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Integrated ML Workflow for Joint Fault and Horizon Extraction on Mega Seismic Surveys in the Middle East

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Objectives/Scope: This paper presents an integrated ML workflow for extracting faults, horizons, and channels across large-scale seismic volumes. Using a case study from offshore Abu Dhabi (50,000 sqkm), we demonstrate how jointly refining geological features can reduce manual workload, improve consistency, and support faster interpretation for exploration and reservoir characterization.

Methods, Procedures, Process: The workflow combines ML-based and deterministic methods to streamline interpretation. We apply pre-trained 3D U-Nets and Vision Transformers to (1) denoise seismic data, (2) estimate fault probability volumes, and (3) compute a relative geological time (RGT) volume via dip inversion. Fault probabilities with orientation differences ≤3° from RGT dips are filtered prior to surface extraction. Horizons are then disconnected and sharpened at the extracted fault surfaces. These refined volumes support high-resolution stratal slicing and enable downstream channel detection using another pre-trained U-Net model.

Results, Observations, Conclusions: We applied the workflow to the full Abu Dhabi dataset and observed structurally consistent RGT volumes and improved fault-horizon integration. The results include clearly defined horizons and fault surfaces, even in complex geological settings such as salt-influenced anticlines. Visualization outputs demonstrate enhanced structural clarity and reduced false positives. While the approach significantly reduces manual interpretation effort, results remain suitable for interpreter review, refinement, and targeted model adjustments.

Novel/Additive Information: This study presents an ML-based joint fault and horizon extraction workflow for a mega seismic survey using on-premise HPC. Using geological context at early stage of seismic processing, enables better engagement with geologist and interpreter during the processing project.