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"Real time" imaging of blended seismic data

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Summary

To ensure successful exploration and development campaigns, it is crucial to comprehend the complexity of the subsurface. This proposal suggests combining tomography and fast beam migration to create a robust velocity model with minimal processing time. In this abstract, we apply Fast Beam Migration (FBM) and Tomography to a blended type of seismic acquisition survey to achieve an accelerated and fast velocity model update with higher resolution. The advantage of this approach is that it requires minimal or no pre-processing of the seismic data. Additionally, this product can serve as an initial model for advanced geophysical imaging algorithms.

Introduction

Fast Beam Migration *(FBM)* with Tomography based velocity updates is an algorithm that accelerates significantly the velocity model building process. It is two orders of magnitude faster than the standard Kirchhoff depth migration algorithm (Popovici et al., 2013). It further allows multi-path imaging as it can handle abrupt lateral velocity changes, a property that is typically associated with wave-equation migration algorithms (Tanushev, Popovici and Hardesty, 2017). This abstract presents a successful application of Fast Beam Migration and Tomography on blended seismic data that obtains a robust and efficient velocity depth model to be used for advanced imaging algorithms and FWI starting models.

Method

A typical beam migration workflow consists of beam mapping and forming, depth migration and image forming. In fast beam migration methods, seismic data need to be decomposed into representative beams. Several techniques such as Plane Wave Destructive Filter (PWD) and local Slant Stack can be used in the beam forming stage. The beam forming stage represents a major computational cost in the fast beam tomography workflow. Nevertheless, it only needs to be done once as the beam events are independent of the velocity model.

Meanwhile, beam tomography combines aspects of beam migration and an automated tomography to create computationally efficient velocity depth models iteratively. In our application, the tomography tackled a special blended seismic acquisition survey to achieve a high-resolution velocity model with no pre-processing. The dispersed source array field acquisition concept was used where seismic sources shooting simultaneously resulting in a significant reduction in acquisition time. We also further evaluate and compare FBM/tomography results by applying a de-blending operator as a pre-processing step prior to imaging.

Application on Blended Seismic Data

Subsurface reflectivity images were obtained through a successful application of the fast beam migration tomography on the blended and de-blended datasets. A typical de-blending process aims to differentiate between overlapping energy sources and produce subsequent seismic deblended gathers for processing. Comparable high resolution velocity models were achieved through running Fast Beam Tomography on both datasets **Figure 1**. Furthermore, the achieved velocity models matched the low frequency behaviour of several wellbore interval velocity data within the area of acquisition. This suggests that *FBM* Tomography is a powerful algorithm even for a blended data. It further provides an ultra-fast and automated solution for velocity model building and accelerate the performance of advanced geophysical imaging techniques such as Least-Square Reverse Time Migration and Full Waveform Inversion. Meanwhile, a key factor limiting the velocity model updates is the number of computed beams that can penetrate deeper in the velocity model. Therefore, a major difference between the two retrieved velocity models can be explained in **Figure 2** as the beam intensity is generally higher in the deblended seismic data over a wider region. The latter indicates a higher confidence in the beam tomography update at the depth of interest.

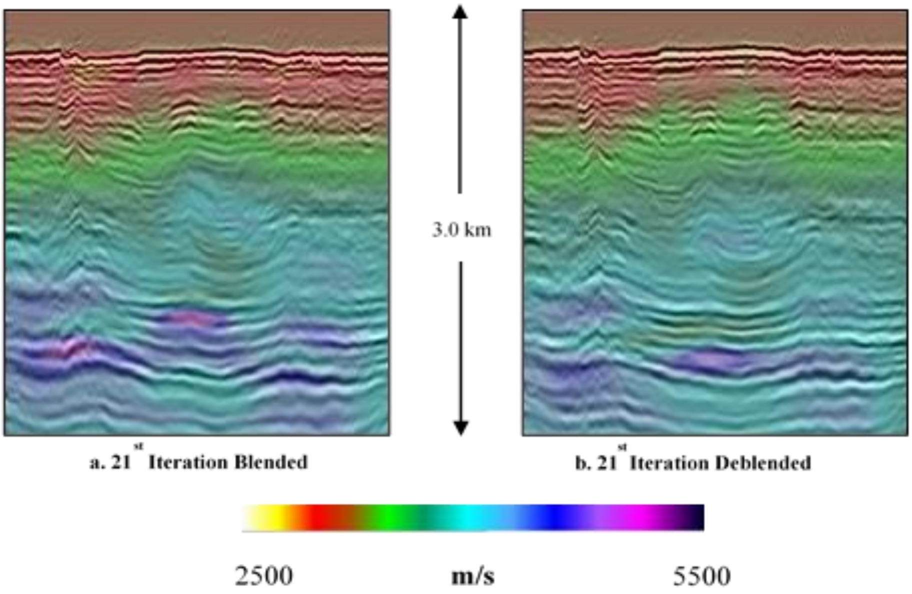

Figure 1 *The velocity model overlaying for the seismic stack of an inline in a. blended and b. deblended migrated data sets after 21 iterations of fast beam migration and tomography.*

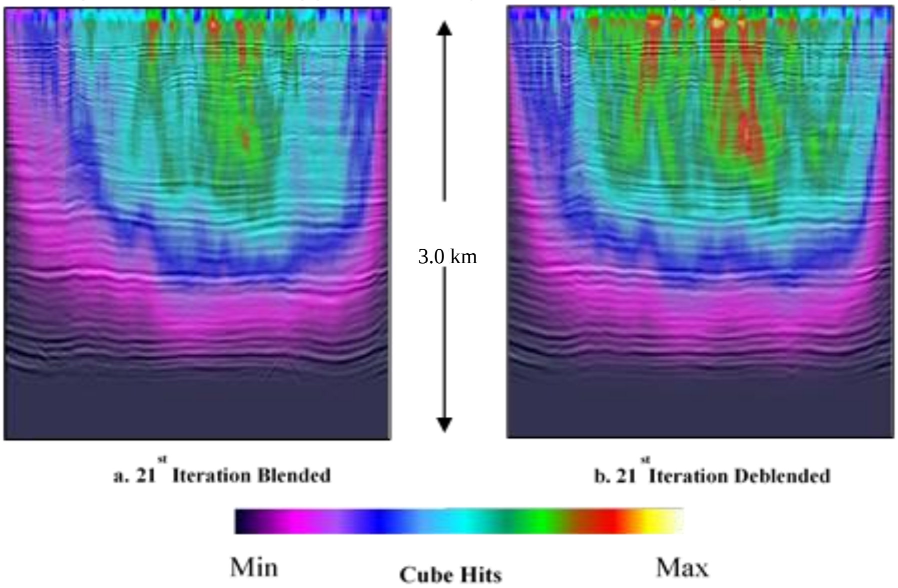

Figure 2 *The calculated beam intensity overlaying the stack generated from a. blended and b. deblended migrated datasets after 21iterations of fast beam migration and tomography*

Conclusions

The application of fast beam migration with automated tomography velocity updates on both datasets succeeded in achieving comparable velocity depth models. Applying FBM on blended data sets can be done almost “real time” as the seismic crew is shooting in the field. This could possibly lead into changing the acquisition geometries or conduct infill shooting in certain poor illuminated areas. Nevertheless, we further realize that de-blending is a necessary step for a successful beam migration tomography in general. The latter can accelerate the velocity depth model building process and increase efficiency to obtain accurate velocities for LSRTM and FWI applications.

References

Popovici, A.M. *et al.* (2013b) 'Fast beam migration using Plane wave destructor (PWD) beam forming,' *Proceedings* [Preprint]. https://doi.org/10.3997/2214-4609.20130725.

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