

## Major interest for EAGE Rome workshop on developments in full waveform inversion

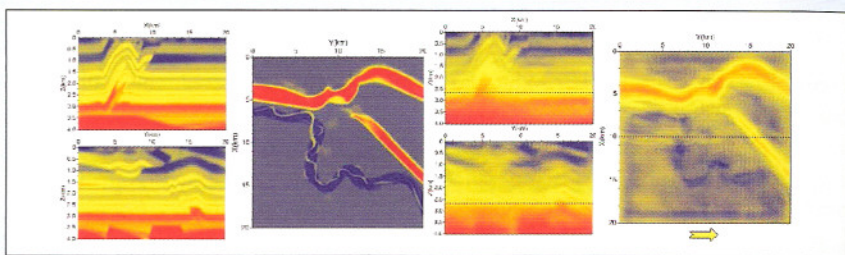
### Workshop Report

René-Edouard Plessix, Stephane Operto and Wim Mulder report on the well attended workshop at EAGE Rome for which they were the convenors.\*

Getting more information from seismic data is one of the main challenges for geophysicists. Since it was first proposed in the 1980s, full waveform inversion has become more and more attractive with the acquisition of long offset and wide azimuth data and the increase in computer power. The workshop on full waveform inversion at the 70<sup>th</sup> EAGE conference in Rome was organized to discuss the current status and the perspectives. More than two hundred delegates attended this workshop.

Full waveform inversion generally consists of minimizing the least-squares misfit between computed synthetics and observed data in order to determine the viscoelastic parameters of the Earth. The goal is to obtain a precise Earth model that explains all the wiggles recorded in the seismograms and reproduces the complete waveform. The approach suffers from so-called local minima, which may complicate or even prevent convergence of the full waveform inversion towards a realistic model. With reflection data, researchers have proposed different approaches, generally referred to as migration velocity analysis and based, for instance, on semblance or differential semblance, to overcome the problem of local minima. With long offset and wide azimuth data that contain transmitted, diving, or refracted waves, researchers have developed the technique of full waveform tomography that is closely related to full waveform inversion but focuses on those specific waves.

The workshop was split into three parts: a session with seven oral presentations on full waveform tomography and inversion, a session with three oral



3D Waveform Inversion.

presentations on automatic migration velocity analysis, and three poster sessions of five presentations on real data examples, modelling, and inversion. While most of the talks were on full waveform tomography/inversion based on the least-squares formulation as proposed by Albert Tarantola, three talks presented automatic velocity analysis methods that extract velocity information mainly from the kinematics of the reflection data and utilize an optimization criterion that differs from the least-squares misfit.

During the workshop, semblance, differential semblance, and a focusing functional based on a correlation between observed and synthetic data in the time domain were discussed. It was shown that these velocity analysis approaches are less sensitive to the initial model than the standard least-squares misfit. The presentations on full waveform tomography/inversion reviewed the advantages and difficulties of this method. Synthetic and real examples of the time-domain and frequency-domain approaches were shown, and possible workflows were proposed. The approach was illustrated using a wide range of data to show its potential: long offset surface data, vertical seismic profile data, and crosswell data. Some of the difficulties

were also discussed, including the lack of low frequencies and long offset/wide azimuth in the data, the determination of a good enough initial model (which is generally obtained by first arrival traveltimes inversion), the windowing of the data, and the presence of multiples. The need to account for elastic and anisotropic wave propagation was also discussed. Different three-dimensional implementations with time-domain or frequency-domain solvers were shown, and some modelling aspects were presented. While still expensive, inverting three-dimensional data sets is nowadays possible on large computer clusters with either a time-domain solver or a frequency-domain solver.

The twenty-five presentations came from universities and the oil and gas industry. Together with the large audience of this workshop, this illustrates the interest in full waveform inversion and automatic velocity analysis techniques to image the Earth more accurately. Those interested in this topic can find the abstracts of the presentations made during this workshop on the EarthDoc website: [www.earthdoc.org](http://www.earthdoc.org). A special issue of *Geophysical Prospecting* on full waveform inversion is planned for the end of the year.

\*We offer our apologies to the authors of this article which was inadvertently omitted from the group of EAGE Rome Workshop reports published in the September issue of First Break.