Fast Track Imaging Using Beam Tomography for Land Data

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Seismic data acquisition is an optimization problem. It should be designed to fulfill the imaging/interpretation requirements while satisfying the economic constraints. The conventional workflow in the seismic value chain starts with data acquisition in the field, followed by an extensive time/depth processing back in the office before it reaches an interpreter. The lengthy time to acquire and process the data is needed before the results are truly evaluated. We propose below a novel fast-track depth imaging solution whereby the interpreter can access a quality brute stack in depth while the data is still being acquired in the field. We demonstrate the workflow on a 3D blended field data to generate depth images. The obtained seismic volume provides quality control images allowing a real time assessment of the recorded data, identifying illumination challenges, and subsequently allowing possible alterations of acquisition field parameters.

The critical aspect in this workflow is building a depth velocity model using field data. We rely on Automated Beam Tomography workflow, which is a combination of Fast Beam Migration (FBM) with an optimized Beam-Domain Reflection Tomography (BRT). FBM by design is a faster migration engine than conventional techniques using beam forming, a process where prestack traces are converted into local beam coherent events. The beams are used to image the subsurface and equally update the velocity model. In return, Beam-Domain Reflection Tomography instead of applying the conventional workflow of residual move out picking and semblance analysis performs an automated 3D residual time shift in the beam domain. Converting those shifts into local velocity updates allows us to build an azimuthally dependent tomographic solution. This process is carried out without any significant human intervention.

The target in our data is a zone with pronounced low offset faults. Overlying the target, a high velocity zone complicates the illumination pattern. The acquisition design is an unconstrained and decentralized blended acquisition where multiple sources are firing almost simultaneously resulting in a collection of high density broadband blended seismic data. This acquisition design significantly expedites the acquisition filed operations, however, it generates significant crosstalk noise due to the blended acquisition. De-blending processing technologies aim to suppress crosstalk and can be time-consuming and computationally demanding. The blended data was processed via the conventional processing workflow including de-blending generating processed data. A sparse inversion based deblended algorithm was used providing crosstalk free data.

We carry the Beam Tomography on both field data sets (i.e., blended and deblended) to establish the accuracy of our brute depth images. Essentially, we rely on the Beam Forming/imaging as an indirect filtering mechanism for reducing the crosstalk as well as random and coherent noise.

Nine iterations were required for the processed data to produce flat depth angle FBM gathers vs ten iterations for the field (blended) data. The corresponding velocity models show great similarities honoring the high velocity zone above the target. Model updates are not optimum at the edges due to poor illumination. We used Kirchhoff depth migration to image and stack the field and processed data using their corresponding velocity model. Both stacks show the desired low-offset zones at a similar depth.. Furthermore, due to the nature of the geology and acquisition parameters, we see very little update in the deeper section.

Beam tomography provides an automated fast turnaround velocity model building technique. It can reduce significantly the cycle of the velocity model building. We have demonstrated the efficiently of the method on a blended field data. This novel approach increases the reliability and efficiency of the whole geophysical cycle. This workflow paves the way for a semi-real time depth solution that impacts acquisition, processing, and interpretation.

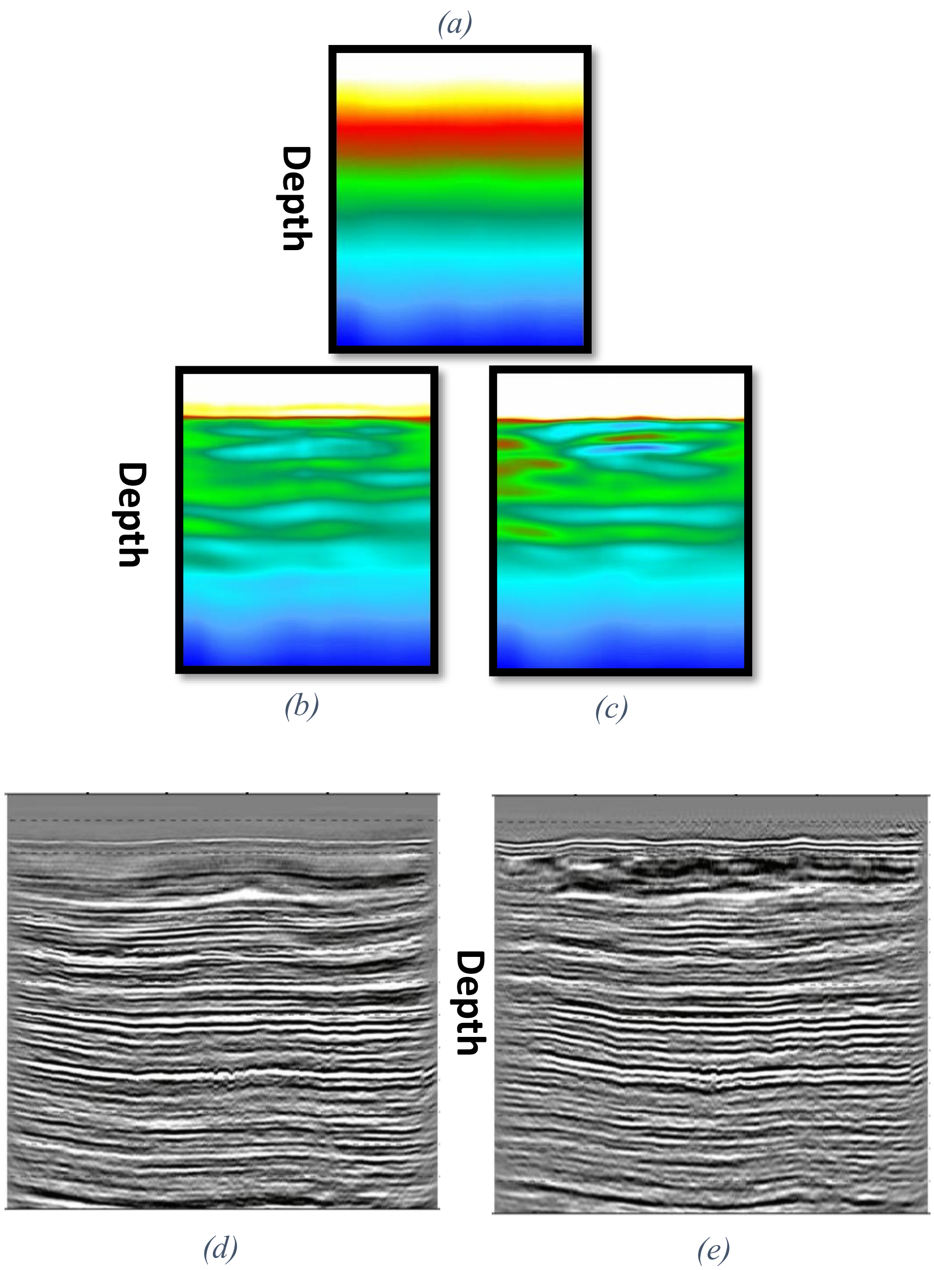

Figure 1. (a) Initial interval velocity model. (b) 9th iteration using the de-blended processed data. (c) 10th iteration using the blended data. Depth migration stack using (d) Processed de-blended data and velocity (Figure 1.b). (e) Field data and velocity (Figure 1.c)