AIRY [Techlab]

RANGE: Rock Characterization and Mechanical Earth Model

LINE: Digital and Conventional Rock Analysis

REPSOL Technology Lab

Short Description

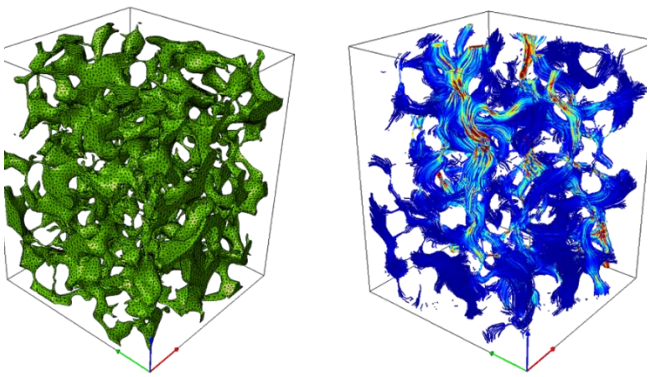
AIRY (StAndard DIgital Rock PhYsics) is our numerical modelling solution. It generates and/or consumes tomographic 3D images reconstructed from X-Ray Tomographers and FIB/SEM microscopes. By advanced numerical simulations and pore network modeling, physical phenomena is recreated in the digital model to mimic actual laboratory protocols to obtain rock properties.

Deliverable

- REV Analysis, Porosity and Permeability multipoints and correlations. Capillary pressure and relative permeability end-points or full curves.
- Rock families and categorical analysis for improved heterogeneity understanding can be deployed if requested.
- **Deliverable format:** stack of TIFF images + technical report + .csv and .las files (if depth profile is needed).

Benefits

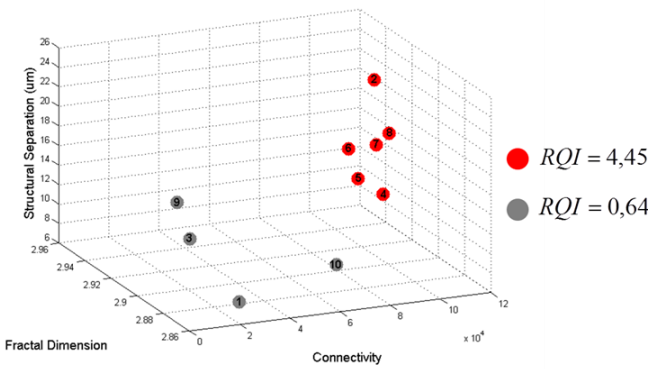
- Multiple Properties points per sample (up to 10^2) compared with only 1 point using conventional methods.
- When fully deployed times for extensive SCAL campaigns can be diminished up to 70%.
- Properties uncertainty can be addressed as numerical simulations can be conditioned for several probability scenarios.
- Not only scalars are reported. When feasible also full tensor/multipoint characterization can be obtained by analyzing all models directions behavior.



Left: Meshed High Resolution (um scale voxel) pore space. **Right:** Fluid flow simulation of a water wet siliciclastic system (colored by fluid velocity, red higher) . Permeability can be measured by the flux rate at each model direction. Displayed digital model around 3x3x6mm

Differential Features

- New developed PNM applications can speed up Absolute and Relative Permeability together with Pc calculations from hours to minutes per sample.
- New properties, non accessible using conventional lab protocols, can be acquired for improved rock physics models.
- Advanced Repsol categorical analysis tools strongly enhances spatial characterization and propagation of numerical estimated properties for better Earth models.



Reservoir property behavior characterization in several wells using new properties extracted by advanced calculations in the generated 3D digital model. i.e. Fractal Dimension, Connectivity and Pore Structural separation. (Trinidad and Tobago Field)

Requirements

- Rock samples are needed. Alternatively tomographic or FIB/SEM 3D images previously acquired by the client (under Repsol guidance and quality standards) can also be used.
- Rock samples needs to be of quality and good size for proper pluging/sub pluging depending on needed resolution and FOV needs.
- This rock material should come from coring, SWC or any other recovery with enough volume for proper cylindrical probe generation.

Limitations

- Results calibration using [TechLab] in-house developed models or conventional RCAL data from some few analog samples is advised for more accurate outputs.
- Current image capabilities are strongly not recommended for pore sizes under 0,1 microns.
- Tomographic image contrast and s/n ratio should be good enough for proper image segmentation.

The Product in Depth

Product starts with a proper 3D image dataset either from X-Ray tomographers (main pore sizes over 1um) or FIB/SEM instrumentation (sub micron pore sizes). Pore space and solid phase of the model are separated by image segmentation. Once the pore and grain space are correctly defined, these phases can be modelled by a meshed numerical method (i.e. Finite Elements, Finite Differences) or unmeshed numerical methods (i.e. Lattice Boltzmann or Smoothed Particle Hydrodynamics methods). Also some numerical approximations can be implemented like the Pore Network Modelling to speed up final delivery. Each image is processed to observe the appropriate Representative Elementary Volume (REV). If this REV is smaller than current image multiple numerical experiments can be conducted on one sample providing a richer number of data points and better uncertainty understanding. Because all experiments are conducted in a digital domain boundary conditions and field directions can be completely modified (which cannot be done in the laboratory) to get probability analysis and full tensor behavior if requested.

Some Use Cases

Use Case / Model	Client	User	Cost (K€)	TimeToMk (m)
Gulf of Mexico (Leon 2 well, ~30 samples). Comprehensive RCAL/SCAL analysis (2016).	• Gulf of Mexico	• Petrophysicists • Reservoir engineers	80	4
Trinidad & Tobago. Reservoir Quality and Permeability analysis lab tests (~20 samples) due to samples physical dimensions (2018-2019).	• Trinidad & Tobago	• Petrophysicists • Reservoir Engineers	33	1