3C Acquisition of the Delhi Field 3D, Richland Parish, Louisiana

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Summary

The Delhi 3C 3D, for the Colorado School of Mines' (CSM) Reservoir Characterization Program (RCP), was initially planned to be a full 9C program, utilizing 3C vibroseis source and 3C analog receivers. Budgetary restraints and considerable operational limitations resulted in significant changes of acquisition design, recording system choice, source type and field implementation. These changes achieved the anticipated budgetary goals, but also yielded data quality improvements in several areas.

Introduction

In the Fall of 2009, CSM RCP planned a 3-component program over their Delhi Field, in Richland Parish, Louisiana (Fig. 1). The plan was to utilize P-Wave and S1/S2-Wave vibes and an analog 3C recording system to produce a high resolution 9C data set encompassing the prospect, as well as integrate a Vertical Seismic Profile (WSP) and a buried and fixed 4D spread. The data acquisition was to take place during the 2009-2010 Winter and was to target formations at ~3000ft of depth. RCP supplied the initial design.

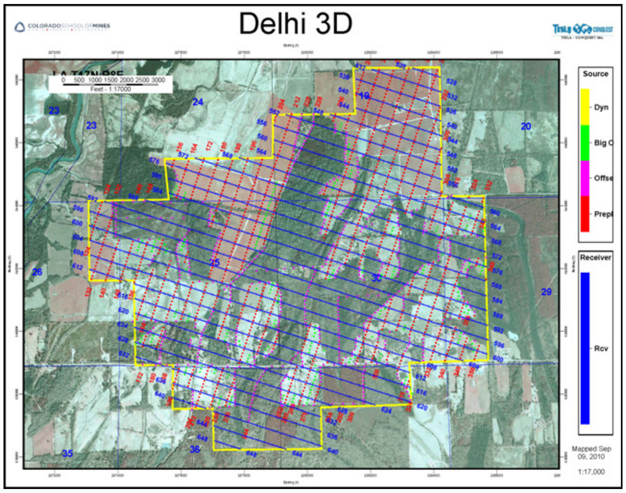
Initial Design Parameters and Layout

RCV Interval	55ft	Receiver Type	3C Analog
SRC Interval	110ft	Source Type	Vibroseis S1, S2 & P1
RCV Line Interval	440ft	Sampling Rate	2ms
SRC Line Interval	440ft	Listen Time	4sec (P) 5sec (S1, S2)
Recording Patch	22x150	Bin Size	55ftx55ft
	4,100x4,800ft offsets	Trace Density	1,898,496/sqmi (x9)

(Table 1, Initial Design Parameters)

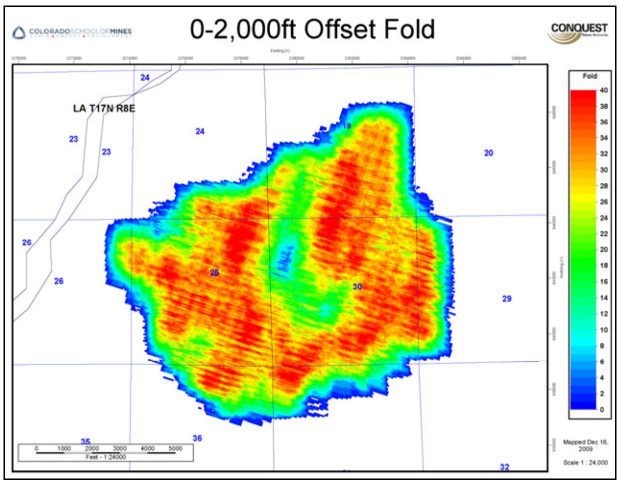
The initial parameters showed the high effort and tight resolution RCP was trying to achieve. The trace density was quite high and can be multiplied by 9 when considering 9C (Tab. 1). Nearly full offset/azimuth was to be acquired with a ~5:6 aspect ratio of the recording patch.

The program was adjusted to fit the terrain and vibe access limitations, which were surprisingly severe. The recording grid was rotated, sources were offset, and in some cases sources were dropped to best accommodate and avoid the treed and wet areas (Fig 1).

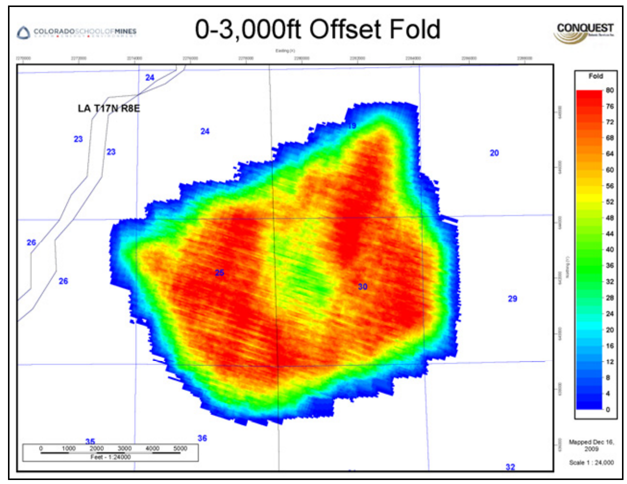


(Figure 1, Revised Initial Layout with terrain)

The resulting coverage was understandably compromised for the ~3,000ft targets. 0-2,000ft and 0-3,000ft offset fold plots showed significant depressions in coverage ((Figs 2 & 3). It is important to note that we saw this degradation was before any hazard survey was performed. Setback distances for utilities, roads, water wells, homes, cisterns, oil & gas pipelines & wells, permit issues, etc. had yet to be considered. This meant that the poor coverage we saw in the initial rotated layout was the best we could hope for.



(Figure 2, 0-2,000ft Offset Fold – Initial Design)



(Figure 3, 0-3,000ft Offset Fold – Initial Design)

Scouting Conclusions

A scout was performed in Fall/Winter. It was determined that the ground was wet which was typical here. There was little chance of drying or freezing. The ground would not support the weight of the vibrators. Dynamite would have to be used in place of vibroseis. The drilling costs changed the economics of the acquisition, as it was significantly more expensive. The initial design was no longer financially viable.

Modified Design Parameters and Layout

RCV Interval	82.5ft	Receiver Type	3C MEMS
SRC Interval	165ft	Source Type	Dynamite (1lb @ 30ft)
RCV Line Interval	495ft	Sampling Rate	2ms
SRC Line Interval	495ft	Listen Time	5sec
Recording Patch	185x108	Bin Size	82.5ftx82.5ft
	4,400x4,400ft offsets	Trace Density	663,552/sqmi (x3)

(Table 2, Initial Design Parameters)

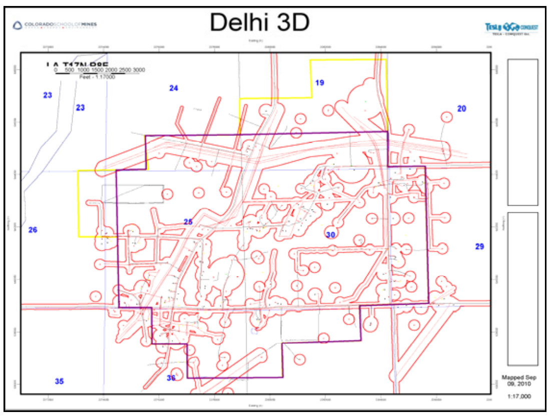
The rotated line orientation was kept, but the source and receiver densities were reduced considerably. This resulted in coarser resolution and a lower trace density. With the loss of the S-Wave vibes as a source 3 traces instead of 9 would be recorded at each receiver location for each source (Tab. 2). The patch was a more symmetric full azimuth/offset (1:1 ratio). The 3C analog recording system was replaced by the INOVA FireFly System. Its wireless aspect would allow greater flexibility in what was becoming a logistically challenging program.

Planned source offsets for treed areas were no longer required, as the drills were not hindered in these locations. Two small segments of the program were dropped to further reduce costs.

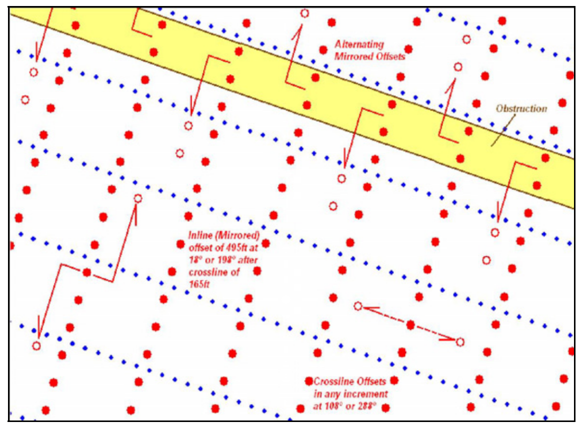
Survey Operations

The initial phase of the survey operation, The Hazard Survey, revealed an extreme number of hazards and culture. Setback distances for these hazards (utilities, roads, wells, etc.) were draped over the surveyed hazard locations. This left very little room for source positioning (Fig 4)

A precise source offset methodology needed was employed. It allowed for the safe offsetting of sources while preserving geophysical attributes (Fig. 5).

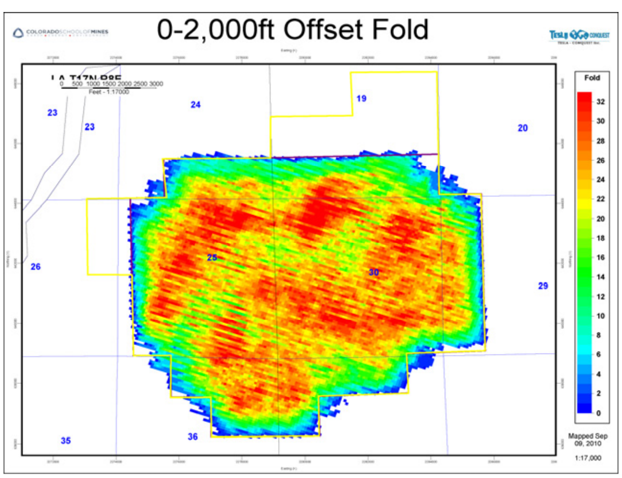


(Figure 4, Safe Operating Buffers)

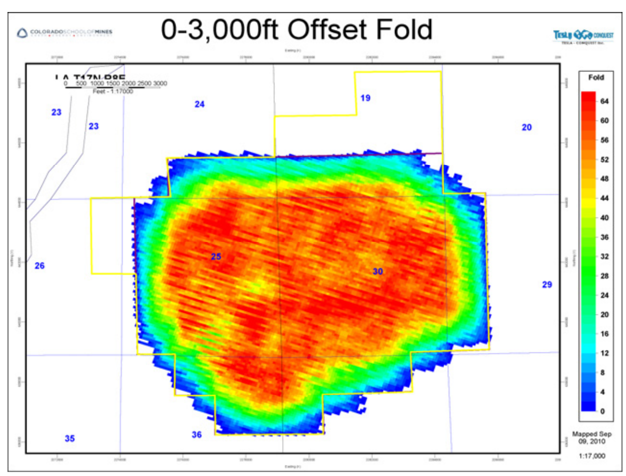


(Figure 5, Diagram of Source Offset Guidelines)

Resulting Fold Coverage



(Figure 6, 0-2,000ft Offset Fold – Final Layout)



(Figure 7, 0-3,000ft Offset Fold – Final Layout)

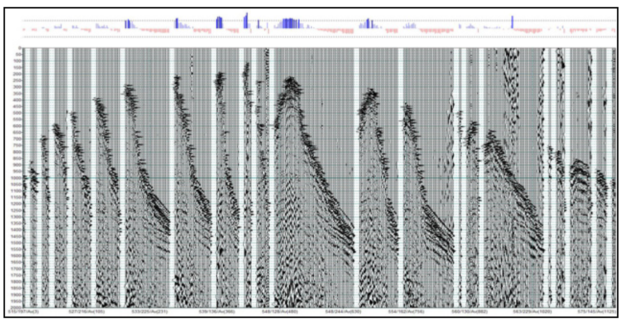
The surveyors employed the offset guidelines to the source positioning. The results looked random, but there was a methodology behind it. The consistency of the resulting fold was considerably better than the original design (Figs 6 & 7). While there were still the inevitable depressions in coverage, these were unavoidable and they were still less extreme than seen with the original option which had no hazard offsets applied (Figs 2 & 3).

Recording Operation / INOVA FireFly Recording System

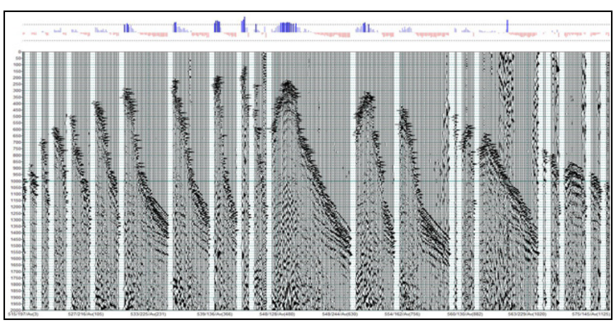
The operational shortcomings of the prospect were overcome with the use of the INOVA FireFly cable-less recording system. It worked well for the conditions which also included limited access, traffic, construction, and a variety of natural hazards (water, wildlife, impenetrable bush, etc). The crew was comfortable with the system, having just recorded two other programs with it. The system was lighter and easier to deploy than a typical cabled system, which reduced safety exposure. 100% of the data was recovered.

Data

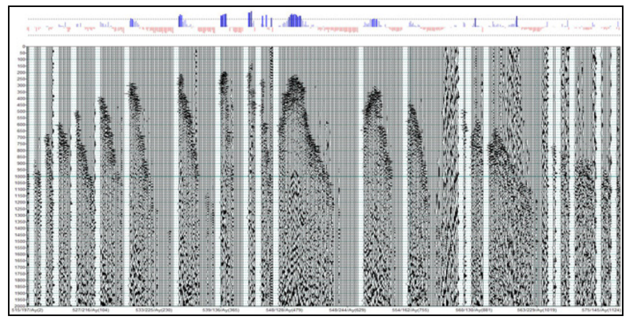
Aside from local culture generated noise, the data quality was exceptional (Figs 8, 9 & 10).



(Figure 8, P-Wave Shot Gather)



(Figure 9, S1-Wave Shot Gather – No Rotation)



(Figure 10, S2-Wave Shot Gather – No Rotation)

Conclusions

The Delhi 3C 3D, for the CSM RCP, was completed within budget and achieved the primary objectives of adequately imaging 3,000ft targets, despite considerable operational and design challenges. This was achieved by accepting reduced resolution, radically redesigning the program, changing source types, holding the survey tolerances to very restrictive offset guidelines, and deploying the INOVA FireFly Recording system.

Acknowledgements

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