Workshop in the Seismic Expression of Carbonates (G080)

Tutor(s)

Gene Rankey: Professor, University of Kansas.

Overview

The aim of this course is to provide a general overview of the basic principles of carbonate systems and their expression in seismic data, and to demonstrate its utility for exploration and production. The course will include conceptual models, practical hands-on exercises, and demonstrations of the utility of seismic data and derived products. Key examples will illustrate how seismic stratigraphy and seismic attribute analysis can be used to assess reservoir fairways, subdivide a reservoir, constrain reservoir models, and generate high-resolution, geologically constrained predictions of reservoir systems. An important part of this course will be to draw attention to unique aspects of carbonates and how they might differ from siliciclastic from pore to basin scales.

Objectives

You will learn to:

1. Establish a working knowledge of carbonate sediment and depositional systems.
2. Assess carbonate seismic attributes, their general classes, and situations in which different types of attributes are most appropriate.
3. Evaluate quantitative applications of seismic attributes to map seismic facies and porosity in carbonate reservoirs.
4. Recognize the expression of carbonates in three-dimensions, how these patterns reflect dynamic stratigraphic evolution, and how these patterns can be related to reservoir trends.
5. Identify the variation and controls on carbonate reservoir architecture in different system tracts.
6. Appreciate how carbonate petrophysics influences the seismic response of carbonates.
7. Appraise the different types of carbonate platform on seismic data and assess the presence of key seismic facies.
8. Illustrate the seismic geometries of carbonate ramps and rimmed shelves and their possible reservoir character.

Level and Audience

Intermediate. The course is aimed at geologists and geophysicists working on carbonate exploration and production projects. No prior knowledge of carbonates is assumed but participants should have some background in the geosciences.

Duration and Logistics

Classroom version: 2 day classroom course comprising presentations, exercises and case studies. Course notes and exercise materials will be distributed to participants during the course. The manual will be provided in digital format and participants will be required to bring a laptop or tablet computer to follow

the lectures and exercises

Virtual version: Four 3.5-hour interactive online sessions presented over four days. Digital course notes and exercise materials will be distributed to participants before the course. Some exercises may be completed by participants off-line.

Course Content

Overview of Carbonate Sediment and Depositional Systems

- Carbonate factories
- Skeletal and non-skeletal carbonate grains
- Differences from siliciclastics
- Introduce facies models – ramps, rimmed shelves, isolated platforms
- “Unique” aspects of carbonates (produced in place, diagenetically unstable, complex pores, etc)

Carbonate Sequence and Seismic Stratigraphy

- Basic concepts and terminology: introduction to stratigraphic hierarchy, parasequences, systems tracts, sequences; similarities and differences with siliciclastics
- Stratal terminations; major surfaces in seismic; features that look like carbonates…but are not

Exercises

- Defining sequences and unique aspects of carbonates

Seismic Resolution and Seismic Modeling

- The strengths and limitations of seismic data
- Illustrate how geometric modeling provides insights into possible pitfalls, and how to avoid them
- Case studies: Cretaceous, Italy and Bahamas; Permian, west Texas

Exercises

- Stratal terminations

Seismic Geometry of Isolated Carbonate Platforms

- Introduce and illustrate seismic geometries, recognition of seismic sequence boundaries
- Describe common seismic facies (sequence-based)
- Potential impact on reservoir character and production

Exercises

- Seismic expression of isolated platforms and some challenges

Carbonate Pores and Petrophysics

- Pore types and petrophysical classes (Choquette-Pray/Lucia)
- Diagenetic environments and products
- Influence of cements of velocity
- Relation between diagenesis and sequence stratigraphy (sequence boundaries, diagenetic alteration related to sequence boundaries, role of climate; spatial variability in diagenesis)
- Understanding the seismic response of carbonates requires at least a fundamental understanding and appreciation of these principles

Exercises

- Petrophysics and carbonates

Seismic Expression of Carbonate Ramps

- Introduce and illustrate seismic geometries, recognition of seismic sequence boundaries
- Describe common seismic facies (sequence-based)
- Potential impact on reservoir character and production

Exercises

- Seismic expression of carbonate ramps and some challenges

Seismic Expression of Carbonate Rimmed Shelves

- Introduce and illustrate seismic geometries, recognition of seismic sequence boundaries
- Describe common seismic facies (sequence-based)
- Potential impact on reservoir character and production
- Case studies: Jurassic, Atlantic margins; West Australia

Exercises

- Miocene, Bahamas

Seismic Attributes

- Define seismic attributes, their general classes, and situations in which different types of attributes are most appropriate
- Illustrate examples of the qualitative use of seismic attributes to understand carbonate reservoir systems
- Discuss quantitative applications of seismic attributes to map seismic facies and porosity in carbonate reservoirs
- Highlight limitations on seismic attribute analysis

Exercises

- Seismic expression of carbonates and some challenges

Seismic Geomorphology of Carbonates

- The expression of carbonates in three-dimensions, how these patterns reflect dynamic stratigraphic evolution, and how these patterns can be related to reservoir trends
- Time slices, horizon slices, volumetric interpretation
- Volumetric analysis of seismic data

Exercisees

- Seismic expression of carbonates in three dimensions

Advanced Seismic Attributes

- In-depth case study from the Devonian of Western Canadian Basin demonstrates the application of seismic modeling to enhance interpretation. This interpretation of high-frequency sequences is followed by seismic attribute analysis to qualitatively predict reservoir distribution and properties