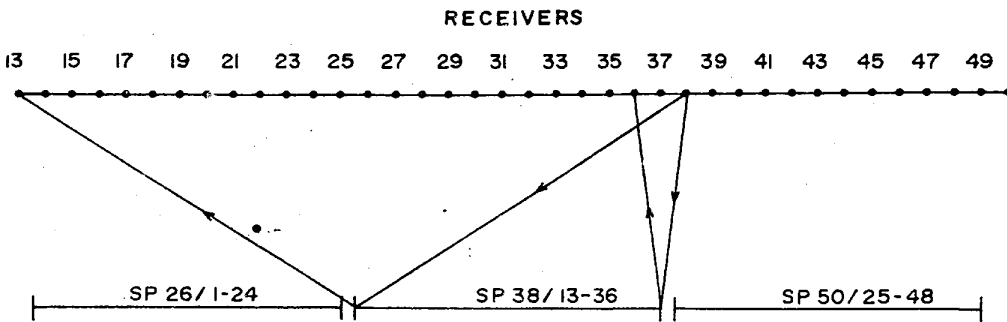


Fig. 2: Continuous subsurface coverage with single fold.

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-fold subsurface coverage. It is clear that shot and spread moveup 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.

$$M = NS/(n + s) \quad \dots 2$$

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

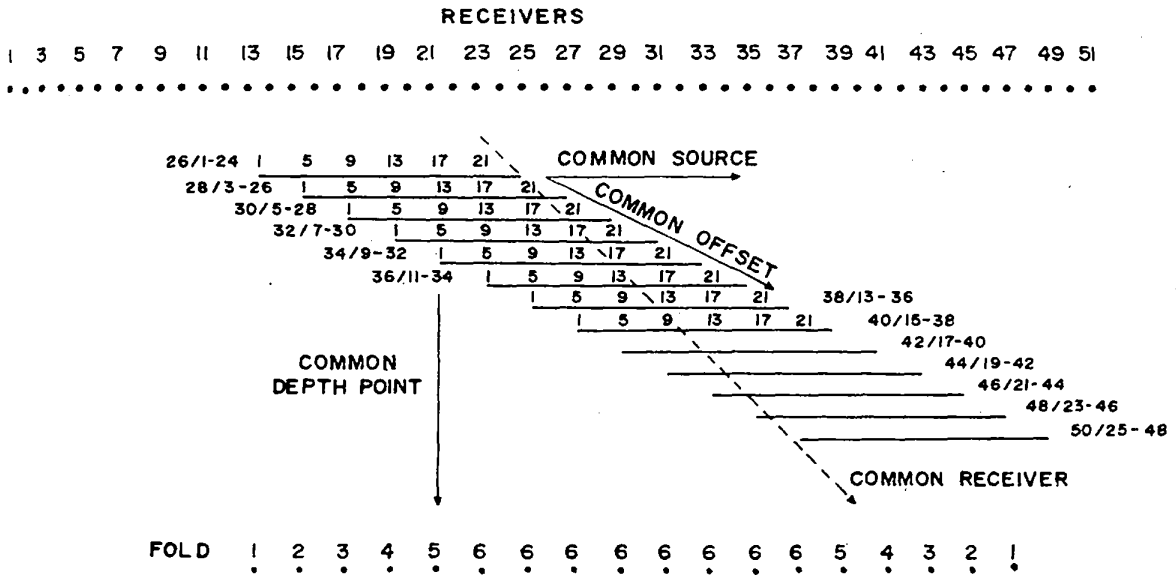


Fig. 3: Multifold subsurface coverage (six fold) for moveup of four groups (two groups moveup for shot and two groups moveup for spread).

$$M = NS/2n \quad \dots 1$$

spread moveup plus shot moveup.

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

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

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 beginning (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 algebraic equations:

$$D = 2(P - O) - 1 \quad \dots 3$$

$$K = S - 2N + 1 \quad \dots 4$$

$$S = 2(P - N - 1) \quad \dots 5$$

$$A = 2N \quad \dots 6$$

$$B = D - 2N + 1 \quad \dots 7$$

Where: D is the total number of 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 algebraic 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 arbitrary parameters (ex: number of channels equipment, number of pickets on a seismic line and offset).

ACKNOWLEDGEMENTS

The authors are thankful to Dr. H.N. Siddiquie, Director, N.I.O., Goa, for constant encouragement and providing facilities. The authors are also thankful to Prof. O. Eldholm, University of Oslo, Norway for his valuable suggestions.

Appreciations are due to Shri G.C. Bhattacharya, Shri M.V. Ramana for critical comments and Dr. O.S. Chauhan for timely help.

REFERENCES

- Dobrin, M.B., 1976: Introduction to geophysical prospecting, Mc Graw-Hill, Inc., Japan, p. 107.
- Mayne, W.H., 1962: Common reflection point horizontal data stacking technique, *Geophys.*, V. 27, pp. 927-938.
- Robinson, W.B., 1971: In society and industry briefs, *Geophys.*, V. 36, No. 3, pp. A-30.
- Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D.A., 1976: Applied Geophysics Cambridge University press, London, p. 295.