7th International Conference & Exposition
on Petroleum Geophysics

"HYDERABAD 2008"

P - 122

# Negotiating Area Having Drilling Difficulty due to Gravel Boulder Beds in Near Surface-An Example from Cambay Basin

***Ramkumar*, R. K. Srivastava, I. M. Mehra, V. Subramanyam, D. K. Sinha, B. K. Pradhan***

*ONGC, Baroda, India Email: basanta76@gmail.com*

## Summary

*Presence of gravel boulder bed in near surface poses problem in manual rotary drilling of shot holes. The desired depth of shot holes are not achieved resulting in suboptimum depth. This causes recording of strong ground roll, with regular charge size. An example of this type from Narmada – Tapti tectonic block of Cambay Basin is presented here, where in order to negotiate the hard formation zone, distributed charges of a number of detonators as well as small quantity of explosive in shallow multiple holes were blasted simultaneously and the study gave encouraging results. Multiple shallow holes with detonator bunch as energy source show appreciable increase in frequency bandwidth though the energy is less. This suggests that use of suitably developed explosive of high detonating speed and enough energy per unit can yield wider frequency bandwidth and higher frequencies. As use of detonator bunches could not be continued in regular practice for practical and safety reasons, the study could not be carried out further. However use of shallow multiple holes (two) with 0.5 Kg charge in each hole helped in imaging sub-surface, where drilling of shot holes up to optimum depths is difficult. This resulted in reduced skip of shots and more consistency of data quality compared to what would have been achieved in normal course. The study shows encouraging results of shallow multiple holes blasted simultaneously, that can be used as considerably good alternative to single deeper holes in similar problematic areas in Cambay Basin or elsewhere.*

## Introduction

The Sisodara – Kosamba area falls in Narmada – Tapti tectonic block of Cambay basin (south-east of Ankleswar oil field). The area has been known for the shot hole drilling difficulty due to gravel boulder bed in near surface for many years, since seismic surveys have been carried out in the area. While acquiring 3D seismic data in the area recently, a SW-NE trending Zone, approx. 2 -2.5 Km wide, having drilling difficulty (through manual rotary method) has been encountered in almost all the swaths. The near surface velocity in this zone, below 2 – 4 m is approx, 1500 m/s. Though this zone is unfriendly with respect to shot hole drilling but energy transmission wise it is friendlier due to high velocity. Drillability in this zone varies from 15m and with the regular charge size of 1.0 Kg; shallow depth of shot holes poses a big problem in terms of increased ground roll. Holes of very shallow depths are not blasted for safety reasons, resulting in skipping of shots.

In pursuit of finding a viable solution to this problem it was pertinent to experiment with reduced and distributed charges in shallow multiple holes. The regular charge size in the area was 1.0 Kg (slurry based emulsion capsules). As charge denominations lower than 0.5 kg were not available, experiments with a bunch of detonators in place of small charge size were conducted.

## Methodology

The experimentation was carried out at four very closely spaced locations, A, B, C, D, all falling in the drilling difficulty zone (Fig.1). Shots were taken with different combinations of depth and charge as shown below.

1. Single hole of 5 m or more depth with explosive charge of 1 kg, 0.5 kg or a bunch of detonators.
2. Multiple (2 or 3 ) holes of ~ 5 m depth with a bunch of detonators(17 or 25) in each hole or 0.5 kg explosive in each hole.

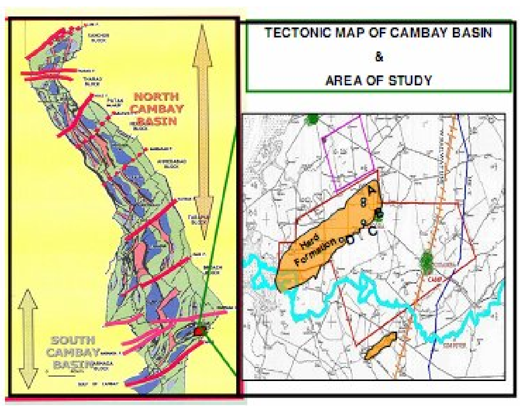


Fig.1 Location of study area showing the drilling difficulty zone

In two hole pattern the two holes are at a distance of 3 m on both sides of the shot picket in in-line direction. In three hole pattern, the third hole is at the shot point with other two holes at 3 m distance on either side in in-line direction (inline linear pattern).

## Results and Analysis

**Single deeper hole vs single shallow hole with explosive and single shallow hole with detonators**

- Single hole of depth more than 7 m results in good quality record having good signal stand outs and frequency band-width (Fig 2-6). Ground roll increases with decrease in shot hole depth.
- Single hole of depth ~ 5m with regular charge size of 1 kg shows increased ground role and less frequency band-width (Fig.2 (b)).
- Single hole of ~5 m depth with 0.5 kg charge shows good frequency band width with weaker signal stand outs below 1.3 sec (Fig.3 (b)).
- Single hole with detonators shows wider frequency band-width (Fig. 3 (c)) with good signal stand out upto 1.3 sec though over all energy is less as compared to an explosive shot record.

Analysis of these records suggests desirable depth to be more than 7 m to minimize ground roll and charge size to be at least 1.0 kg to have sufficient energy below 1.3 second.

**Single deeper hole vs shallow multiple holes with detonators and explosives**

- Multiple holes with detonators (two holes with 25 detonators in each hole as well as three holes with 17 detonators in each hole) show considerably wider frequency band-width and higher frequencies (Fig. 2, 4 and 5) with good signal stand outs upto
- 1.3 sec though overall energy is less as compared to explosive records.
- Record of two hole pattern with 25 detonators in each hole is comparable with that of three hole pattern with 17 detonators in each hole (Fig. 4 (b & c).
- Record of two hole pattern with 0.5 kg charge in each hole (Fig.6 (b)) shows better band-width than that of a single hole of more depth with 1 kg charge(Fig.6 (a)), but signal stand outs below 1.3 sec are weaker than the single hole (deeper depth). Record of three hole pattern with 0.5 kg in each hole shows narrower frequency band-width than that of two hole pattern with 0.5 kg in each hole as well as that of a single hole of 12 m depth. Three hole record shows better signal stand outs in deeper section below 1.3 sec as compared to two hole record but still not as good as that of single hole of 12 m.
- The velocity of shooting medium in all these cases is ~ 1500 m/sec for depths up to 12 m. Velocity of shooting medium in case of single hole of 21.8 m is ~ 1700 m/sec (Fig. 7).

Two shallow holes with 0.5 kg charge in each hole, blasted simultaneously (equivalent to regular charge of 1.0 kg) result in a better combination of frequency band width and energy below 1.3 second

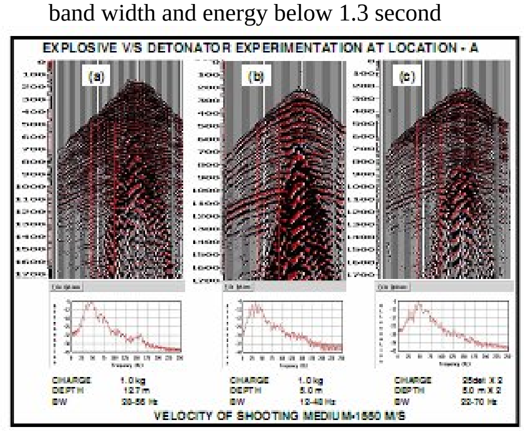


Fig. 2 Raw records of experimentation at location A

The results shown by detonator records are encouraging. These raw records show considerable increase in frequency band width by more than 10 Hz (Fig 2-5). The signal standouts in the primary time window of interest (300 – 1000 ms) are very good but the same are weak in the zone below due to less energy. The increase in spectral band-width appears to be having bearing with the type of explosive. This may need further studies to comment on this aspect. For safety and security reasons, using large quantities of detonators in normal production work is impractical.

Shots taken with two holes of ~5m with 0.5 Kg explosive in each hole, blasted simultaneously also have shown improvement upon the usual shallow single hole with 1.0 Kg explosive ( which was regular charge size ) and finally the area having drilling difficulty was negotiated with two hole pattern with 0.5 Kg charge in each hole, blasted simultaneously. The brute stacks of two nearby swaths (Fig.8) show examples of swaths where usual charge size in shallow holes with some shot skips due to very shallow depths (Fig. 8 A) and another with uniformly used shallow (~5m) pattern holes (two holes linear in-line pattern) with 0.5 kg explosive charge in each hole (Fig. 8 B). With distributed charges shots were also taken in very shallow depths of 2 -3 m thus minimizing shot skips. The brute stack with multiple holes in the drilling difficulty zone (Fig. 8 B) has brought out better continuity and consistency in the data quality.

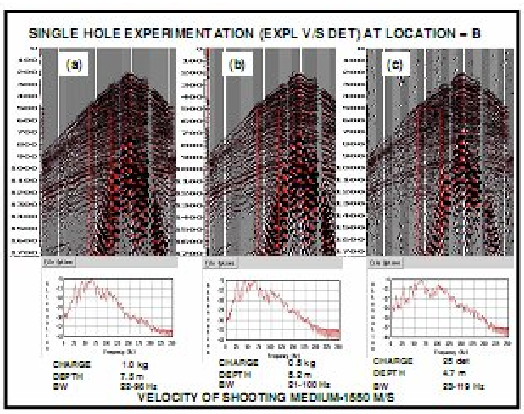


Fig. 3 Raw records of experimentation at location B

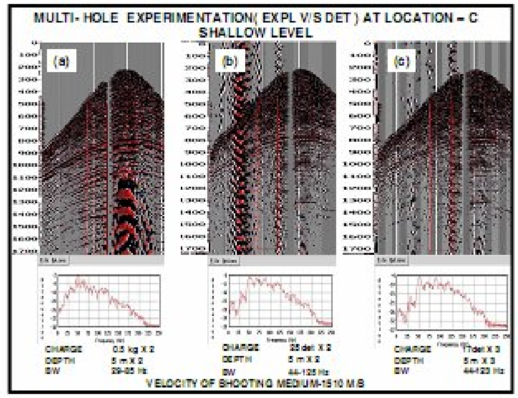


Fig. 4 Raw records of experimentation in shallow level at location C

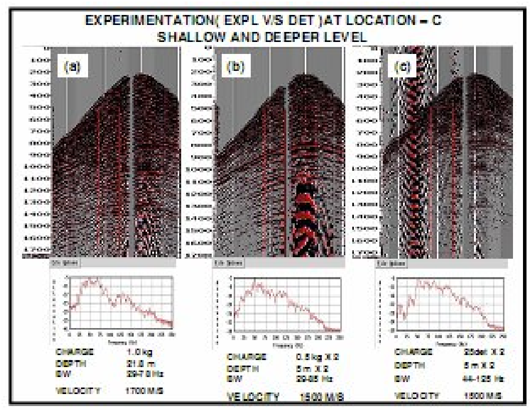


Fig. 5 Raw records of experimentation in shallow Level & deeper level at location C

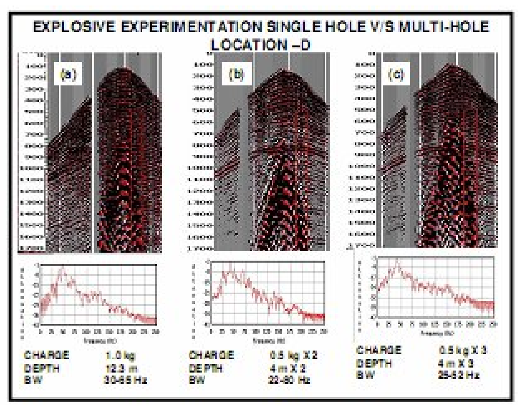


Fig. 6 Raw records of experimentation in shallow level at location D

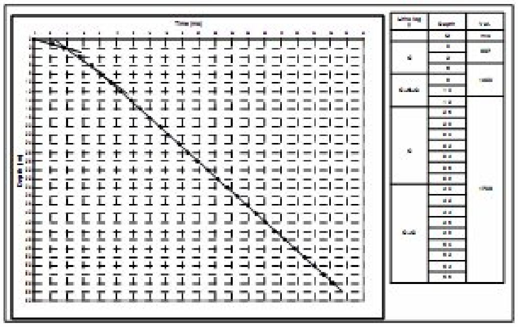

Fig. 7 A typical uphole plot showing near surface velocity variation

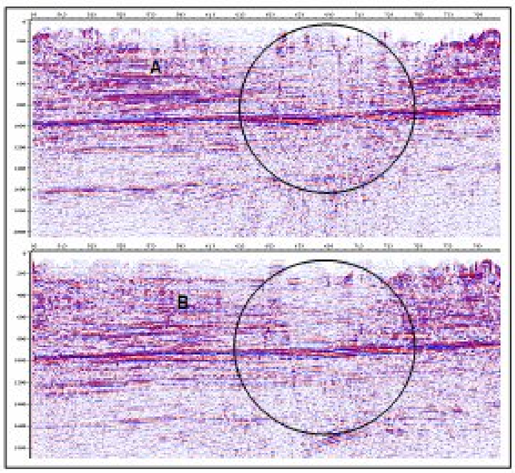


Fig. 8 Brute stacks of two adjacent swaths covering the zone of drilling difficulty with (A) regular charge in single holes of varying depths, (B) distributed charge in shallow pattern holes. The circles show the zone of drilling difficulty.

## Conclusion

The detonator records show considerably wider frequency band-width as well as good signal stand outs in the section upto 1.3 sec. Energy appears to be diminishing in the deeper section though overall energy is very low as compared to explosive records. Results obtained here in the experiment indicate correlatability between frequency band-width and amplitudes with the type of explosive. Probably a suitably designed and developed explosive with higher detonation speed and considerable energy may help acquire seismic data with wider frequency band-width and higher frequencies. It needs further studies to come to a clear conclusion on this aspect.

Shots in single holes of optimum depth, as suggested by the up-hole data, are ideal for acquiring good quality data in the area. However in the zone having drilling difficulty, shallow multiple holes with distributed charges ( total equivalent to regular charge size ) can be adopted as an alternative to get considerably good data which would not be possible otherwise in a normal way. This technique has given considerably good results especially in a case where objective of exploration is quite shallow (within 1.3 sec). Two holes of shallow depth (~5m) with 0.5 kg charge in each hole helped negotiating the drilling difficulty zone with minimizing shot skips and better consistency in data quality. Shallow multiple holes in proper shooting medium, with distributed charge, can be used as an acceptable alternative to single holes of deeper optimum depth in areas having drilling difficulty, in other parts of Cambay Basin or elsewhere.

## Acknowledgements

The authors are thankful to the management of ONGC for providing necessary support and guidance to carry out the study. The support provided by Party personnel of Geophysical Party No. 15, Western Onshore Basin, ONGC, Baroda is thankfully acknowledged. The necessary processing support provided by Sri Harish Chandra, SG(S), of RCC, ONGC, Baroda is duly acknowledged.