

2014 AADE Fluids Technical Conference
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Automated Vision Based Particle Analysis

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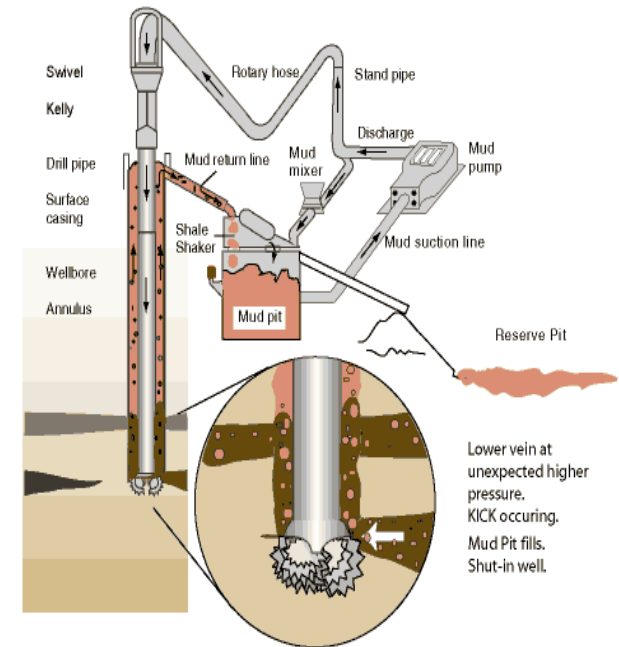
Particle Size Analysis of Drilling Fluids

- Introduction

- Drilling muds or fluids are complex aqueous or oil-based suspensions designed to fulfill a number of important functions during the oil extraction process.

- Main Functions

- Provide hydrostatic pressure to prevent formation fluids from entering the well bore
- Keep the drill bit cool and clean during drilling
- Carry out drill cuttings
- Suspending drill cuttings while drilling is paused and while drilling assembly is brought in and out of the hole
- Avoid formation damage and limit corrosion



Typical Drilling Mud System

Importance of Particle Size for Mud

- Mud performance controlled by manipulating the mud composition and the properties of the constituents through the addition of different additives.
- Particle size significantly affects the way in which the mud interacts with the surrounding geology.
- Particle size and shape measurements play an important role in the formulation of high performance drilling muds.
- Particles smaller than the pore size of the surrounding geological formation will bridge rock pores during mud circulation, leading to the formation of a filter cake that prevents the egress of fluids from the well during drilling.
- This “filter cake” protects the surrounding rock from damage while simultaneously preventing fluid loss and achieving well stabilization.

Drilling Mud Particle Analysis – Drill Cuttings & LCM's Background Information / Applications

Drilling Mud Functions Include;

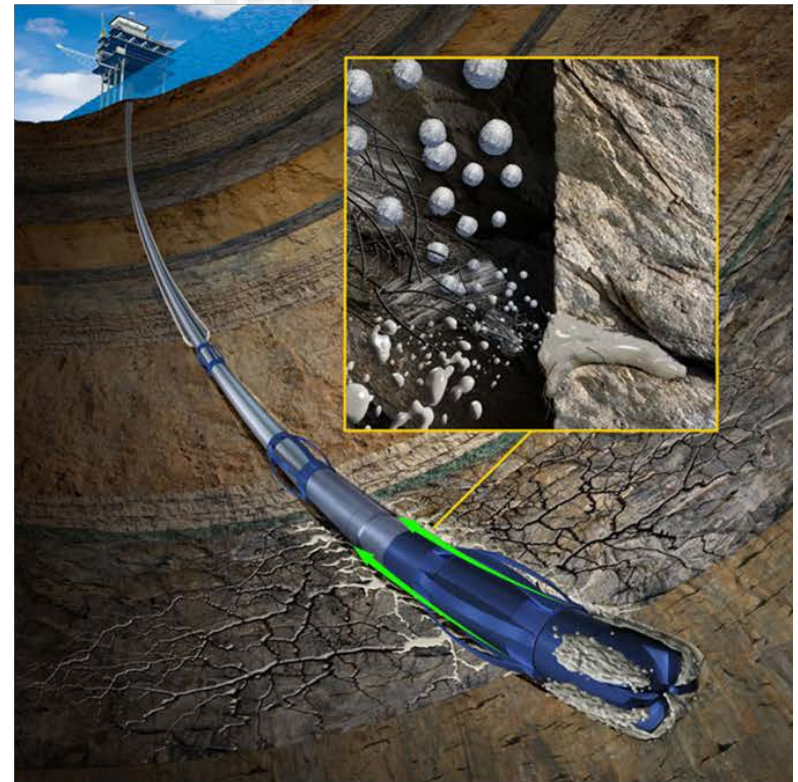
Seal Permeable Formations – Materials (including LCM's - Lost Circulation Materials) are added to the mud to bridge large openings / fractures in the bore wall, and form a thin low permeability filter cake on the bore wall – particle size measurement of the added material is critical to ensure effectiveness of bridging particles



Drilling Mud Particle Analysis – Drill Cuttings & LCM's Background Information / Applications

Drilling Mud Functions Include;

Control Formation Hydrostatic Pressure – Unbalanced formation pressures can cause unexpected influx of pressure in the well, possibly leading to a blowout. Mud density is controlled (often with barite or other weighting materials) to balance pressure & keep the wellbore stable. – particle size measurement of the barite & fines within the drilling mud is critical to controlling the density of the drilling mud in order to balance with the formation pressure pressure



Typical Instruments Currently Used

- Sieves
- Laser
- Vision
- Only Vision can do shape analysis.

- Sieve Analysis
 - Used for many years, simple & inexpensive
 - Disadvantages:
 - Time (Sedimentation and Sieving are both slow and time consuming processes)
 - Particle Size (Particles too small for separation by sieving to be practical)
 - Error (Over-energetic sieving causes attrition of the particles and thus changes the calculated particle size distribution)

Laser Diffraction

- Quickness and ease of use
- Disadvantages:
 - Water droplets (in oil based) Oil droplets (in water based) mud measured as particles.
 - Non-spherical objects (large discrepancy between laser measurements)
 - Laser 1D (equivalent sphere) and not recommended for large aspect ratio.
 - Distortion of Measurements (existence of “ghost” particles caused by sharp edges on the objects which produce high angle diffraction)
 - Acicular particles (shows much larger sizes compared to laser diffraction, undercounts events generated by major chord)
 - Laser diffraction intrinsically biased towards the smaller edge of spectrum.
 - Difficulty with coarse materials

Lasers and Large Particles

As particle size increases agreement between laser measurements is lost. A reproducibility test recently performed found the following data with three different Laser instruments:

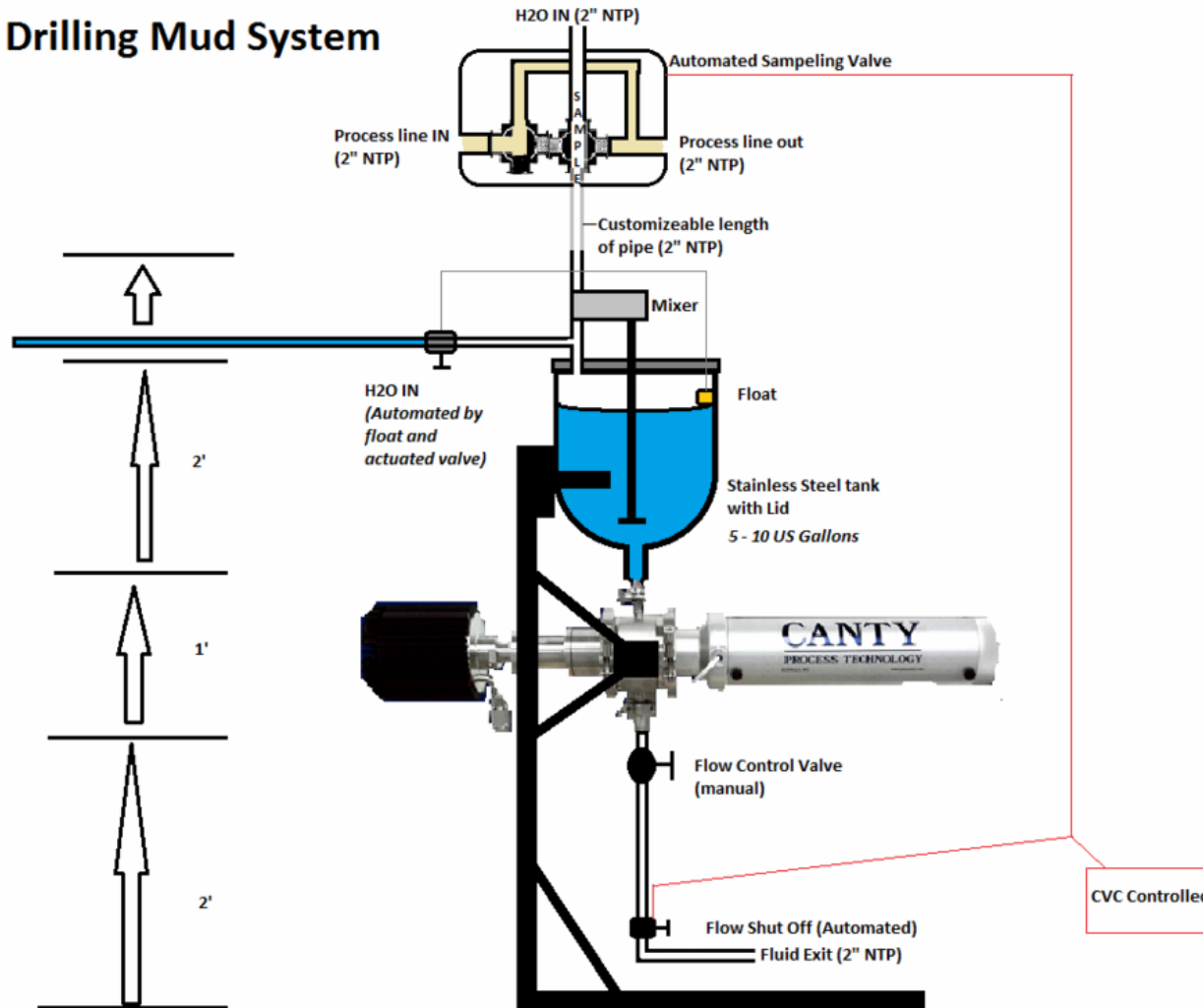
	D10	D50	D90
Instrument 1	720	1602	2866
Instrument 2	834	1392	2531
Instrument 3	810	1466	2949

Imaging Advantages

- Real time 2Dimensional particle shape analysis.
- The particles are oriented in the fluid dynamically designed flow cell to measure the largest length and widest section of the particles. All aspect ratios are measured correctly
- Direct measure of particle area – a two dimensional measurement.
- Direct measurement of particle perimeter – a two dimensional measurement.
- Direct measure of major axis and minor axis – a two dimensional measurement.
- Able to separately measure various particles separately water, barite, polymer using size shape and color data
- Direct measurement of particle color.
- Large particle range – 2” down to .7 micron

At Line Dilution

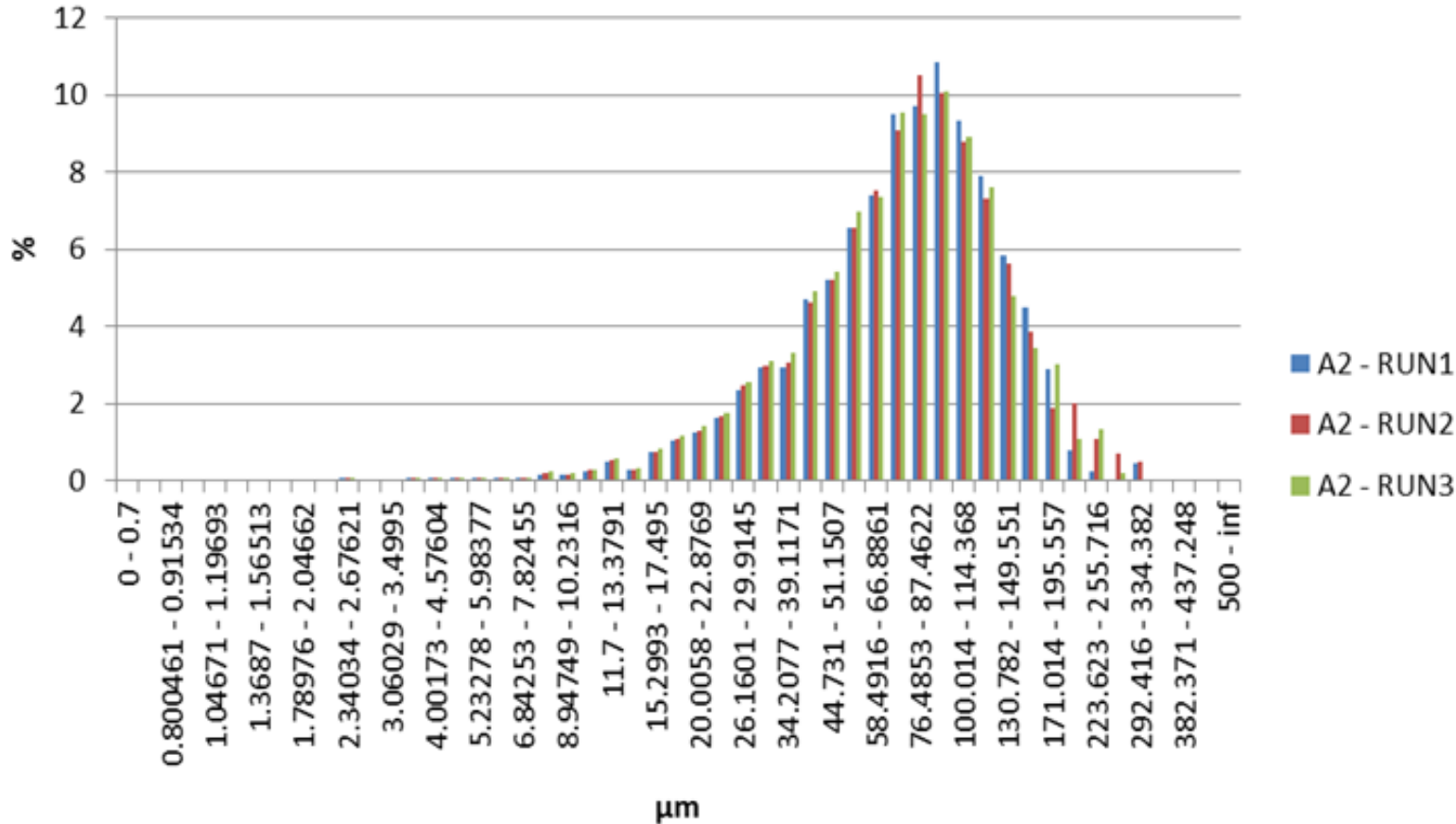
Drilling Mud System



Cross Cut Sampling

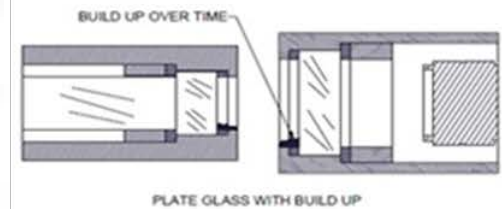
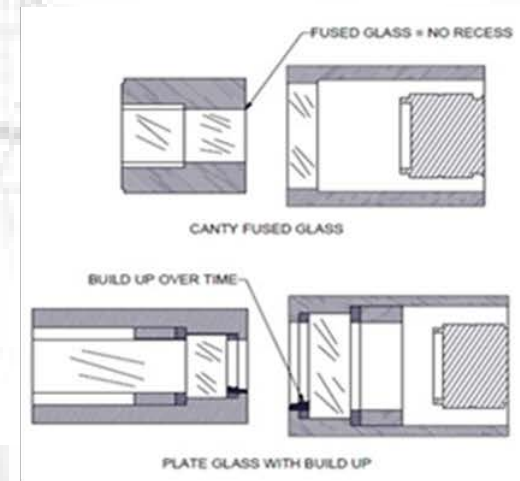


Typical Vision Repeatability

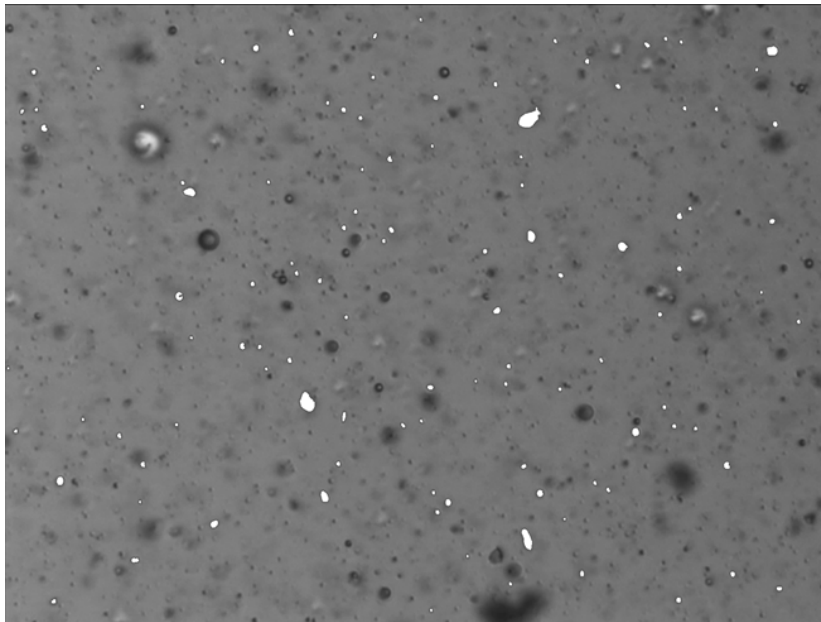


Drilling Mud Particle Analysis – Drill Cuttings & LCM's Image Retrieval – Hardware – Fused Glass Flow Path

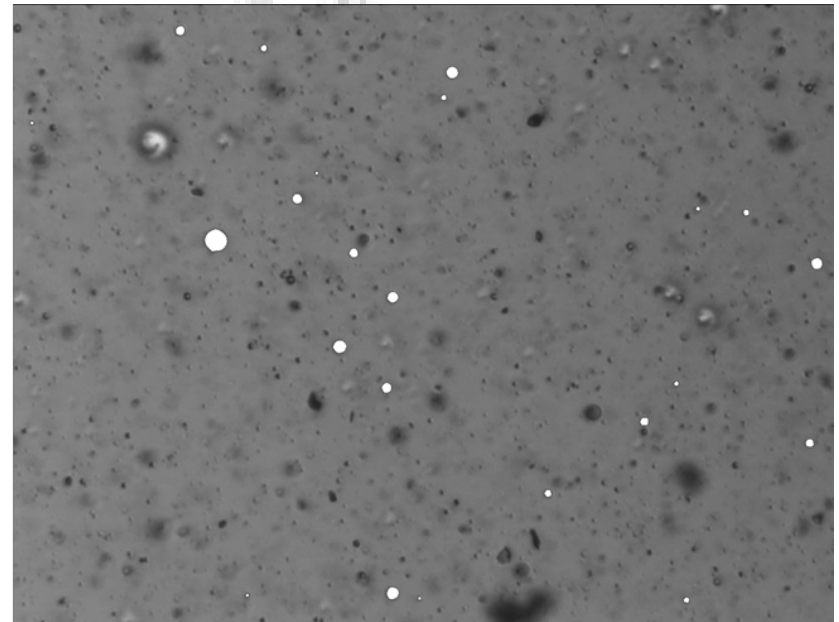
- Fused one piece construction with no recesses or steps where product can adhere to and build up
- Pressures to 600 BAR
- Integral Jet Spray Ring
- Adjustable Gap Size dependent on sample present



Solid Particles and Water Detected Simultaneously (OBM)

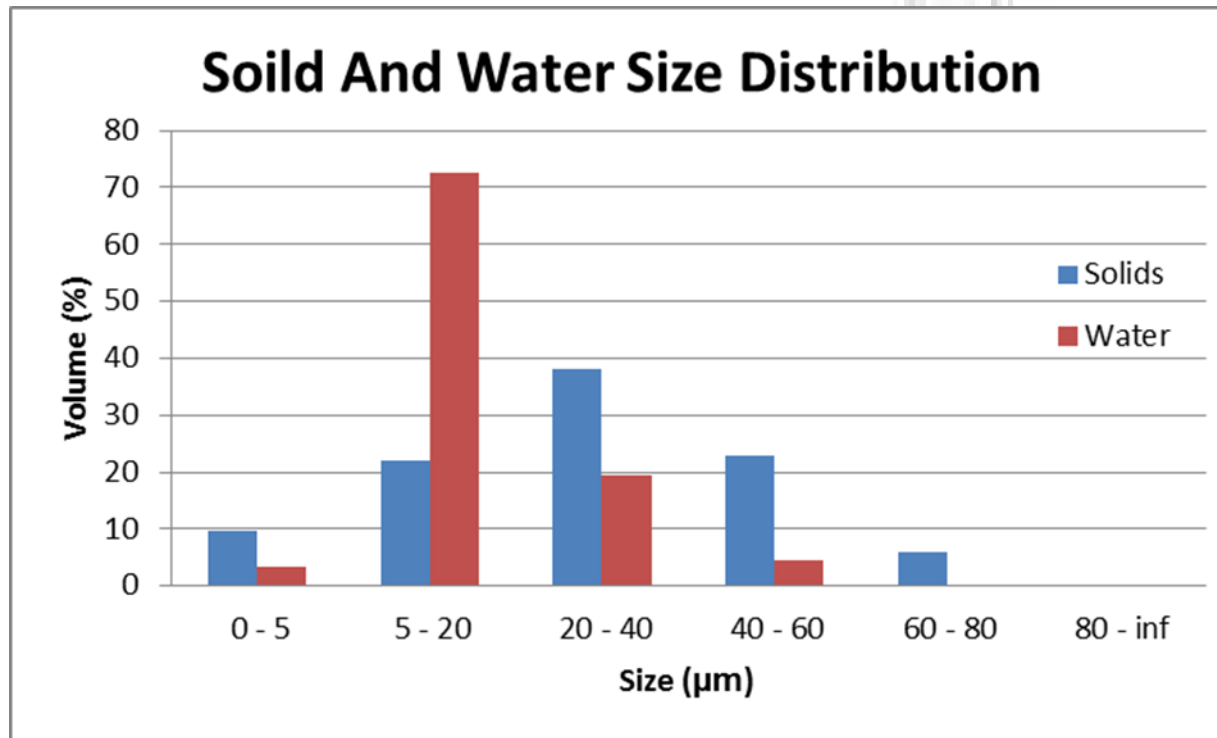


Solid Particles Detected



Water Droplets Detected

Simultaneous Solid and Droplet Size Distribution



Typical Vision Interface

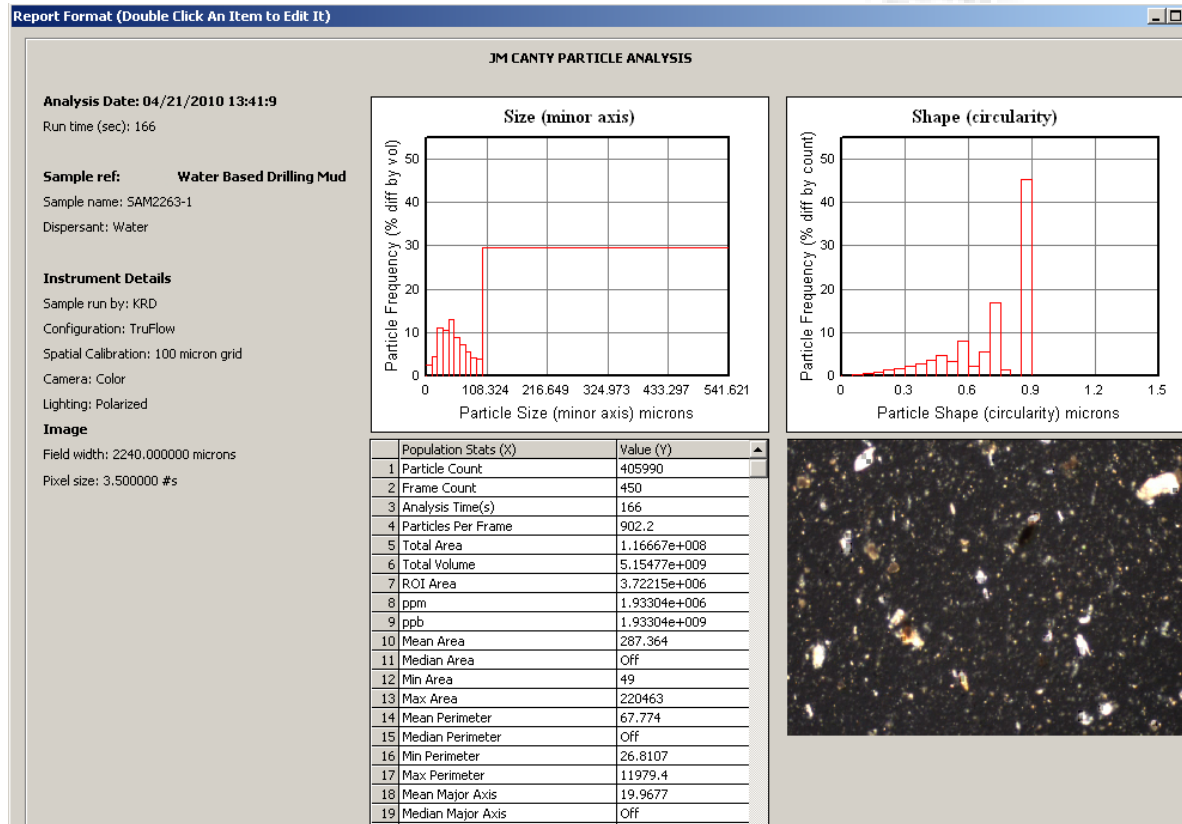
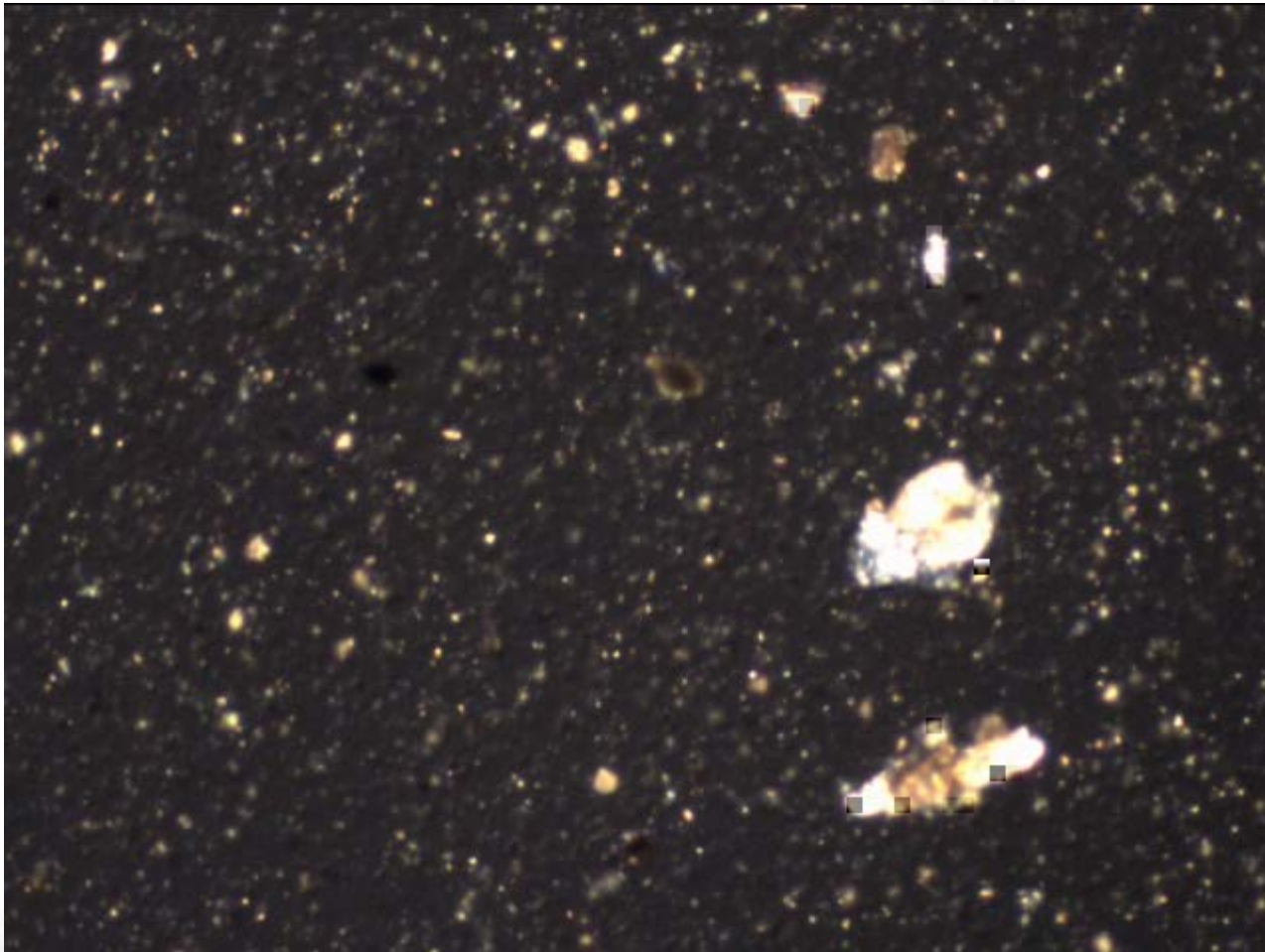


Image of Mud Particles



Thank You

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