ROME 2008
LEVERAGING TECHNOLOGY

Practical 3D wavefield tomography on field datasets

Ivan Stekl, Mike Warner, Adrian Umpleby, Joanna Morgan, Chris Pain, Yanghua Wang (*Department of Earth Science and Engineering, Imperial College London*, SW7 2AZ, UK)

Waveform tomography has been used for a number of years in 2D on synthetics and field data and recently in 3D (Stekl et al 2007, Ben Hadj Ali et al 2007, Sirgue et al 2007) but only on synthetics data sets. 3D waveform inversion is still computationally expensive procedure but recent developments on computing power have enabled application of the procedure on the production scale data. We are going to show results obtained by 3D waveform inversion method developed by Stekl, Warner, Umpleby 2007 on a field data set over a shallow channel.

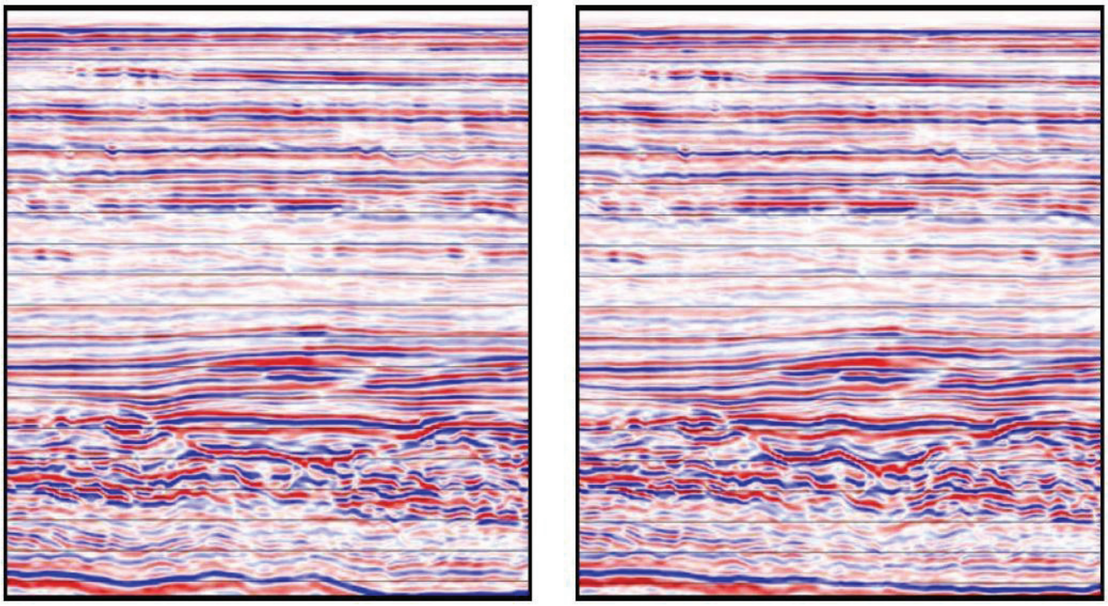
Field data present a different challenge than the synthetics since the code does not cover exact physics and some data adjustments are necessary as well as a problem of obtaining an appropriate starting model. The difference is for example in existence of a free surface which generates not only multiples which can be eliminated by SMR techniques but also a source receiver ghosts which almost cancel a direct arrival in field data but which is one of the strongest arrivals in synthetic seismic data generated by inversion code. Other problems include loss of data energy with depth which not accounted for leads to difficulty in imaging the deep part of the model since main energy (main data residuals) comes from the shallow reflections/diffractions. We will present ways of dealing with these issues on a particular data set.

In a paper we will discuss appropriate ways to generate a starting velocity model for the inversion and discuss the influence of inappropriate starting models on the result. Waveform inversion is much better in building the image then in changing it. In other words if there are string assumptions in the starting model they will be apparent in the final image so one has to be careful with the choice of the initial model.

In our scheme due to computational demands of the 3D waveform inversion we use composite shots (source grouping) to reduce the CPU/ world time required for the inversion. We group a number of shots in marine seismic line to a single composite shot although in principle with larger resources one may not have to do this but the effect especially on lower frequencies is negligible due to high source sampling per spatial wavelength.

Iterative solver as a core part of out inversion procedure enables low memory usage for realistic experiment sizes and quick execution times on multi core multi processor clusters with high CPU utilization. Average run takes order of days on a cluster with 6 nodes each with dual quad core CPUs. This leads to acceptable production time runs in exploration environment.

Figure 1 a) shows a migrated section using original velocity model supplied with a data it is visible that reflectors under the channel section are affected by wrong migration velocity generated by conventional processing. In Figure 1 b) the same section is migrated using a waveform inversion velocity model for migration and some of the artefacts have disappeared.



a) b)

Figure 1: Migrated seismic data a) using original migration velocities b) using full waveform inversion velocities. Structure generated under the shallow channel by using the wrong velocities has flatten in figure 1b) where more accurate waveform velocity is used for migration. Note more detailed channel image in figure 1b).

Acknowledgments
We would like to acknowledge support by our consortium members.

References

H. Ben Hadj Ali, S. Operto, J. Virieux and F. Sourbier 3D acoustic frequency-domain full-waveform inversion, SEG Conference, San Antonio 2007 (Extended abstract).

L Sirgue, J Etgen, and U Albertin :3D full-waveform inversion: Wide- versus narrow-azimuth acquisitions, SEG Conference, San Antonio 2007 (Extended abstract).

I. Stekl, M.R. Warner, A.P. Umpleby :3D Frequency Domain Waveform Inversion – Synthetic Shallow Channel Example, London 2007, 69th EAGE Conference & Exhibition incorporating SPE EUROPEC 2007 (Extended abstract).