Proactive geosteering workflow for enhanced oil recovery

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Aims
- Systematic and transparent updating of geological uncertainties around and ahead of bit while drilling
- Highly automated workflow for model-based geosteering decision support

Methods
- Ensemble-based uncertainty tool automatically updates earth model realizations in real-time, based on measurements received while drilling
  - Always up-to-date earth model with uncertainties
  - Uncertainty modelling at local scale around and ahead of bit, constrained by global scale interpretations
  - Multiple different geological concepts (scenarios) at local scale can be handled simultaneously
- Local updates of global 3D earth model while drilling
  - New technology for scale management
  - Local updates of structural connectivity (topology), e.g. insertion of new fault or pinch-in of layer into earth model grid
  - Automatic/assisted control via geological parameters
- Uncertainty in well trajectory
- Expert interaction to monitor and guide the modelling process when required
  - E.g. propose new geological scenarios to be tested against the measurements
- Optimized well path for decision support
  - Robust optimization under uncertainty over the updated ensemble of earth model realizations
  - Multiple geosteering objectives
- Risk analysis, predict outcomes of decisions under uncertainty

Case study 1: Uncertainty in structure and water saturation

Model setup
- 100 realizations in ensemble
- Sand layer in background shale
- Simplified earth model with vertical faults
- Model parameters
  - Fault displacement and location, horizon geometries, $S_w$ in each grid block
- Steering objectives:
  - Stay in the middle of target layer (+/- 20%)
  - Avoid water above and below

Results
- Pre-drill uncertainty in both structure and water saturation is reduced when new measurements constrain the model
- Good reservoir coverage by calculated optimized well path
- More LWD logs would further reduce uncertainties

Case study 2: uncertainty in structure

Model setup
- Uncertainty in horizons and depth of OWC
- Fixed resistivity (shale 100 ohm-m, sand 300 ohm-m, below OWC 5 ohm-m)

Results
- Reduced uncertainty in horizon geometries
- Good reservoir coverage by calculated optimized well path

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