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How big data particle-size measurements can be used by oilsands geoscientists

Russell, P.W. Stancliffe and Bruce James
GeoR.E.D. and James Reservoir Inc.

Summary

Core and chip samples are often collected when drilling an oilsands well but rarely are the grain size data used to their full potential. Often this is due to time and cost considerations but increasingly due to the lack of knowledge as to what the value-add might be. This talk aims to highlight a number of uses currently available along with new and possible areas of future applications.

Background

The drilling programs of most exploration and development companies create large amounts of core and drilling chips to meet government requirements and provide data for mapping and modelling. However, subsequent analyses of the rock are often dependant on the time and money available, which is usually limited. Chips are often not even cleaned and analysed and cores just logged and not subject to Special Core Analysis (SCAL).

One such dataset, which has fallen from the standard analysis process is grain size determination, though the generated information can have many important applications. Previous datasets were generated using sieve stacks and weighing the retains to estimate the amounts of each grain size. The results were often altered by deformed holes in the sieves and the variable presence of non-silica grains in the fractions. An alternative common method uses the coulter technique which measures the impedance of each grain to calculate its volume. These results can also be altered by the presence of conductive minerals and grain ‘clumping’.

With the advent of high-resolution imaging, it is now possible to resolve all the individual grains of a core slab or chip sample. With the addition of artificial intelligent analysis, each grain can be measured in 2 dimensions, its angularity determined along with how ovoid it is. Also, the colour can be recorded along with the reflectance. The dataset developed can have statistical significance, is repeatable and acquiring it is non-destructive and quickly obtained. It is also large, though modern computing can now handle the Megabytes of data involved.

Observations,

Some of the current uses of grain size data are outlined below. A further section outlines possible future developments using this technology.

- Sedimentology
  - The provenance of particles can be determined by the grain size and colour. Also, the maturity of the grains (the shape, angularity and rounding) varies over

the length of transport. Furthermore, in flume studies the grains are assumed to be spherical and these new shape measurements can highlight the variation away from the assumption

- Stratigraphy
  - Common sand on sand contacts can be resolved using the change in grain size along with sorting changes. Also, variations in cap rock geomechanical properties are often dependent on grain size changes along with the amount of sand grains present.
- Depositional environment
  - The calculation of the energy needed to transport a grain by, for instance saltation, often uses spheres. The use of real shapes can produce better approximations. Gamma logs are often used to determine fining up (fluvial) and coarsening up packages (shoreface). However, the technique uses radioactivity as a proxy for grain size making for errors in sediments sourced from radioactive volcanic sources.
  - Unimodal and bimodal grain size packages are used to determine the presence of tides in estuarine sediments. Large outlier grains can often create false records but this can be negated by measuring all the grains. The amount of sorting can also be used to determine the depositional environment.
- Porosity
  - The calculation of porosity often assumes spherical grains but the new dataset shows this is normally not so. The packing of grains is also based on spherical grain models. The new dataset will create more accurate models.
- Permeability
  - Using the grain sizes found to generated a permeability value of many small zones along a core. This key data is often not generated due to legacy techniques which are costly and take a long time to complete.
- Resource calculation
  - Net to gross determination depends on the porosity values which can be suspect. Also, the oil/water contact can often be associated with a grain size change.
- Horizontal well drilling
  - Real time location of horizontal wellbores in different sand packages can be determined by plotting the grain size changes in recovered chips. If a lost circulation zone is drilled the remediation can be optimised if the grain size is known. Knowing the variation in porosity at the centimeter scale is also important for steam thief-zone location
- Well completion
  - Includes slot size determination, wire screen wrap selection, gravel pack sizing and cement type optimisation. All are influenced by the grain size.
- Flow Control Devises
  - Location along wellbore can be optimised if the sand grain size is known which in turn can be used to determine the permeability present

New possible applications

- Location of SAGD production in a steam chamber over time using changes in grain type flowing back to surface

- Optimise oil/water separation in surface tanks
- C.H.O.P.S. history and development
- Geomodels – location of thin porous zones and their minimum dip in core
- Porosity calculation at the cm level across and along a core
- Capillary pressure calculations at oil/water contacts
- Permeability calculation improvement by using grain angularity and ovoid shape variations to determine tortuosity
- Wettability calculation based on non spherical grains
- Reservoir dilation with the correct sized proppant sand grains
- Placement of multiple slot sizes in horizontal wells
- Use rock fragment size in chips along with Pason data to locate cemented zones
- Determine the change in secondary cementation of grains along a well bore
- Could 3D measurements of grains be achieved using sonic techniques and high speed cameras?

Conclusions

The measurement of individual grains in a core or chip sample produces large data sets quickly and cheaply. These can be now used to refine present applications so that the old sieving and coulter models of measurement can be abandoned. New applications are also being developed so that wells can be drilled and developed more efficiently with increased chance of success.

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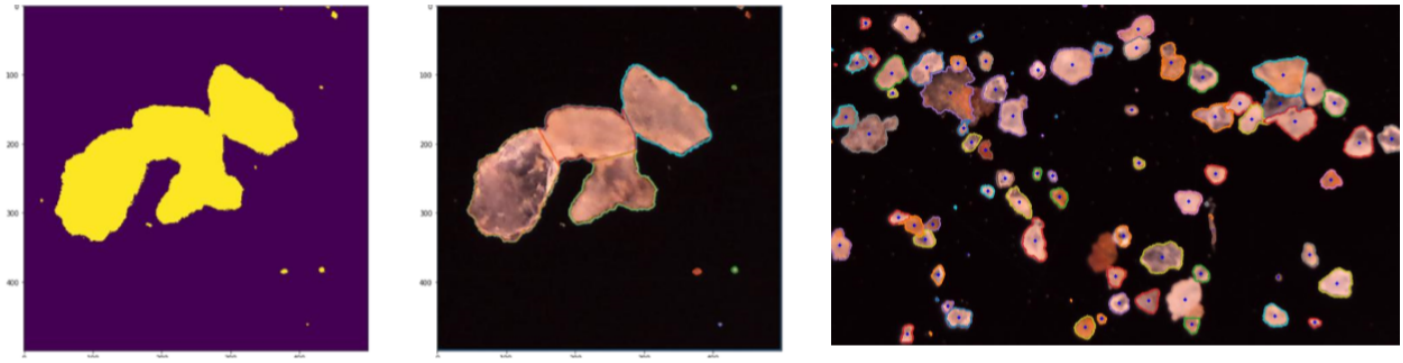

Text Figure 1: Each grain or cluster of grains is automatically outlined by the computer to produce a dataset. This in turn is then subsampled to separate out the single grains for measurement (length, breath, roundness and roughness) along with a colour determination. The clusters can be processed for individual grain measurement though the roundness and roughness values cannot be used. The amount of clustering can indicate the amount of secondary cementation of grains along the wellbore.