SAFARI – An outcrop analogue database for reservoir modelling

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CIPR - Centre for Integrated Petroleum Research

The Norwegian Centre of Excellence in Petroleum Technology

- Applied research into increased oil exploitation and secure CO\textsubscript{2} storage
- Specialty in integration of traditional research areas in cross discipline cooperation
- Research topics:
  - Enhanced oil recovery (EOR)
  - Geosciences $\rightarrow$ Virtual Outcrop Geology (VOG)
  - Reservoir simulation
- more than 100 researchers and PhDs from all over the world
Virtual outcrop geology group

- **3D spatial data collection** for building and interrogating *models of geological outcrops*
  - Laser scanning (LIDAR): ground-based + helicopter-based
  - photorealistic models of outcrops

- **Technique development**
  → maximizing the quantitative information extracted and used from VO data

- **Sedimentological outcrop analogue modeling**
  - Interpretation of features
  - Quantitative analysis
  - accurate and high resolution input for reservoir modeling

- **Visualization and data integration**
Oblique Helicopter-based LIDAR scanning for outcrop mapping
Mediumfjellet (Svalbard)

Fracture and fault analysis

Simon Buckley
Statistical and dynamic analysis of virtual outcrops and geocellular models for shallow marine deltaic systems

Mapping of clinoforms

Building of surfaces

Dynamically testing reservoir models (flow sim.)

Water injector

Producer

Building of reservoir models

Håvard Enge
Integration of hyperspectral imaging and lidar for geological mapping (1/2)

Sensor with rotation stage

dolomite
limestone

dolomite
limestone

spectral image

Tobias Kurz
Result – Classified point cloud (2/2)

- Highly dolomitized: 1.1% pixels
- Moderate dolomitized: 17.8% pixels
- Limestone: 24.1% pixels
EUSA
Empirical Understanding of Sedimentary Architecture

Project goals:
• To collect large volumes of spatial geological outcrop data addressing the preserved stratigraphic architecture
• To setup a database with all the existing data and large volumes of new data
• funded by the Norwegian Research Council, NPD, 19+ oil companies through FORCE consortium
• project start was in June 2009
• 4 year
Sedimentary Architecture of Field Analogues for Reservoir Information

Objectives

• A database for all outcrop data
  → hard data = numerical information on sand body and barrier
  → soft data = for improved conceptual understanding of depositional systems

• Common outcrop standard for nomenclature, data categories and domains

• Combines a large variety of different data sources
  – SAFARI data
  – Existing literature data
  – Virtual outcrops 3D data from CIPR
  – …
Database requirements

- Storage and visualization of multiple data types
  → e.g. geographical coordinates (GPS), numerical, vector, raster and 3D outcrop data, pictures
- Common standards for nomenclature, categories and domains
- XML exchange standards
- Search and query functionality
- Data analyses
  - 2D statistical plots
  - 3D virtual outcrop interpretation
Database implementation structure

proposed DB structure:
- flexible, easy to use
- fully accessible over the internet

Database
(e.g. File GeoDB, SDE Oracle, ...)
- SAFARI data
- 3D virtual outcrops
- published literature
- modern depositional systems

ArcGIS Server 9.3.1

viewers
ArcGIS Explorer
Web mapping application
ArcGIS Desktop
ArcGIS mobile

server

data

XML import/export
ArcExplorer demonstration
Data standardization

lion ≠ elephant ≠ giraffe
Data standardization

≠

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first draft – just 3 weeks old!
Standardization

SAFARI database

- Depositional environment
- Sub-Environment
- Architectural element (AE)
- Lithofacies (LF)
  - LF geometry
  - AE geometry

- Project info
- Outcrop info

- Outcrop physical description and geometry
  - Setting
  - Stratigraphy
  - Geological age

- Additional data
  - Cross sections
  - Logs
  - Pictures
  - Samples
  - Survey data (incl. 3D virtual outcrop data)
  - Model data

- Reference (Lit.)
- Georeference

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Open discussion of outcrop standards and nomenclature! → just started!

Do you like to contribute to the standardization and nomenclature process or maybe your geologists?

Contact me: Nicole.Richter@uni.no

http://org.uib.no/cipr/Project/SAFARI/
Conclusion and outlook

• Preliminary database structure
• Definition of standards and nomenclature
• Acquisition and standardization of new datasets
  – 8 virtual outcrops
  – 117 deep water outcrops data sets
  – 32 rivers with 155 sections

→ Setup of ArcGIS Server and clients
→ Design of maps, tools and functionality
Sponsors

The Research Council of Norway

FORCE Sed/Strat group

through the PETROMAKS programme

Sponsors

- VNG Norge
- ConocoPhillips
- PETNORSKE
- ROCKSOURCE
- ExxonMobil
- Lundin
- Eni Norge
- TOTAL
- Chevron
- Shell
- Norwegian Petroleum Directorate
- REUS
- GDF Suez
- RWE
- NORECO
- Statoil
- Bridge Energy
- DONG Energy
- Aker Exploration

CIPR
More information?    Want to be part?

Get in contact!

http://org.uib.no/cipr/Project/SAFARI/

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Thank you for your attention!