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Rock Physics, Reservoir Sim., & 3+4D Seismic

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SUMMARY

The need for massive Rock Physics information is growing exponentially for (1) Geo steering; (2) Better recovery rates; (3) Better well bore management, (4) Advanced reservoir simulation; and (5) Better drilling.

Because physical measurements of special rock properties are slow and cumbersome, massive data sets can only be obtained through computational rock physics. This involves very high resolution and very fast imaging of the pore spaces of cores, plugs, or cuttings. The images are used to compute bulk properties and simulate pore scale processes, such as capillary pressure, relative perm, electrical conductivity, strength, elastic constants, seismic velocities, and NMR response.

The major impacts of this emerging technology is to (1) Transform special core analysis as practiced today, (2) Obtain permeability logs from cuttings in quasi real time, (3) Rigorously link logs and rock properties, (4) Link log and rock properties and 3D seismic to look away from the borehole, (5) Significantly enhance the interpretations of time-lapse InSar, EM, Gravity and 4D Seismic, (5) Create massive special rock properties data bases (relative perm, cap pressure, Archie's 'm' and 'n', elastic properties) and (6) Provide rock properties for shales including permeability and relative permeability that are otherwise impossible to obtain.

The need for massive Rock Physics information is growing exponentially for (1) Geo steering; (2) Better recovery rates; (3) Better well bore management, (4) Advanced reservoir simulation; and (5) Better drilling.

However physical measurements of rock properties on cores, plugs, and cuttings are slow and cumbersome, and often impossible to do or do well. They are also very sparse: what is needed are properties not for 10's of samples but 1000's or tens of thousands samples.

The only way to obtain such massive data sets is through the emerging computational rock physics methodology. This methodology consists of very high resolution (< micron and even down to nanometers) and very fast imaging of the pore spaces of cores, plugs, or cuttings. The images are used to a. accurately compute bulk properties very fast (minutes) and b. simulate pore scale processes also very fast (tens of minutes).

Computed properties obtained include porosity, permeability, capillary pressure, relative perm, electrical conductivity, strength, elastic constants, seismic velocities, grain and pore size distributions, NMR response.

Rock types are sands, carbonates, heavy oil/tar sands, tight gas sands, and especially gas and oil shales. Samples can be cores, plugs, and cuttings. With the images we can also computationally simulate pore scale processes: Fine migration, Formation damage, Compaction associated with production, CO₂, steam, water injection, Diagenetic processes, Chemical reactions in pore space

The most immediate and major impact of this emerging technology will be to (1) Transform routine and special core analysis as practiced today, (2) Obtain permeability logs from cuttings at the well head in quasi real time, (3) Rigorously link logs and rock properties, (4) Link log and rock properties and seismic to look away from the borehole (drill virtual wells), (5) Significantly enhance the interpretations of time-lapse InSar, EM, Gravity and Seismic, (5) provide massive special rock properties (relative perm, cap pressure, Archie's 'm' and 'n', elastic properties) and (6) Provide rock properties for shales including permeability and relative permeability that are otherwise impossible to obtain.

In this presentation I discuss how this emerging technology is the key to (1) Transform routine and special core analysis as practiced today, (2) Obtain permeability logs from cuttings at the well head in quasi real time, (3) Rigorously link logs and rock properties, (4) Link log and rock properties and seismic to look away from the borehole (drill virtual wells), (5) Significantly enhance the interpretations of time-lapse InSar, EM, Gravity and Seismic, (5) provide massive special rock properties (relative perm, cap pressure, Archie's 'm' and 'n', elastic properties) and (6) Provide rock properties for shales including permeability and relative permeability that are otherwise impossible to obtain.