SALTWORK TRAINING - CARBONATE GEOSYSTEMS
“Scientific knowledge is in perpetual evolution; it finds itself changed from one day to the next”

Jean Piaget
Why?

Geologists and geophysicists working in carbonate reservoirs know that to understand and predict reservoir quality needs more than the application of a simple depositional model. Such simple models may suffice for sandstone reservoirs, but in carbonates, the original depositional poroperm is often radically altered by a combination of diagenetic and structural overprints.

Saltwork’s applied carbonate course modules are designed to understand better the reservoir’s porosity distribution, fluid saturation, and the mechanisms by which pores are linked to allow flow. This leads to improved wireline and seismic interpretation and knowledge of how to apply this understanding in improved exploration and development efficiencies.

For more info please visit: www.saltworkconsultants.com
SALTWORK TRAINING

WHAT YOU WILL GET

Our course structure is modular so you, or your training coordinator, can construct a training program that meets your particular needs. The minimum-recommended program length for carbonate studies is three days made up of two days of the “understandings” modules (3000 code #’s), followed by a more specialized one-day program. A specialized third day is made up of two advanced modules covering two topics of specific interest. For a five-day course your choices of other more-advanced modules are included. Historically, some of the most popular advanced modules are:

- Wireline in carbonates
- Dolomitization
- Reef plays in SE Asia

The curriculum can be supplemented with specific topics related to carbonates in saline systems. You can also select from modules in the evaporite catalog (refer to website), e.g.,
- Evaporite basins
- Salt tectonics
- Saline reservoirs

We can also integrate our training with problem-specific training, including core, wireline, rock property, seismic and other data. Introductory aspects of training in the use of these data are also possible.
## COMPREHENSIVE COVERAGE OF CARBONATE GEOSYSTEMS

### Understandings
- What defines carbonate sediments?
- Diagenetic evolution
- Porosity and permeability
- Carbonate geosystems in time

### Oil and Gas
- Reservoirs and seal
- Sequence stratigraphy
- Reef plays in SE Asia

### Advanced topics
- Dolomitisation
- Wireline interpretation of carbonates
- Diagenetic stratigraphy in seismic

### Additional topics (from saline geosystems)
- Salt tectonics
- Saline reservoirs
- Source rocks
UNDERSTANDINGS
WHAT DEFINES A CARBONATE SEDIMENT?

Limestones and early dolomites are deposited with distinctive textures that can indicate the original depositional setting, ocean chemistry and water depth.

Topics: Carbonate grains; Depositional textures; Altered textures; Mud in carbonates; Classification of carbonates; Why carbonates are complex

Course 3000

Course 3000’s overview modules (2 days) are recommended as a common base to all courses

DIAGENETIC EVOLUTION

Carbonate texture and rock chemistry preserve evidence of as the various diagenetic fluids it was exposed to during burial, re-equilibration and uplift.

Topics: Marine cements; Meteoric alteration; The burial environment; Uplift and alternation; Isotopes and other tracers

Course No.3025

www.saltworkconsultants.com
Porosity and permeability distributions in ancient carbonates are rarely directly related to the deposition-al setting. Rather, they indicate a complex interplay of depositional and diagenetic factors.

Topics:
- Ø & k textural variation;
- Choquette and Pray Ø types;
- Lucia classes & k prediction;
- Classes & reservoir quality;
- Poroperm trends & burial;
- Diagenetic geometries

The modern gives a limited sampling of epeiric and saline basins. This reflects the limited climatic and tectonic spectrum of today. Past systems were more extensive and variable.

Topics:
- Eustasy, greenhouse, icehouse;
- Epeiric seaways and giants;
- Eustacy, karst, present & past;
- Are carbonates different?
- Are all carbonates fractured?

Course No. 3050

Course No. 3075
**DOLOMITISATION**

Most dolomite is a diagenetic mineral phase. Sometimes dolomitization enhances reservoir quality, other times it destroys it. There are many types and styles of dolomite, some are economically significant and can have recognisable criteria at both the local (wireline) and regional scales. Some sequences maintain economic levels of dolomite induced or enhanced poroperm, while overdolomitisation destroys it.

**Topics:** Models & geobodies; Permeability contrasts; Reservoir linkages

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**WIRELINE INTERPRETATION OF CARBONATES**

Wireline-based porosity logs give values that are typically not reliable representations of values in the reservoir. The module defines petrophysical effects of matrix and porosity variability and the effects on m, n and Sw in a variety of carbonate textures. Using Archie's Law, it then applies this knowledge to quantify better the reservoir.

**Topics:** Conventional Ø logs; Matrix styles versus log response; What is a real m & n? Reliable Ø interpretation; Combining logs

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**Course No. 3100**

**Course No. 3125**
Biogenic factors must be considered during sequence stratigraphic modelling and the definition of sequence boundaries. A fundamental difference is apparent if seismic and eustatic interpretations and poroperm pattern predictions were based on the siliciclastic-like assumption that sedimentation patterns respond to physical energy.

**Topics:** Carbonate responses are different to clastics; Sealevel & primary patterns; Carbonate eustacy over time; Highstand versus lowstand patterns and biological responses

**Course No. 3150**

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**SEQUENCE STRATIGRAPHY**

Reservoir sedimentation and diagenesis varies from field to field and region to region across the Phanerozoic. Understanding the depositional, climatic and diagenetic controls on these variations is critical to effective and efficient petroleum exploration and field development.

The module gives a predictive understanding of carbonate reservoirs distribution within a climatic and plate tectonic framework.

**Topics:** Platform & basin scalings; Diagenesis and geobodies; Predictive reservoir models

**Course No. 3175**
### Diagenetic Stratigraphy in Core and Seismic

Porosity distribution in ancient carbonate platforms is variably overprinted by diagenesis. Sometimes the distribution follows depositional facies patterns. More often, poroperm follows a hydrological pattern across eogenesis through mesogenesis into telogenesis.

**Topics:** Diagenetic geometries and overprints; Primary patterns and eogenetic alteration; Mesogenesis, telogenesis and fracture overprints; Is diagenetic alteration visible in seismic?

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### Tertiary Reef Plays in SE Asia

Most reservoirs producing from carbonates in SE Asia are hosted in Oligo-Miocene sediments. Unlike the giant fields in the reef-rimmed carbonate platforms, these SE Asian fields are typically smaller and hosted in bedded heterozoan sediments. This module classifies the various carbonate fields of SE Asia and discusses why they and their depositional models are distinctive.

**Topics:** Climate & tectonism; Island arcs & foreland basins; Carbonates in tectonically-active monsoonal settings

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**Course No. 3200**

**Course No. 3225**
**Terrigenous Clastic**

- Exposed shelf
- Incised valley
- Lowstand wedge
- Lowstand fan
- High
- Low

**Humid Carbonate**

- Exposed shelf
- Karst
- Lowstand shelf wedge
- Starved basin
- High
- Low

**Arid carbonate/basinwide evaporite**

- Equilibrium aggradation (>100's m) with transition into “fill & spill”
- Exposed basin margin
- Basinwide evaporites
- (mudflat, saltern, deep)
- Brine level
- Aggradation dominates

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**Terrigenous Clastic**

- Coastal plain and nearshore
- Estuarine
- Offshore marine (starved)
- High
- Low

**Humid Carbonate**

- Peritidal (lagoonal)
- Subtidal
- Reefs and shoals
- High
- Low

**Arid carbonate/platform evaporite**

- Platform Evaporites
- Mudflat
- Saltern
- Exposed barrier

Slight relative fall in sealevel isolates back barrier (e.g., 4th-order fall superimposed on 3rd-order rise) - eustatic response is preserved in evaporite and brine reflux alteration (plugging fades away from saltern)

Aggradational suaqueous stacks (<10's m) with sharp transitions into next marine episode
WHO & WHAT

PRINCIPAL TRAINER

Dr. John Warren is the leading expert and technical coordinator for Saltworks. His career spans more than 30 years in salty systems.

Interests include: Wireline Analysis, Carbonate and Evaporite Systems, Oil and Gas, Economic Geology and Potash exploration and development.

He has written four books on economic aspects of carbonates and evaporites, has contributed related chapters in a number of books and has published more than 60 scientific articles in applied aspects of carbonate and saline geology.

COURSE MATERIALS

Each participant in the course receives a complete set of digital course notes. This material is a series of hi-resolution pdf files that give the participant a copy of every slide presented during their training course.


This all-color edition runs to more than 1800 pages and has been cited as the most complete summary of saline carbonates and evaporites currently available.
ARE THESE THE END TIMES? YES. AND THEY HAVE BEEN THIS WAY SINCE THE BEGINNING. WELCOME TO PLANET EARTH, A WONDERFUL BUT NOT ENTIRELY STABLE PLACE TO LIVE.

Craig Childs