Next Generation Seismic Imaging: High Fidelity Algorithms and High-End Computing

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The rich oil reserves of the Gulf of Mexico are buried in deep and ultra-deep waters up to 30,000 feet from the surface. Minerals Management Service (MMS), the federal agency in the U.S. Department of the Interior that manages the nation's oil, natural gas and other mineral resources on the outer continental shelf in federal offshore waters, estimates that the Gulf of Mexico holds 37 billion barrels of "undiscovered, conventionally recoverable" oil, which, at $50/barrel, would be worth approximately $1.85 trillion. These reserves are very difficult to find and reach due to the extreme depths. Technological advances in seismic imaging represent an opportunity to overcome this obstacle by providing more accurate models of the subsurface.

Among these technological advances, Reverse Time Migration (RTM) yields the best possible images. RTM is based on the solution of the two-way acoustic wave-equation. This technique relies on the velocity model to image turning waves. These turning waves are particularly important to unravel subsalt reservoirs and delineate salt-flanks, a natural trap for oil and gas. Because it relies on an accurate velocity model, RTM opens new frontier in designing better velocity estimation algorithms.

RTM has been widely recognized as the next chapter in seismic exploration, as it can overcome the limitations of current migration methods in imaging complex geologic structures that exist in the Gulf of Mexico. The chief impediment to the large-scale, routine deployment of RTM has been a lack of sufficient computer power. RTM needs thirty times the computing power used in exploration today to be commercially viable and widely usable. Therefore, advancing seismic imaging to the next level of precision poses a multi-disciplinary challenge.

To overcome these challenges, the Kaleidoscope project, a partnership between Repsol YPF, Barcelona Supercomputing Center, 3DGeo Inc., and IBM brings together the necessary components of modeling, algorithms and the uniquely powerful computing power of the MareNostrum supercomputer in Barcelona to realize the promise of RTM, incorporate it into daily processing flows, and to help solve exploration problems in a highly cost-effective way. Uniquely, the Kaleidoscope Project is simultaneously integrating software (algorithms) and hardware (Cell BE), steps that are traditionally taken sequentially. This unique integration of software and hardware will accelerate seismic imaging by several orders of magnitude compared to conventional solutions running on standard Linux Clusters.

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