IMPERIAL COLLEGE
Fullwave GameChanger

Imperial College, London, is a science-based university with an international reputation for excellence in teaching and research. It is consistently rated amongst the world's best universities.

Full-wavefield tomography, also known as full-wavefield inversion, has the ability to capture the full range of acoustic wave data picked up from seismic survey recordings and can accurately image the subsurface condition in three dimensional, anisotropic conditions. This produces radically enhanced images of the subsurface compared with conventional timetravel tomography techniques.

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BACKGROUND

ITF has worked closely with Imperial College over the past decade to maximise industry engagement in the development of the Fullwave GameChanger software. The joint industry project (JIP) has involved around 15 participants across a number of stages, including major oil companies and geophysical survey companies. ITF has helped to facilitate direct oil company funding of close to GBP7.5m (USD11m) in addition to leveraged government research backing sourced by the Imperial College research team.

CHALLENGE

Traditional seismic analysis techniques have significantly under-utilised potential information from recorded seismic data and have been limited by their ability to "see" deep into the reservoir. In the case of offshore seismic surveys, access to this data is made more complicated by having to send and record acoustic waves through the water column.

In contrast to conventional seismic tomography which minimises the mismatch between observed and calculated seismic travel times, full-wavefield tomography seeks to create a highly resolved quantitative model of the subsurface structure that is able to explain all aspects of the recorded seismic wavefield.

Though wavefield tomography is an established technique, recent advances in mathematical algorithms, as well as hardware, have made the method feasible on realistic-sized datasets in three dimensions. However, though the technology has demonstrated unprecedented resolution and clarity, with the promise of changing development and production strategies as a consequence, it was not fully effective at generating images of the more deeply buried reservoir targets.

ACTION

In 2007, ITF launched the "hydrocarbon mapping through integrated geophysics" call for proposals. This followed global discussions between ITF members, the UK Government Industry Initiative PILOT, and Oil & Gas UK to seek solutions which would focus on the use of advanced imaging technologies and processing to improve the industry's ability to locate hydrocarbons.

The Fullwave GameChanger project was progressed across a number of stages to accelerate the insight and knowledge needed to develop the next generation of integrated wavefield-tomographic tools. The most recently completed phase, Fullwave III, developed techniques leading to improved understanding of the "top layers" of geological structures at high spatial resolution.

Furthermore, the team at Imperial College incorporated patented adaptive waveform inversion techniques to elevate the capabilities of the technology compared with other competing fullwave inversion methodologies.

Throughout the project, individual participating oil companies have been able to regularly submit, in a confidential manner, their subsurface datasets to be trialled on the developing Fullwave GameChanger software. Outputs, findings and results are then shared across all JIP participants in a non-attributable fashion. Knowledge on how the analysis techniques performed was then used by participants for their own internal application. The Fullwave GameChanger software is now being rapidly improved through testing on real subsurface applications provided by the JIP members.

RESULT

ITF continues to support the creation of the next generation of integrated wavefield-tomographic tools.

The latest phase of the Fullwave GameChanger JIP has welcomed significant sponsorship and engagement by the major geophysical survey companies, CGG and Shearwater with a view to applying the Imperial College software for commercial use. The university has since launched its start-up company Seismic Cube (S-Cube) to commercialise the outcomes.

Since 2008, participating companies have used the developing software to support commercial decisions. Knowledge gained from the JIP has already influenced more than 100 drilling and well placement decisions with a cumulative value of about USD500m. Oil company Hess is promoting the benefits of this innovation alongside their objective of applying best new technologies in seismic imaging as seen from their website.

http://www.hess.com/technology/developing-fields/full-waveform-inversion

The current phase of the Fullwave Gamechanger project will conclude in December 2017 with the majority of members expected to continue on to phase 3 which has a planned start date of January 2018.

"Accurate subsurface imaging is crucial to identify hydrocarbon reserves and towards precise placement of highly expensive wells. Thanks to ITF and its members, the general approach of applying full wave-form inversion over the next decade or so will influence every well that's drilled, every prospect that's developed, probably every barrel of oil and every cubic metre of gas that is produced. It will help companies avoid spending millions exploring areas where there will be little or no returns.

The relationship with ITF and the tangible results its collaborative efforts have achieved, demonstrates the power of the JIP model to introduce and implement new innovations which make a real difference."

Professor Mike Warner, lead researcher on Fullwave GameChanger, with Imperial College, London