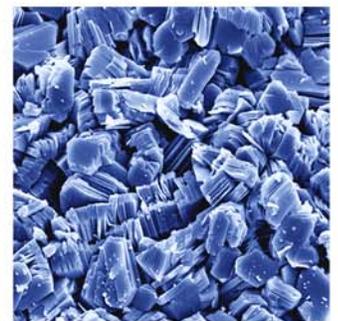
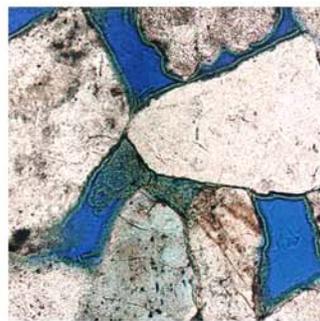
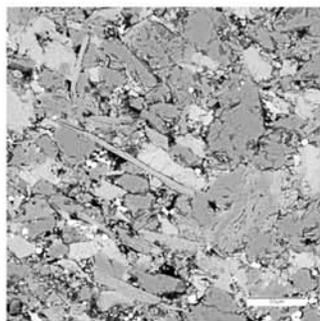
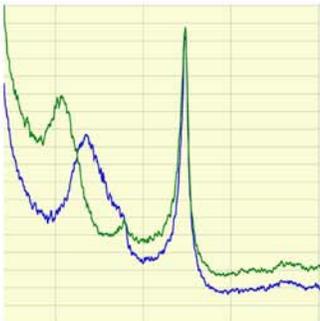




*Calgary Rock
and Materials
Services Inc.*

SERVICES CATALOGUE

Calgary Rock and Materials Services Inc.
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#3, 3610 29th Street NE, Calgary, AB T1Y 5Z7



Calgary Rock and Materials Services Inc.

Introduction

Calgary Rock and Materials Services Inc. (Calgary Rock or CR) is an advanced geological lab utilizing innovative reservoir characterization techniques to provide results with turn-around times that are highly competitive in the international geoscience community. In addition to standard services, many specialized tests are offered. Our services provide timely techniques to aid in project planning, development and solutions for problematic mid-project drilling operations.

Standard services include thin section manufacture, X-Ray Diffractometry (XRD), Scanning Electron Microscopy (SEM), reservoir characterization through Porosity and Permeability (P&P) analysis at surface and reservoir conditions, and petrographic analysis. A few examples of our specialty services include the use of ultraviolet fluorescing epoxy for microfracture and micropore analysis, fluid inclusion investigation from thin section and select palaeontology services.

Calgary Rock maintains cutting edge, source specialized techniques and procedures by basing their techniques on client demands. Through these demands we have formed working relationships with labs that specialize in techniques that we are unable to provide.

The following package will help you to determine which CR services will be best suited for your needs. Calgary Rock and Materials holds their clients in the highest regard and understands the proprietary nature of client data. All samples and results are handled in the strictest of confidence.

If you do not see a listing of the service you require, please feel free to contact us.

Thank you for taking the time to learn more about Calgary Rock and Materials Services Inc.

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About the President

Raymond Strom



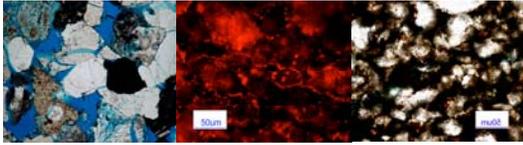
Raymond Strom graduated from the Industrial Chemistry Program in Chemical Technology from the Southern Alberta Institute of Technology (SAIT) in 1971. Upon graduation, he commenced work in that establishment until 1980 when he was asked to join a major oil and gas company. Over the next 18 years, Ray developed expertise on the equipment utilized for rock analysis in the oil and gas industry. In 1998, Ray formed a partnership creating Continental Rocktell Services Inc. In 2005, Ray became independent and continued working in the oil and gas service industry as Calgary Rock and Materials Services.

Over the past 10 years, Ray and Calgary Rock have displayed innovative and progressive techniques designed specifically for use in the oil and gas industry.

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Calgary Rock and Materials' Petrographic Services



Thin Section Manufacturing

- Core/Outcrop
- Lead and Teflon sleeved plugs
- Side Wall Cores
- Unconsolidated/consolidated oil sands
- Oil/Tar carbonates
- Drill Cuttings
- UV fluorescing epoxy options

To increase the stability of our samples before thin sectioning, we pressure impregnate them with a variety of dyed epoxies. With pressure impregnation, we are able to force the epoxy into pore spaces allowing for rapid porosity identification and estimation.

CR stands out from other thin section preparation labs by providing a UV fluorescing agent in all of our dyed epoxies. With this method, the pink Rhodamine B dyed epoxy is no longer fully required for viewing microfractures, and microporosity, unless preferred by the client. These coloured epoxies are instrumental in immediate pore system recognition. It should be noted that Rhodamine B dye is still the optimum for fluorescence imaging.

Further, stains that help to rapidly identify minerals within thin sections are available. Our double carbonate stain is a mixture of Alizarin Red S and Potassium Ferricyanide, which aid in the identification of calcite, ferroan calcite, and ferroan dolomite. Our sodium cobaltinitrite stain identifies potassium feldspars. Stains can be applied in multiple methods as per client requests.

Full petrographic analytical microscopes are used in order to document the thin sections,

using the latest in digital imaging equipment and techniques (discussed later). In addition, petrographic descriptions can be provided for your use, on special request. Petrological descriptions are also available for core and cuttings that have been sampled and thin sectioned.

CR prides itself in providing some of the industry's best-polished thin sections. Using in-house developed techniques, we are able to produce thin sections with mirror-like surfaces to be used in SEM Backscatter Electron Imaging (BSE), Cathodoluminescence (CL), Fluid Inclusion (FI) and laser ablation procedures. We can provide single polished thin sections for use, as an example in BSE. Additionally, double polished thin sections, which have a polish on both the billet side of the sample, as well as on the completed thin section, are available.

Petrographic Descriptions

Calgary Rock and Materials employs in-house petrologists who are able to provide petrographic descriptions of sample either manufactured by us, or provided by the client. This process works best when multiple procedures, such as XRD analysis for mineral composition and SEM analysis are completed. With the aid of additional information the petrologists are able to give in-depth descriptions, thus giving the client utmost knowledge of their sample.

Full Descriptions

Full descriptive reports include the identification and classification of framework grains, cements and clays. Pore architecture, permeability and sensitivity issues are also discussed. Described photomicrographs of each sample are included and described.

Brief Descriptions

Brief reports include a basic description of the rock mineralogy and pore systems. This

does not include described photomicrographs, but incorporates 2 images into the main body of the report.

Photography



DXM 1200 Camera System

The Nikon DXM 1200 12 mega-pixel digital camera allows digital image capture of petrographic thin sections, core and drill cuttings at resolutions of up to 3,840 x 3,072 pixels in JPG, TIF, and BMP formats. These images are suitable for publication, computer manipulation, and report production.

Due to the high resolution of the images, 2 images per thin-section will usually suffice to provide the ability to do desktop petrographic analysis. Typically, print plates are provided to the client at 1 plate per thin section. Each plate has 4 images of varying magnifications.

The high sensitivity of the camera also makes it exceptionally well suited for low light, UV fluorescence and Cathodoluminescence photography.



Core Macro Photography

High-resolution images are produced using an 8-megapixel camera. Full core, small core pieces, plugs and cuttings may be photographed. Images can be supplied as digital files or as print plates.



Thin Section Macro Photography

High-resolution macro thin section images can be produced for clients using a digital scanner, or photographed with our DXM 1200 Camera System. Thin section images are provided to the client in

the format of their choosing. This allows them a visual analysis without necessity of a microscope.

Cuttings Imaging

In addition to post production imaging, CR has the ability to take high resolution images of rock chips/cuttings samples pre-production. This provides clients with 'whole rock' imagery for their cuttings samples. Calgary Rock utilizes a PixelINK® camera mounted to our Nikon SMZ800 zoom stereoscope and a mono-fiber optic light source. This set up provides images up to 20x magnification with visual relief providing invaluable information such as grain size, pore networks and quality of the cuttings.

X-Ray Diffractometry: Rigaku MiniFlex II



- Identification of minerals
- Clay and fines identification
- Corrosion and scale deposit identification

X-Ray Diffraction is a highly useful semi-quantitative method for determining both bulk rock and clay mineralogy of a given sample. Bulk rock is crushed and analyzed to provide mineralogy on the major components. Clay separation of the less than 5-micron fraction, or the less than 2-micron fraction, allows for a detailed study of those components with a variety of treatments used to enhance their characteristics. Jade 2010 software is utilized in the interpretive process to assist in identification and quantification of mineral species.

XRD analysis is instrumental in identifying damaging clays that may play a role in well completion and stimulation procedures. As well as confirming the presence or absence of a particular mineral (such as ankerite) that may pose sensitivity issues.

Scanning Electron Microscopy: Amray 1820 I Digital SEM



- Enhanced mineral identification
- Enhanced clay identification and distribution e.g. smectite,

chlorite, kaolinite, illite and mixed layered clays

- Porosity and pore throat characterization
- Standard and custom photo plate production
- High resolution printing
- Digital image output provided.

SEM service is available to provide topographic details of rocks at a microscopic level. Data derived from the procedure are mineralogy, grain size, pore size, pore throat characterization, clay content and distribution. This provides the user with information relating to the interaction of rock components and fluids. SEM provides a means of high resolution imaging of pore lining clays, such as smectite, chlorite, illite and mixed-layer clays, for identification and distribution analysis. Rapid identification of fine particulates, such as produced fines and scale samples, is particularly useful. Standard and custom photo plate production and digital images and data are provided for the client.

Energy Dispersive Spectrometry

The Energy Dispersive Spectrometry (EDS) system provides elemental spectra of bulk samples, or small particles. It provides a qualitative evaluation of mineral distribution and can identify non-end-member elements in minerals such as ferroan dolomites or ferroan calcites. Data is provided via a single spectrum per sample in either printed or digital form. Semi-quantitative elemental analysis can be provided on request. See "BSE Elemental Mapping."

Backscatter Electron Imaging-BSE

Backscatter Electron Imaging (BSE) techniques allow images of a much thinner portion of the rock to be evaluated. Instead of evaluating the full 30-micron thickness of the rock, a thickness of 1-2 microns is imaged and evaluated. This 2D scan is enhanced, and thus the quantification of rock components are more precisely discriminated leading to measurements that are more accurate.

Standard thin section evaluation is useful for porosity; however it has limitations due to the nature of manufacturing thin sections. Grain and crystal orientation within a 30-micron thin section can have a pronounced effect on determining porosity, simply because textural information and grain boundary relationships are not immediately evident with standard petrographic analysis.

Backscatter imaging provides a means of evaluating porosity in core and cuttings samples to determine quantitative porosity percent, qualitative effective porosity, pore geometry and rock texture.

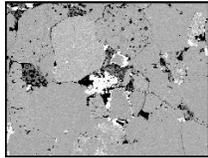
BSE Technique

Impregnated polished thin sections, or polished rock pieces, are coated with a thin film of carbon and placed in the scanning electron microscope. Images of the subject are captured in the grayscale mode at a predetermined magnification. This grayscale image is threshold manipulated to provide a binary image. This image is then evaluated for ratios of black to overall pixel count to determine total porosity.

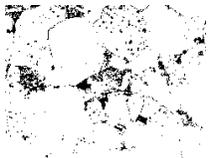
The image is then manipulated using an erosion/dilation processes to eliminate micro-pores in the image area. In excess of 1 million pixels are evaluated in this acquisition vs. the typical 300 points in a point count analysis.

The data are then reported on a print plate, which includes numerical results reported as total porosity and microporosity as a percentage of the bulk volume.

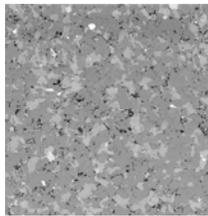
Aspect Ratio analysis of the pore spaces across the scan area is also available on request.



Grayscale image



Binary Image from grayscale image Porosity derived from black-level=5.9%



Unconventional samples report data of total porosity, effective porosity and micro-porosity as a percentage of the bulk volume, however the print plate is only comprised of one grayscale image.

BSE Elemental Mapping (ELM)

Elemental mapping integrates Backscatter Imaging with EDS to effectively map selected elements (e.g. Si, Al, Ca, Fe, K, Na, P) present within the sample at higher magnifications. Pixels by pixel results are achievable. From this, it is possible to select one grain if needed for identification.

Rock Properties

CMS 300 Porosity & Permeability Unit



- Uniaxial pressure, unsteady-state instrument provides a wide variety of data using the latest technologies.

The uniaxial pressure, unsteady-state CMS300 instrument provides a wide variety of data using the latest technologies. Standard porosity and permeability measurements, plus Klinkenberg permeability, alpha, beta and slip factor measurements are provided in the output data set. In addition, multiple overburden pressure points, beginning at 800 psi can be run to determine the effects of pressure on porosity and permeability. This is particularly important when dealing with low porosity and or fractured rock systems, leading to porosity reduction and fracture closure evaluation.

Permeability (Steady State): Frank Jones Air Permeameter



- Steady-state Permeability measurements are taken using a Frank Jones Air Permeameter.
- Permeability measurements can be taken at variable overburden pressures.



Porosity (Steady State): Extended Range Helium Porosimeter

- Provides total porosity (steady state) measurement using an extended range helium porosimeter.
- Porosity measurements are at ambient overburden pressure.

Capillary High Pressure Analysis – Micromeritics AutoPore III



- 60,000 psi
 - Quantitative pore throat size and porosity characterization
 - Water saturation evaluation
 - Height above free water evaluation
 - Plug and cuttings analysis
- Raw data or tabled corrected data available on request
 - Also known as Mercury Injection Capillary Pressure (MICP)
 - New technique to process unlithified sands (heavy oil) for running in MICP tests

The purpose of Capillary High Pressure Analysis is to determine the relationship between pore volumes and pore throat sizes, through which the pore volumes communicate.

This can prove invaluable in determining well viability.

Organic Petrology

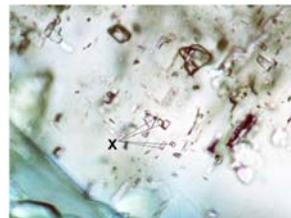
- Kerogen typing and source rock analysis
- Hydrocarbon potential
- Degree of maturation
- Report generation in digital format and hard copy with plates of photo images
- Data includes 1 kerogen slide and 1 oxidized slide
- Samples can be sieved (-20 μ /+10 μ and +20 μ) and then mounted to individual slides

Samples will be handled by lab personnel and will be contracted out for processing and analysis.

Additional Services

- **Custom sample cutting**
- **Custom plug cutting**
- **Plug cleaning services**
- **Sampling services (AER)**

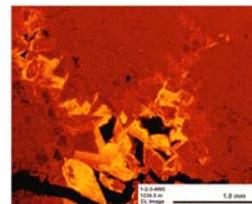
Fluid Inclusion Analysis Linkam Model THMSG 600 with an Olympus BH-2 Microscope



Double polished 100 μ thick thin sections are studied in order to 1) locate inclusions within a sample and 2) determine the composition of fluids found within inclusions.

Utilization of a geological heating/freezing stage with a temperature range of -190°C to +600°C allows the petrographer to evaluate freezing point depression/salinity, and measurement of the homogenization point. These tests assist in determining fluid types, (fluorescence evaluation identifies hydrocarbons) multi-stage mineral growth sequences and fluid migration events.

Cathodoluminescence Imaging – Nuclide Corporation Luminoscope ELM2D Model



CL techniques involve the use of polished thick thin sections or thin billets of polished rock material. The sample is mounted in a vacuum chamber, and a focused beam of electrons is used to excite the sample. Emissions released from this are captured via a digital imaging system. This allows for immediate capture and study of the image.

Rock Comparators – Available Upon Request

- Produced from rock of same formation and locality
- Standards produced from previously analyzed core
- Well site cutting comparators for rapid analysis of rock types
- Estimation of porosity and permeability in closely related rocks

Rock Catalogue and Formation Characterization Studies are compiled utilizing a wide variety of technical data as an exploration tool to assist in categorizing rocks from new locations, including outcrop and actively drilling wells. Basic rock parameters measured on controlled lab samples allow quick visual comparisons between catalogued specimens and unknown samples.

Porosity and permeability, standard petrographic analysis, scanning electron microscopy, X-ray Diffractometry, and petrographic image analysis (PIA) allow for a wide range of parameters to be estimated by comparative visual methods.

Acquiring Services

Services may be requested via email, over the telephone, or electronically through the Calgary Rock and Materials web page. Completion of the electronic Lab Request Form will allow for considerable information input. Well location, depth and formation are particularly important, however this information is not imperative for analysis.

Please contact Mr. Ray Strom at Calgary Rock for any questions, updates or service requests.

**Mr. Ray Strom, Ch. T.
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Service and Price Outline

(May 2014)

Prices do NOT include GST

Petrographic Services

Thin Sections

	Standard Size (27mm x 46mm)	Large Size (50mm x 75mm)
Coverslip	\$42.00	\$70.00
Double Carbonate Stain*	\$47.00	\$75.00
Feldspar Stain	\$51.00	\$79.00
DC and Feld Stain	\$56.00	\$84.00
Alumina Polish	\$52.00	\$85.00
Diamond Polish	\$64.00	\$97.00

****Water sensitive samples will be surcharged 50%****

*Our double carbonate stain consists of Alizarin Red S + Potassium Ferricyanide

Descriptions

Full Thin Section Description \$350.00

Standard petrographic examination includes identification of framework grains, cements and clays. Pore architecture, permeability and sensitivity Problems are discussed. As many color photographs as necessary are provided.

Brief Thin Section Description \$250.00

This provides a basic description of the rock mineralogy and pore system. Does not include plate images, but incorporates 2 images into the main body of the report.

Photography

Plate Production \$30.00

Client supplied images

Digital Images \$7.00

Supplied to the client on CD or DVD

Macro Core & Thin Section Plates \$35.00

Includes 1 image

Macro Thin Section Plates \$42.00

Includes 4 images

Reprints (per plate) \$18.00

Plate Descriptions (per plate) \$70.00

XRD

Bulk & Basic Clay analysis \$450.00

Bulk Only \$225.00

Basic Clay (<5 micron) Only \$255.00

Bulk and Heated Clay \$485.00

SEM

<i>Standard SEM</i>	\$310.00
Includes digital images and 2 print plates with 1 EDS spectrum per sample. Plate descriptions are NOT included	
<i>Plate Descriptions (per plate)</i>	\$60.00
<i>Digital Images Only (no prints)</i>	\$250.00
<i>EDS Only (Energy Dispersive Spectrometry)</i>	\$100.00

SEMBSE (does **NOT** include thin section manufacture)

<i>Conventional Sample:</i>	\$210.00
Includes 1 print plate with a grayscale image. Numerical results are reported as total porosity, porosity after erosion/dilation and micro-porosity component as a percentage of the bulk.	
<i>Additional magnification calculation</i>	\$245.00
As above but with an additional plate and magnification calculation.	
<i>Conventional Sample with Aspect Ratios Calculated</i>	\$225.00

SEMBSE Elemental Map (does **NOT** include thin section manufacture)

Routinely only digital image data is supplied
Custom print plate production can be done.

Rock Properties Testing

Porosity and Permeability (Unsteady State)

CMS 300	1" Plug	1 1/2" Plug
Single pressure, 800 PSI	\$95.00	\$120.00
Each additional pressure	\$15.00	\$15.00

	Regular Plug	Irregular Plug
Extended Range Helium Porosimeter (Steady State)	\$45.00	\$45.00
Frank Jones Permeameter	\$45.00	\$65.00

Capillary Pressure

Standard high pressure run (60,000 PSI)	\$500.00
High resolution/high pressure run (60,000 PSI)	\$750.00

Additional Services Available

Plug coring (1" only) per sample – tap water drilled	\$20.00
Plug manufacture – hand produced	\$40.00
Soxhlet Extraction to remove residual hydrocarbons	\$30.00
Bulk Sample Crushing – per hour	\$35.00
Professional Consulting/Sample Selection – per hour	\$60.00
General handling and core layout – per hour	\$60.00
Custom cutting and polishing of slabs, etc.	by quotation

Fluid Inclusion Analysis (thin section manufacture NOT included)	\$700.00
Includes homogenization temperature, ice melting temperature, 2 digital images of inclusion and possible 3 rd image of UV active inclusion (live hydrocarbons)	
Cathodoluminescence Imaging (thin section manufacture NOT included)	\$225.00
CL setup and brief report Includes 4 images per thin section – 2 plane light, 2 CL images of same plane light area.	
Rock Comparator Manufacture	
Basic: 1 sample	\$70.00
Each additional sample (4 possible)	\$25.00

Prices Do Not Include GST or Shipping

Discounts may apply for high volume of samples.

All prices subject to change without notice.

Rush service prices may be applied to work requested for times shorter than standard
turn-around times.