RockTYPE
Modelling hypothetical diagenetic pathways: application for carbonate Rocktyping

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ICCR philosophy: From data to models, from pore- to field-scale
Outline

• ICCR RockTYPE workflow
• Modelling diagenetic tipping points for step changes in porosity and permeability evolution
  – Classic diagenetic pathways
• Application of RockTYPE
  – A-Field
  – H-Field
Carbonate Rocktyping

- Group petrophysically similar rocks for carbonate reservoir characterisation and modelling
- Mismatch between static properties and dynamic properties
- Insufficient emphasis on the control of petrophysical properties due to diagenetic evolution of carbonates
ICCR RockTYPE workflow

- Identify a finite set of representative carbonate rock textures and associate each with its flow and connectivity properties using Pore Architecture Models.

Core plug

Thin sections

3D Structure

Multi-phase flow

Pore Architecture Model (PAM)
ICCR RockTYPE workflow

- Establish trends to illustrate the **evolution of flow properties** for given a depositional setting and the typical diagenetic processes that modify them to create the final reservoir rock.

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**ICCR RockTYPE** workflow diagram:

- Core plug
- Thin sections
- 3D Structure
- Multi-phase flow

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**Pore Architecture Model (PAM)**

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**ICCR Project RockTYPE**

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Hypothetical diagenetic pathways

Original sediment

Marine diagenesis  Meteoric diagenesis

Burial diagenesis

Modified after Dickson, 1990
ICCR RockTYPE approach

- Establish trends to illustrate the evolution of flow properties for given a depositional setting and the typical diagenetic processes that modify them to create the final reservoir rock.
Porosity and $K_{abs}$ Evolution

Pathway A

- Porosity
- Permeability

Literature values:
- Carbonate reservoir rocks – Lucia, 2007

Original sediment
- Marine diagenesis
- Meteoric diagenesis
- Burial diagenesis
Φ and $K_{abs}$ Evolution

Pathway B

Porosity

Permeability (mD)

Original sediment  |  Marine diagenesis  |  Meteoric diagenesis  |  Burial diagenesis

Porosity (%)
Φ and $K_{abs}$ Evolution

Pathway B

- Original sediment
- Marine diagenesis
- Meteoric diagenesis
- Burial diagenesis

Porosity (%)

Permeability (mD)
\( \Phi \) and \( K_{\text{abs}} \) Evolution

Pathway C

Porosity
Permeability

Original sediment
Marine diagenesis
Meteoric diagenesis
Burial diagenesis
Φ and $K_{abs}$ Evolution

Pathway C

- Porosity
- Permeability

Original sediment
Marine diagenesis
Meteoric diagenesis
Burial diagenesis
Φ and $K_{abs}$ Evolution

- **Pathway B**
- **Pathway C**

**Permeability (mD)** vs **Porosity (%)**

- **Original sediment**
- **Marine diagenesis**
- **Meteoric diagenesis**
- **Burial diagenesis**

**Key Events**
- Pathway C: Increase in porosity and decrease in permeability.
- Pathway B: Decrease in porosity and decrease in permeability.

**Diagenetic Processes**
- Marine diagenesis
- Meteoric diagenesis
- Burial diagenesis

**Note:** The graph illustrates the evolution of permeability and porosity through different diagenetic pathways.
Topology and Connectivity

Pathway A

Original sediment

Marine micritisation

Meteoric dissolution

Frequency (fractional)

Radius (μm)

Pathway B

Original sediment

Marine cementation I

Marine cementation II

Burial cementation I

Burial cementation II

Frequency (fractional)

Radius (μm)

Pathway C

Original sediment

Marine cementation I

Marine cementation II

Meteoric dissolution I

Meteoric dissolution II

Burial cementation I

Burial cementation II

Frequency (fractional)

Radius (μm)

Pathway A

Pathway B

Pathway C
Pc and $K_r$ Evolution

Pathway A
- Original sediment
- Marine micritisation
- Meteoric dissolution

Pathway B
- Original sediment
- Marine cementation I
- Marine cementation II
- Burial cementation I
- Burial cementation II

Pathway C
- Original sediment
- Marine cementation I
- Marine cementation II
- Meteoric dissolution I
- Meteoric dissolution II
- Burial cementation I
- Burial cementation II
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RockTYPE: A-field

- Current reservoir model: 2 $K_r$ curves
- RockTYPE:
  - Investigated impact of diagenesis on $K$ evolution (December 2011)
  - Integrated new Rocktype models into reservoir model (HABITAT): 10 new $K_r$ curves
RockTYPE: H-field

- Validation vs. Plug data

Rocktype scheme by Simpson, 2011
RockTYPE: H-field
Summary

- Rock textures from 2D images produce realistic porosities and permeabilities
- Flow properties of intermediate stages were obtained
- Tipping points were identified in classic pathways of permeability evolution of carbonate rocks

- Update reservoir models with dynamic Rocktypes (A-field, H-field)
- Calibrate basin evolution model with dynamic data
  - Timing of cementation (BasDiHist)
- Create interwell Rocktypes based on spatial diagenetic trends
  - Dynamics of cementation (RockTYPE)
RockTYPE: Key Facts

Key deliverables – started January 2011

- Identify a finite set of representative carbonate rock textures and associate each with its flow and connectivity properties using Pore Architecture Models
- Establish trends to illustrate the evolution of flow properties for given a depositional setting and the typical diagenetic processes that modify them to create the final reservoir rock

Business impact

- Improvement of existing carbonate rocktyping schemes to better constrain reservoir model

Field data and pre-salt potential

- Applied to A-Field data, technology applicable to pre-salt

Technology transfer

- Workflow and software for digital rock physics in carbonates

Links to Brazil

- Visits to and shared datasets with UNESP and UFSC

Publications and presentations

- Oral presentation at EAGE 2012. Invitation to publish in First Break.
- Paper in preparation for peer-review