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Back to Basics: Fundamental Principles of Geomodelling for Carbon Capture and Storage

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Summary

This presentation focuses on the fundamental principles that make geomodelling an invaluable tool in carbon capture and storage (CCS) projects. Emphasizing a 'back to basics' approach, key aspects such as understanding scale, effective communication with non-technical stakeholders, and applying uncertainty analysis to ensure robust decision-making will be explored. By returning to core principles, model reliability can be improved and stakeholder confidence in geomodelling outputs enhanced. The session will also highlight practical strategies to reduce complexity and streamline workflows, making it easier for geologists to focus on what truly matters—understanding the geology.

Challenges and uncertainties in CCS geomodelling arise from limited data availability, including sparse well control and seismic resolution issues. The inherent heterogeneity of subsurface formations and the complexity of fluid behavior further contribute to modeling uncertainty. Additionally, regulatory compliance requirements, such as demonstrating conformance and containment, and ensuring proper measurement, monitoring and verification (MMV), add another layer of complexity to the geomodelling process.

Theory / Method / Workflow

Geomodelling in CCS requires a structured and iterative approach, incorporating precise data acquisition, integration, and interpretation to achieve reliable models.

1. **Back to Basics of Scale**: Understanding scale is fundamental in geomodelling, ensuring geological heterogeneities are accurately captured. Effective communication of scale to non-technical stakeholders is crucial for aligning technical outputs with business objectives. Using real-world analogs such as buildings or landmarks provides a relatable perspective on the size and depth of geological features. Multi-scale modeling techniques enable better representation of large-scale reservoir properties and finer geological details, essential for effective project planning.
2. **Automation and Data Integration**: Streamlining geomodelling processes through automation and efficient data integration can significantly reduce manual effort and improve consistency. Tools such as automated workflows for data processing and machine learning algorithms for pattern recognition allow geoscientists to focus on geological interpretation. Integrating multiple data sources seamlessly makes geomodelling more robust and adaptable to evolving project needs.
3. **Uncertainty Analysis**: Effective uncertainty quantification is essential for risk mitigation and strategic decision-making in CCS projects. Uncertainty and sensitivity modeling provides insights into potential variabilities, ensuring resilient project planning. Sensitivity analyses allow geologists to identify key parameters influencing model outcomes, facilitating targeted data collection and enhanced forecasting.

Results, Observations, Conclusions

Application of these principles in CCS projects has resulted in improved model accuracy and stakeholder engagement. Automated workflows have led to significant reductions in processing time, while uncertainty quantification has provided confidence in model predictions. Using real-world objects for scale communication has improved collaboration across technical and non-technical teams.

Novel/Additive Information

This session will showcase how adapting traditional geomodelling workflows to CCS applications can lead to more robust and dependable models. Emphasizing scale, automation, and uncertainty provides a framework applicable to various subsurface energy projects. Integrating AI-driven analytics and automation in CCS geomodelling presents an opportunity to set new industry standards.

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References