

From Unstructured Reports to Real-Time Decisions: An Integrated AI Workflow for Formation Evaluation, Geosteering and Drilling Execution

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Introduction

Well planning and execution generate large data volumes that remain difficult to exploit in real time. Daily drilling reports, mud reports and surveys often arrive as scanned or unstructured documents that are imported manually; formation tops are picked by hand; horizontal wells are geosteered manually from measurement-while-drilling (MWD) gamma ray (GR) and surveys; and drilling parameters are frequently selected from experience. As rates of penetration (ROP) and the number of wells interpreted per geosteerer increase, these manual steps limit consistency and response time. Moreover, GR-only geosteering is inherently non-unique, and most automated approaches treat each well in isolation, ignoring offset-well knowledge captured by experienced interpreters. This study presents an integrated set of machine-learning (ML) and large-language-model (LLM) tools that combines wellsite data, geological interpretation, drilling optimization and user interaction, and evaluates whether AI models can match or enhance human decisions.

Procedure

LLMs combined with optical character recognition (OCR) extract structured data from daily drilling reports, mud reports and surveys, and ML correlation picks formation tops automatically. The AI geosteering model (Figure 1) predicts apparent dip from interpreted offset wells using robust hybrid plane fitting, segments the lateral with the Pruned Exact Linear Time (PELT) algorithm, and correlates each segment against typewells, offset laterals and the lateral itself. A selection algorithm propagates the 100 most plausible scenarios on GPUs, with hyperparameters calibrated on approximately 5,000 onshore Eagle Ford wells in South Texas. Neural networks trained on offset drilling data generate formation-specific roadmaps of optimal drilling parameters, while binary decision trees with dynamic thresholds classify rig activity and flag hazards. A conversational LLM agent trained on domain knowledge bases answers user queries, creates and modifies wells, and generates scripts that automate reporting and optimize well placement.

Results / Observations

Offset-well conditioning allowed the structure predictor to reproduce interpreted dip trends without GR from the active well, and hyperparameter optimization converged after approximately 300 iterations to match interpreter variability and error. Deployed continuously on about 1,000 public-domain Eagle Ford wells in an unfaulted setting, automated geosteering achieved a lateral root-mean-square error (RMSE) of 6.3 ft and an endpoint RMSE of 13.5 ft relative to manual interpretations, at about six seconds per interpretation. Automated alerts notify the geosteerer whenever the active target may leave the planned corridor. LLM/OCR parsing converted unstructured reports into a digital-ready format that feeds offset analysis, drilling roadmaps and rig-activity classification. The conversational agent lets engineers and geoscientists query more than 1,000 wells, for example retrieving the best lateral ROP across a set of wells or the maximum dogleg severity in a well, reducing data silos and supporting integrated geoscience and drilling analytics.

Conclusion

Linking AI tools across the well life cycle, rather than deploying them in isolation, compounds their value: structured report data, automated tops and offset interpretations become shared constraints for collaborative subsurface decisions. Offset-well conditioning constrains the ambiguity of GR

correlation, while human-in-the-loop alerts keep operations teams in control and reduce manual workload. The solution can be restricted and calibrated to specific formations, and performance metrics continue to be refined for data parsing, top picking and drilling optimization. Next steps include automated fault prediction to improve well placement and in-zone percentage. The workflows are transferable to mature fields on the Norwegian Continental Shelf, where azimuthal logging-while-drilling, subsurface and wired-drill-pipe data streams could be integrated to extend automated formation evaluation while drilling.

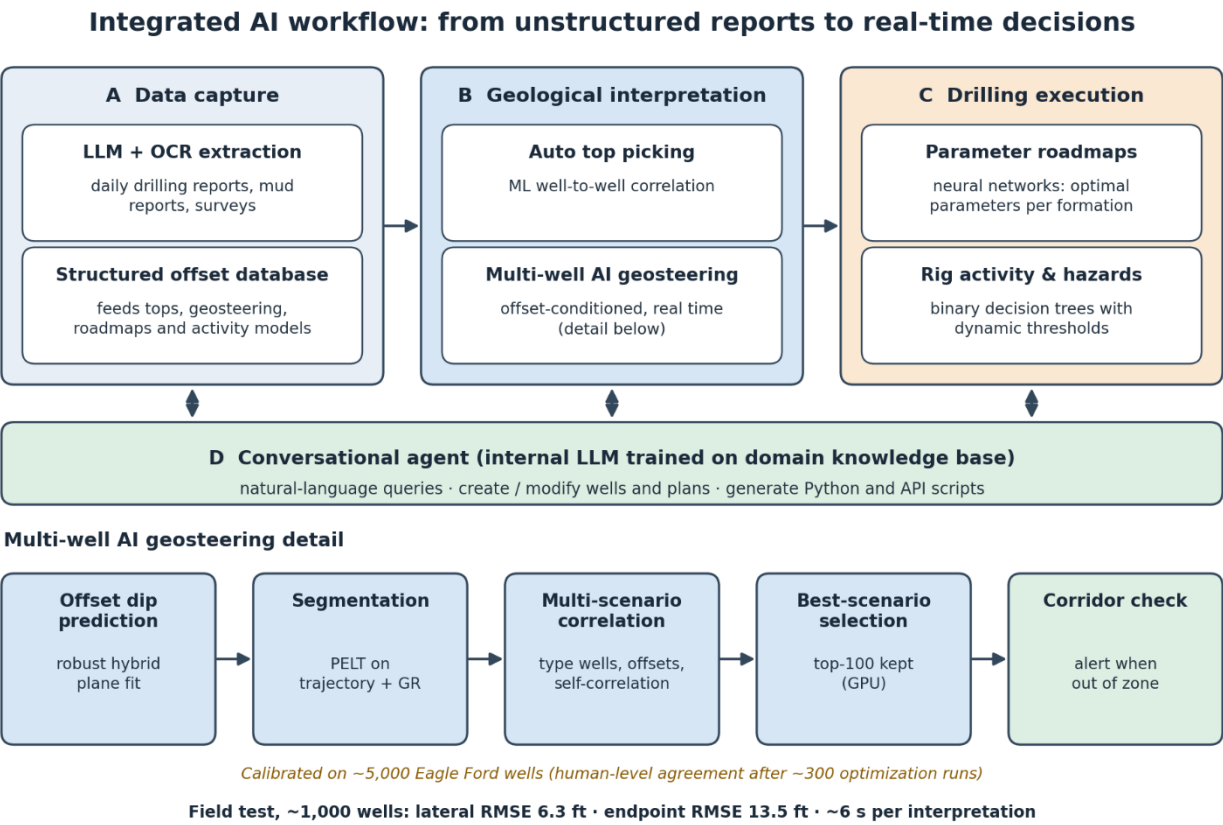


Figure 1. Integrated AI workflow — (A) LLM/OCR for data capture, (B) automated geological interpretation for top picking and multi-well geosteering, (C) neural-network for drilling-parameter roadmaps and decision-tree rig-activity/hazard detection for drilling execution, (D) conversational LLM agent, where the lower panel details the geosteering workflow and its validation metrics.