

RESERVOIR QUALITY STUDY OF SILICICLASTIC AND CARBONATE ROCKS

**3 days course in Oybin, Germany
5th - 7th of November 2018**



Course Agenda

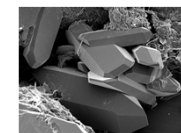
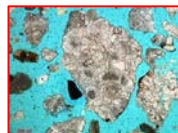
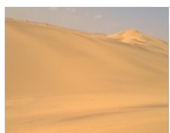
5th - 7th of November 2018 in Oybin, Germany

The technical workshop (**3 days oral & practical sessions**) are aimed at giving specialists from the oil industry a detailed introduction to the study of siliciclastic & carbonate reservoirs. Workshops are structured in oral and practical sessions, with PPT presentations, didactic material/exercises and work at a polarising microscope. Examples of SEM and CL analyses are also shown to integrate the different methodologies utilized for diagenetic/reservoir quality studies. Examples from oil reservoirs from different basins in the world are also taken into consideration.

RESERVOIR QUALITY STUDY OF SILICICLASTIC RESERVOIRS

MODULE 1: Introduction. Siliciclastic rocks, classification of sedimentary rocks, type of petro-facies, sediment texture (sorting, grain size, grain shape, grain contacts, textural and mineralogical maturity), detrital components. Sandstone classification, ternary plots (Pettijohn, 1987), Optical properties of most important minerals of siliciclastic rocks under PPL and XPL (*e.g.* undulatory quartz) and their link with source areas (plutonic & metamorphic sources), depositional markers, chemical & mechanical stability of minerals Sandstone composition, provenance and tectonic settings: Data collection methods (Gazzi- Dickinson), litho-types vs. provenance (Dickinson plots), QFL of sedimentary rocks in different tectonic regimes and rock composition vs. porosity/burial depth. Other techniques for provenance studies (CL, Qemscan and geochemistry) will also be explained. Types of depositional environments, Provenance and reservoir quality. Examples from current East & West Africa reservoirs (*e.g.* Central Atlantic margins). Exercises.

MODULE 2: Definition of matrix, pseudomatrix & authigenic components (main cements and replacement components): Compaction, silica cementation, carbonate cementation, feldspar authigenesis, clay minerals and zeolite authigenesis. Porosity types in sandstones: Primary pores (intergranular), secondary pores (secondary intergranular, intragranular>incipient dissolution, moldic pores, natural & artificial fracture porosity). Porosity-permeability plot for kaolinite-illite cemented sandstones, assessment of reservoir quality of studied petro-types, cuttings TS descriptions/analysis tied to wireline logs, targeted cuttings TS analysis, relative % of petro-types in cuttings. Porosity prediction in frontier basins: Estimating subsurface reservoir quality from outcrop samples. Exercises.



MODULE 3: Rock Typing, petrophysical assessment of uncored siliciclastic sediments (*e.g.* cuttings), practical work performing rock typing classification of selected cuttings to create Rock Typing datasheets. The Rock Typing classification scheme(s) to be utilized will be those created by Dr. Salvatore Morano (under copyright), mentor of the course, and/or other schemes as from oil industry methodologies (*e.g.* Sneider & King, 1984). Rock Typing and assessment of reservoir quality. Diagenesis of siliciclastic rocks, diagenetic environments & sequences. Diagenetic marine environment, Hot & humid/arid non-marine, near surface, eogenetic environment & burial environment. Diagenetic controls on reservoir quality and porosity variation with depth. Regional petrography vs. stratigraphy. Emphasis on single well or multi-well studies, with regional petrographic correlations. Exercises.

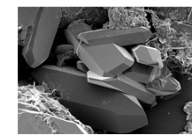
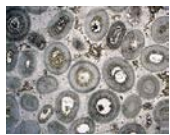
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RESERVOIR QUALITY STUDY OF CARBONATE RESERVOIRS

MODULE 1: Introduction, mineralogy of carbonate sediments (*e.g.* aragonite vs. calcite); Components of limestones: non-skeletal particles, skeletal particles. Table of taxa vs. mineralogy, carbonate matrix and pseudomatrix, classification of limestones (Dunham & Embry & Klovan), definition of crystalline rocks by crystal size. Sedimentary structures of limestones (*e.g.* hardgrounds). Carbonate depositional environments and facies: lacustrine limestones, marine carbonates, petrographic markers, intertidal-supratidal, lagoonal limestones and actual reservoirs (*e.g.* West Africa), reef limestones and reservoirs. Exercises. Pelagic limestones, re-sedimented deep-water limestones, limestone cycles, calcite vs aragonite seas in the geological record. Reservoir quality and source potential of each of the analysed depositional environments. Exercises in groups.

MODULE 2: Carbonate diagenesis and reservoir quality: neomorphism, compaction, marine diagenesis, intertidal-supratidal, subtidal cementation, marine dissolution, discussion of marine cements, meteoric diagenesis, vadose and phreatic zones, calcite spar and its origin, dolomitization of calcite, types of calcite cements. Dolomite textures, xenotopic vs. idiotopic dolomites, saddle dolomites, hydrothermal dolomites structure and stable isotope signature, dolomite texture vs. petrophysics, dolomitization models (Sakha/evaporation, mixing zone, seepage reflux, burial), limestone vs. dolostone rocks in terms of poro- perm characteristics of the analysed rocks. Exercises (individual and in groups). Carbonate diagenetic stages (eogenetic, kenogenetic, telogenetic zones).



MODULE 3: Porosity in carbonate rocks, dissolution of carbonates and associated processes, petrophysics by carbonate rocks, porosity preservation in carbonate rocks. Exercises. Reservoir quality of carbonate rocks, controls on reservoir quality (environment of deposition, burial of sediments, dissolution vs. cementation and structural deformation. Relation between rock fabric and wireline log responses, carbonate porosity evolution vs. diagenesis and geological time. Exercises. Carbonate reservoir models (*e.g.* geological reef model), interpretation of diagenesis, mineralization and reservoir quality, porosity vs. depth, regional carbonate petrography vs. stratigraphy. Rock typing of carbonate sediments in uncored intervals. Exercises.

Field Trips

5th - 7th of November 2018 in Oybin, Germany

Day 1



Upper Turonian Sandstone
Goblet Stone
90 minutes walk
guided tour

Day 2



Upper Turonian Sandstone
Rose Stone
90 minutes walk
guided tour

Day 3



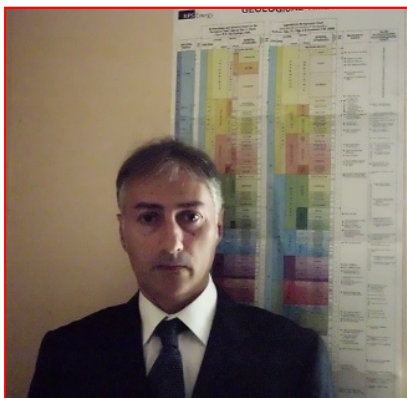
Upper Turonian Sandstone
Guard
60 minutes walk
guided tour

Please note: There are unfortunately no carbonate outcrops in the closer vicinity.

Instructor`s Profile

5th - 7th of November 2018 in Oybin, Germany

Dr. Salvatore Morano
Senior Petrography Advisor at Morano Petrography
Napoli, Campania, Italy
www.moranopetrography.com



An experienced sedimentary petrographer, specialized in the assessment of reservoir potential of siliciclastic and carbonate oil and gas reservoirs at well, field and regional scales. Author and co-author of multiple regional projects from reservoirs in East/West Africa, South America, Asia, Australia, New Zealand, Middle East and Europe.

Author of many academic papers and contributor of oil industry events (posters, abstracts and presentations). Mentoring and training of oil corporation staff in sedimentary petrography topics. Expertise in TS analysis of core samples & cuttings tied to wireline logs, as well as, Rock typing, SEM, CL, stable isotopes & epifluorescence microscopy of gas shale samples.

Oil industry job positions did include:
ALS Petrophysics (UK), Core Laboratories (UK) & Corex (UK);

Academic research roles:

Post-doc at the University of Burgundy (France) & Libre Universite' de Bruxelles (Belgium), and PhD research position at the University of Naples "Federico II".

Key Information

Dates:	5th - 7th of November 2018 (3 days)
Location:	Oybin, Germany (next airport Dresden)
For whom:	oil industry geologists/petrophysicists/geophysicists/reservoir/ engineers/drillers and post graduate students, useful for understanding of sandstone and carbonate reservoirs types.
Participants:	max. 15 persons
Contact:	ok@klarenco.com
Course Fee: (all excl. VAT)	<u>Option 1</u> EUR 1209 / p.p., including 3 nights at the Haus Hubertus, including breakfast and dinner http://www.naturparkhotel-oybin.de/haushubertus.html
	Shuttle to Airport Dresden and back Two guided tours to Upper Turonian Sandstone outcrops
	<u>Option 2</u> EUR 939 / p.p. without accommodation, shuttle and field trips
For Eurogeologists:	Option 1: EUR 1020 / p.p. Option 2: EUR 750 / p.p.
Cost for each field trip:	EUR 15