TETRA TECH RPS ENERGY | TRAINING

N675: Sandstone Diagenesis and Reservoir Quality for Exploration, Appraisal, Field Development, and CCS Projects

Instructor(s): Richard Worden

Format and Duration

Classroom - 3 Days
Virtual - 5 Sessions

Summary

For geoscientists working in the geoenergy sectors of CCS and oil and gas, this course offers a comprehensive exploration of sandstone reservoir quality and diagenesis. It is designed to enhance your understanding of how these factors impact exploration, appraisal, field development, and CCS projects. The course starts with foundational concepts and advances to complex topics such as fluid properties, porosity and permeability measurement, and diagenetic processes. Practical, hands-on exercises are integrated throughout, equipping you to effectively address real-world challenges. By integrating these insights, you will be better prepared to optimise project outcomes and make well-informed decisions in your geoenergy work.

Learning Outcomes

Participants will learn to

1. Understand Diagenesis and Reservoir Quality: Demonstrate how diagenesis and reservoir quality fit into geoenergy workflows, including exploration, appraisal, field development, and CCS projects.
2. Analyse Fluid Effects: Explain the roles of water, oil, gas, and CO2 in sandstone diagenesis, focusing on mineral reactions and fluid interactions.
3. Evaluate Porosity and Permeability: Identify and measure these properties and relate them to reservoir quality and petrophysics.
4. Apply Analysis Techniques: Summarise and apply techniques for analysing reservoir quality, including petrographic and geochemical methods.
5. Interpret Sediment Origins and Processes: Describe the origins of clastic sediments and sedimentary processes affecting sandstone reservoirs.
6. Assess Diagenesis: Distinguish between early and burial diagenesis, including controls on mineral cements and compactional processes.
7. Predict Cementation and Porosity Changes: Analyse and predict how different cements and processes impact reservoir quality and secondary porosity.
8. Apply Knowledge to Projects: Use principles of reservoir quality and diagenesis in real-world oil, gas, and CCS projects, including making predictions based on core data and geochemical models.

Training Method

A course of 5 virtual classrooom sessions or 3 days classroom of lectures, case studies and practical exercises.

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Who Should Attend

This course is ideal for Petroleum Geologists, Reservoir Engineers, CCS Specialists, Field Development Managers, and Energy Sector Analysts. Professionals involved in data analysis, strategic decision-making, and project planning in the geoenergy sector will benefit from a deeper understanding of sandstone reservoirs and their impact on project outcomes.

Course Content

Part A: Basics

- **Integration of Diagenesis and Reservoir Quality:** Understand how these factors fit into geoenergy workflows, including exploration, appraisal, field development, and CCS projects.
- **Fluid Properties and Diagenesis**: Examine how water (brine), oil, gas, and CO2 influence sandstone diagenesis, covering mineral reactions, wetting states, and CO2 effects on pH and carbonate equilibria.
- **Porosity and Permeability**: Learn the fundamentals of measuring these key properties and their links to reservoir quality and petrophysics.
- **Analysis Techniques:** Overview of methods for assessing reservoir quality, including petrographic, mineralogical, and geochemical analyses.

Part B: Clastic Sediments

- **Origins and Processes:** Explore the sources of clastic sediments in sandstone reservoirs, including extraclasts, intraclasts, and detrital mineralogy.
- **Sedimentary Environments:** Understand sedimentary environments relevant to sandstones, such as marine and continental settings, and the influence of climate and biological processes.
- **Sedimentary Processes:** Study processes affecting sediment, including erosion, transport, deposition, and bioturbation.

Part C: Controls on Diagenesis

- **Diagenetic Controls:** Review factors influencing diagenesis and reservoir quality, including thermal history, overpressure, and mineral cements.
- **Diagenetic Processes:** Examine time-temperature history, effective stress, fluid flux, and other processes affecting sandstone diagenesis.
- **Geochemical Modelling:** Understand geochemical processes and modelling related to mineral-water and CO2 interactions during production and injection.

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Part D: Early Diagenesis and Initial Compaction

- **Early Mineral Diagenesis:** Investigate early cementation processes, their timing, and mechanisms such as grain replacement and fluid influx.
- **Initial Compaction:** Learn about mechanical compaction, effective stress, and compaction models during the early stages of burial.

Part E: Burial Diagenesis and Later Compaction

- **Later Compaction:** Study continued mechanical compaction and the onset of chemical compaction, including fracture **porosity and the roles of temperature versus stress.**
- **Carbonate Cements:** Explore the formation and dissolution of various carbonate cements during burial.
- **Clay Cements:** Examine the evolution and effects of clay minerals in burial diagenesis.
- **Quartz Cement:** Understand the sources, effects, and predictive modelling of quartz cementation.
- **Feldspar and Other Cements:** Analyse feldspar diagenesis, sulphate, and oxide cements, and their relative importance to reservoir quality.
- **Secondary Porosity:** Review models and patterns related to secondary porosity development.

Part F: Application to Projects

- **Application to Oil, Gas, and CCS Projects:** Integrate and apply knowledge to real-world scenarios in oil, gas, and CCS projects, focusing on practical applications and predictions.

Exercises Included

This course integrates practical exercises to complement theoretical learning. You will:

- Analyse porosity and permeability ranges in sandstones to understand their impact on reservoir quality.
- Practice predicting permeability from core-derived data and learn methods for upscaling core analysis.
- Explore how sediment texture affects the properties of relatively shallow-buried sandstone CCS reservoirs.
- Investigate the types and growth patterns of cements in sandstones, including practical exercises with carbonate cements and the use of C-stable isotopes.
- Study clay cements using fluid inclusion data and examine quartz cementation through prediction and modelling.
- Explore the distribution of clay in gas reservoirs, applying geochemical modelling to both production and CCS contexts.

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These exercises are designed to refine your skills and enhance your ability to tackle complex challenges in geoenergy projects.