

# **Multi-Scale Optimization for Rapid Horizon Interpretation across Multiple Surveys with Geological Constraints**

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## **Abstract**

The interpretation of seismic horizons is integral to the characterization of subsurface geological structures. Advanced workflows, such as reservoir characterization and stratigraphic studies, benefit from the extraction of large numbers ( $>100$ ) of seismic horizons when building geological models. Therefore, tools or algorithms that can dramatically increase the speed and accuracy of horizon interpretation are necessary to address exploration challenges as more datasets are continually acquired. A practical workflow should be able to: generate high quality automated results; incorporate existing interpreted data, for example well picks, horizons, faults and salt; provide a robust assessment of uncertainty; and allow interactive edits of horizons in near-real-time.

We demonstrate an implementation of horizon extraction using multiscale optimization with respect to structural attributes like seismic dip, coherence, and fault likelihood. Optimization approaches have several advantages compared to machine learning approaches as they do not require training to revise predictions, are readily transferable between datasets and have the flexibility to readily incorporate information from various sources. Our implementation allows the complex global structure of the horizon to be solved on a sparse adaptive grid in near-to-real time. This enables the optimization framework to form the basis for an interactive interpretation workflow. The optimization framework allows the generation of consistent horizons across multiple 2D and 3D surveys, and can also incorporate prior geological constraints and rules. For example, horizons will dynamically respond to interpreted fault planes, salt bodies and unconformities during the optimization. Horizons can also be guided by conformance relationships so that, even in areas of low data quality, horizon geometries are geologically plausible.

To demonstrate accuracy and efficiency of horizon interpretation using our optimization framework, we present a case study from Offshore Norway. Using traditional interpretation tools only key seismic horizons had previously been interpreted over a subset of the total dataset. The optimization framework allows horizons to be generated and refined across several 3D seismic volumes and hundreds of 2D seismic lines simultaneously. The resulting dense stack of horizons provides a detailed structural and stratigraphic foundation for subsequent workflows.