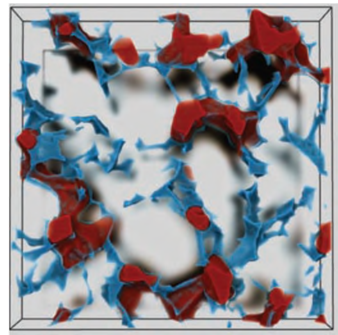
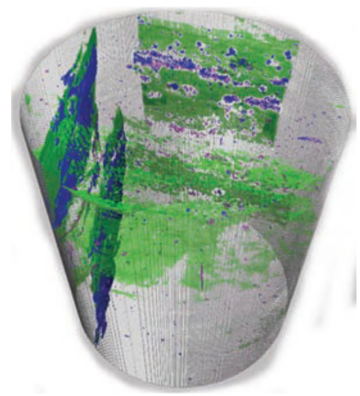
Digital rock physics (DRP)

Look on internet for more details



The most important factor governing the physical behaviour of a real rock sample is the rock microstructure, i.e. the distribution of the grains and pore space. Depending on the rock type these can be rather simple as in the case of a clean water-saturated sandstone or inherently complex like for rock with multiple fluid phases or carbonates with a vuggy porosity, including clay minerals etc. The high variability of observed rock properties reflects the strong differences in rock microstructure. Therefore, the accurate characterization of the rock matrix geometries and pore networks is crucial for the understanding of the material behavior.



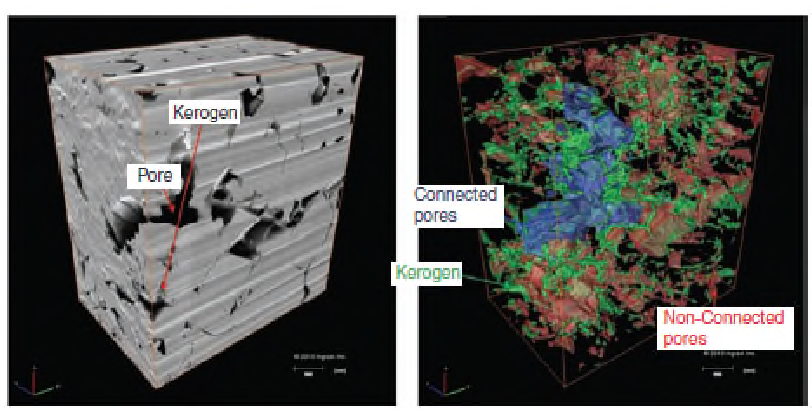
A new and fastly evolving area within the field of rock physics research is the Digital Rock Physics (DRP) technology (Dvorkin et al., 2005; Knackstedt et al, 2009). The two cradles of this technology are X-ray computer tomography (CT) and the direct computer simulation of various rock properties based on the obtained 3D scans. DRP can complement physical laboratory measurements by providing fast and cost-effective access to important rock parameters such as porosity and pore space tortuosity.

Schlumberger has been working on aspects of the “digital rocks workflow” from 2006. The work includes research into fluid dynamics at the micro scale,X-ray microtomography, advance algorithms and 3D image processing. Schlumberger is “validating and calibrating” the components and how they fit into this process, which itsees as a useful long-term tool..

Those in the digital rocks business have created systems designed to ensure their results statistically represent a larger area. All of them rely on multiple images, beginning with images covering larger areas to select representative smaller targets. Results are checked against other indicators.

... methods for elastic upscaling

Seismic waves are regularly used in exploration and subsurface imaging. The elastic shear and compressional rock stiffness is a key factor controlling VP and VS. In addition, the rock stiffness is inherently linked to rock strength and failure. Microscale rock-fluid interaction can also be a source of wave attenuation.



Digital Rock Physics tools can provide

a valuable tool to predict elastic stiffness for different lithologies, porosities and microstructure types. It has potential to include fluid substitution relations.

This can be achieved by computing the stress state on the microscopic level, typically under isotropic and shear deformation.

The principal question of rock physics is:

- ✓ How we relate elastic moduli, electric fields, etc to petrophysical properties such as porosity, permeability, fluid saturation and mineralogy.

Microstructure and mineralogy determine the effective stress concentration, and digital rock physics therefore provides rich information for the understanding of elastic upscaling and rock physics modeling.

Capillary Phenomena

http://encyclopedia2.thefreedictionary.com/Capillary+Phenomena

… physical phenomena caused by the surface tension at the interface of immiscible media.

The form of the contact surface between liquids and solids is substantially influenced by wetting phenomena, which are caused by molecular interactions between liquid and solid.

Wetting implies that a liquid interacts more strongly with the surface of a solid than does a gas over the liquid. The forces of attraction acting between the molecules of the solid and the liquid cause the latter to climb along the wall of the vessel, which leads to curvature of the surface region adjacent to the wall. This creates negative (capillary) pressure, which at each point of the curved surface precisely balances the pressure generated by the rise of the level of the liquid. The hydrostatic pressure within the volume of liquid remains unchanged in this case.

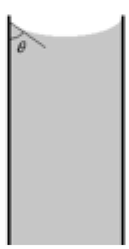
- 

  Illustration of concave meniscus (contact angle < 90°) – like water

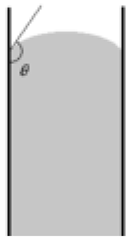
- 

  Illustration of convex meniscus (contact angle > 90°) – like oil

Many of the properties of disperse systems (permeability, strength, sorption of liquids) are determined to a large extent by capillary phenomena, since high capillary pressures are generated in the fine pores of these materials.

Three main variables that determine whether a liquid possesses capillary action are:

1. **Cohesive force**: It is the intermolecular bonding of a substance where its mutual attractiveness forces them to maintain a certain shape of the liquid.
2. **Surface tension**: This occurs as a result of like molecules, cohesive forces, banding together to form a somewhat impenetrable surface on the body of water. The surface tension is measured in Newton/meter.
3. **Adhesive force**: When forces of attraction between unlike molecules occur, it is called adhesive forces.

Capillary action only occurs when the adhesive forces are stronger than the cohesive forces, which invariably becomes *surface tension*, in the liquid.