



GEO TEK

CORE SCANNING, IMAGING &
ANALYSIS TECHNOLOGY FOR MINING
APPLICATIONS

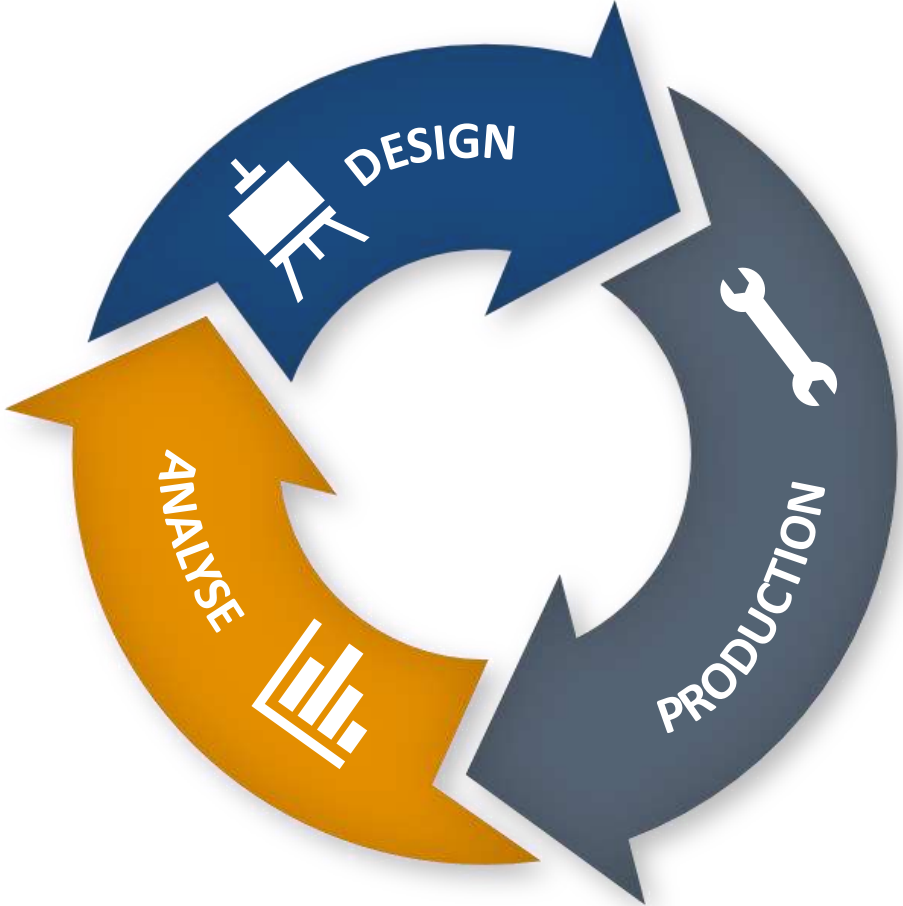
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Sales and Marketing Manager / Geologist

Geotek Strategy for Geoscience Instrumentation

A team of talented individuals at Geotek designs and builds instruments whilst, offering core analysis services with an unmatched level of expertise and experience.



Purchase



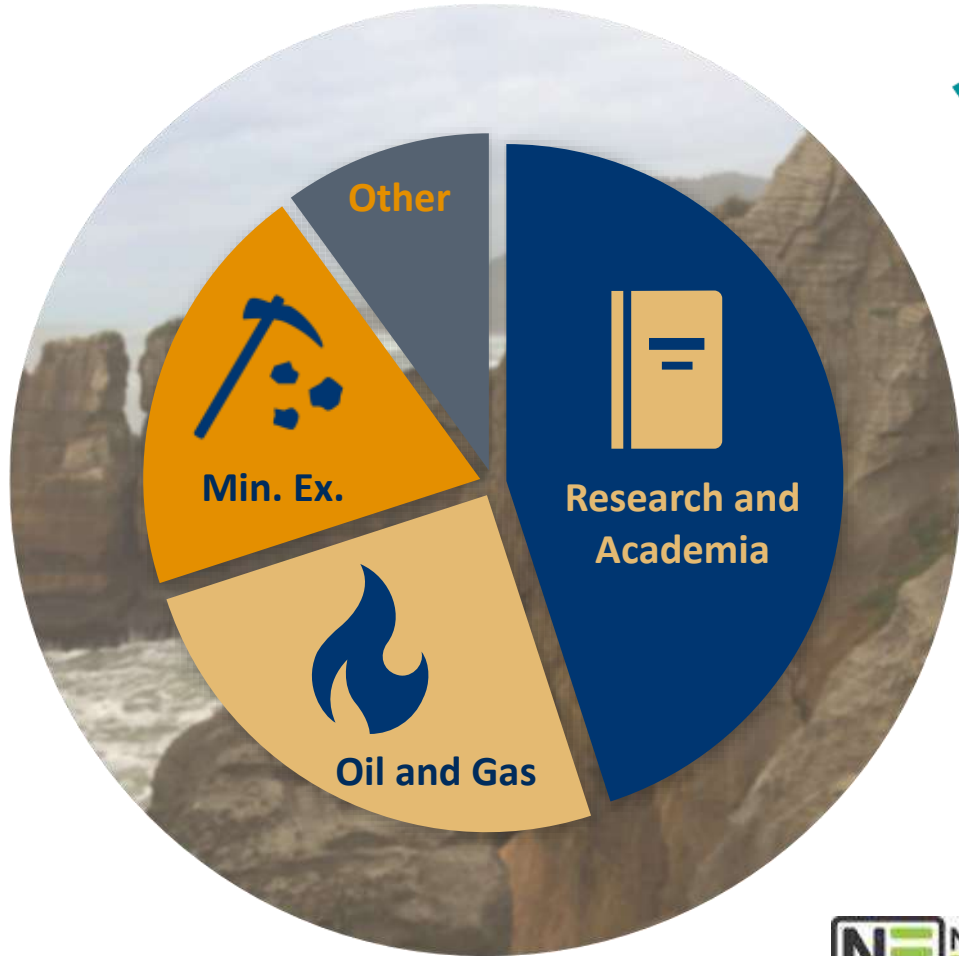
Lease



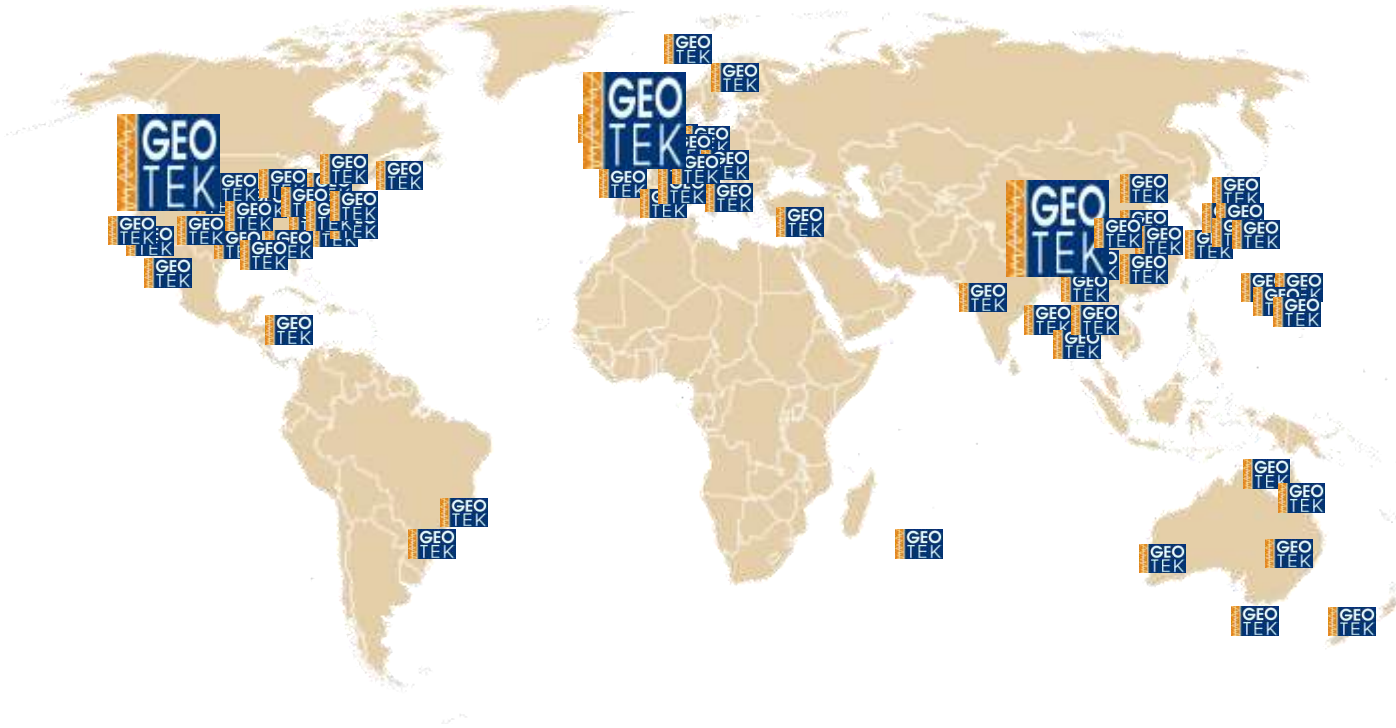
Service



Who Are Our Customers?



Core Analysis Equipment and Services that are Built on Experience



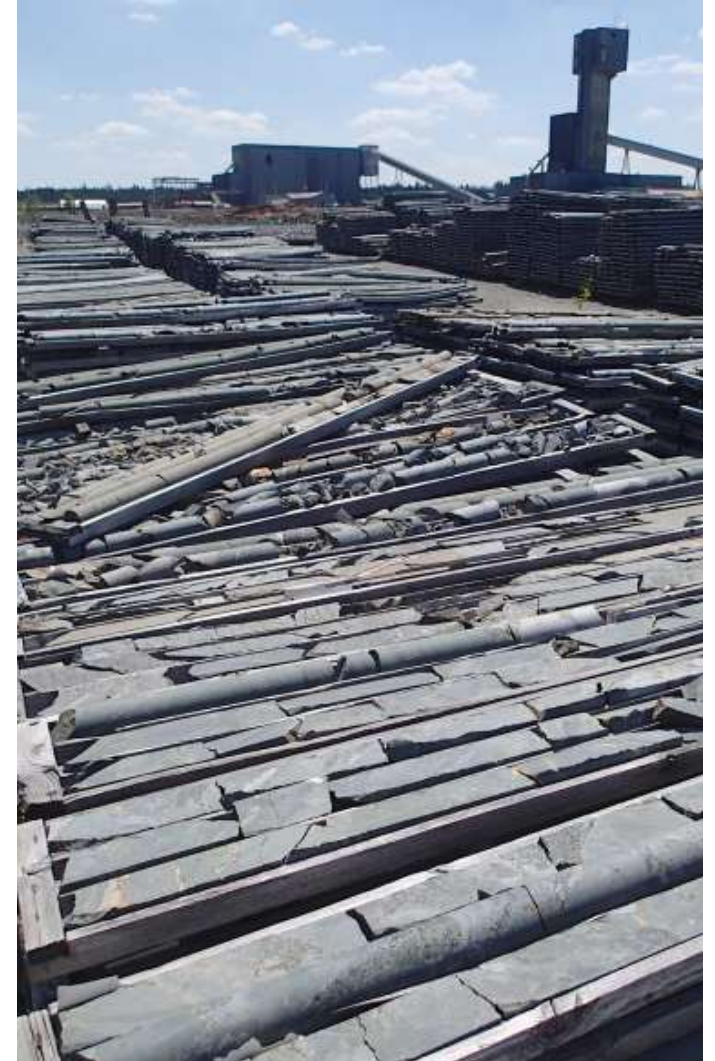
- Provision of **Multi-Sensor Core Loggers (MSCL)** and **X-ray CT systems**
- **25 years experience** of providing core logging equipment
- Over **220 systems sold** worldwide
- Offices in **UK and USA**

Why are Core Scanning Instruments Required?

- Drilling/sampling core material is expensive
- Basic or advanced laboratory testing is expensive
- Therefore there is a need:
 - **To maximise data recovery from every metre**
 - **Understand core heterogeneity**
 - **Identify key geological/engineering horizons**

But...core analysis must be in a time-efficient and cost-effective way

**Under-Utilized
Resource of Information**



Where does Core Scanning fit into a Mine Evaluation?

Table 1. General mine value chain showing broad metallurgical–geometallurgical activities, inputs, and outputs.

Stage	Strategic Geometallurgy			Tactical Geometallurgy	
	Exploration-Early Evaluation	Resource Definition Drilling	Reserve Definition Drilling	Feasibility	Mining
Study	Scoping (SS)	Pre-feasibility (PFS)	-	Feasibility (FS)	Grade/ore control (Expansion studies)
Resources/Reserves	Inferred Mineral Resources	Inferred and Indicated Mineral Resources	Mineral Resources and Ore Reserves	Mineral Resources and Ore Reserves	Mineral Resources and Ore Reserves
Key activity	Develop orebody knowledge Drilling and sampling	Develop orebody knowledge Drilling and sampling Data analysis and modelling	Develop orebody knowledge Drilling and sampling Data analysis and modelling	Develop orebody knowledge Drilling and sampling Data analysis and modelling	Develop orebody knowledge Drilling and sampling Data analysis and modelling
Inputs	<div style="border: 1px solid orange; padding: 2px; display: inline-block;">Core logging</div> Develop proxy tests Mineralogy Geochemistry Metallurgical testwork Physical testing	<div style="border: 1px solid orange; padding: 2px; display: inline-block;">Core logging</div> Proxy tests Mineralogy Geochemistry Metallurgical testwork Physical testing	<div style="border: 1px solid orange; padding: 2px; display: inline-block;">Core logging</div> Proxy tests Mineralogy Geochemistry Metallurgical testwork Physical testing	<div style="border: 1px solid orange; padding: 2px; display: inline-block;">Core logging</div> Proxy tests Mineralogy Geochemistry Metallurgical testwork, incl. pilot or trial plant testing Physical testing	<div style="border: 1px solid orange; padding: 2px; display: inline-block;">Core logging</div> Proxy tests Mineralogy Geochemistry Metallurgical testwork Physical testing
Outputs	Establish database Preliminary characteristics of mineralisation Geological model; Geoenvironmental	Expanded database Domains Block model Preliminary mine plan Models Preliminary process design Geoenvironmental	Expanded database across all disciplines	Expanded database Domains Block model Mine plan Models Flow sheet Scenario analysis Economic analysis Geoenvironmental	Expanded database Domains Block model Mine plan Models Economic analysis Forecasts Reconciliation Geoenvironmental
Potential number of data ¹	1000 s	1000–10,000 s	+1000 s	10,000–100,000 s	100,000–1,000,000 s
Resource uncertainty ²	High	Moderate-High	Moderate	Low	Low
Expected accuracy ³	±50%	±25%	-	±15%	±10%

¹ General estimate of number of data across grade, geochemistry, mineralogy, comminution, recovery, etc., actual highly deposit dependent; ² epistemic uncertainty based on drill spacing, actual highly deposit dependent; ³ standard globally accepted accuracies for project studies.

Geotek Core Analysis Instrumentation

Standard Multi-Sensor Core Logger (**MSCL-S**)

- Accepts nearly any form of core material
- Most flexible with respect to sensor arrangement
- Continuous core logging



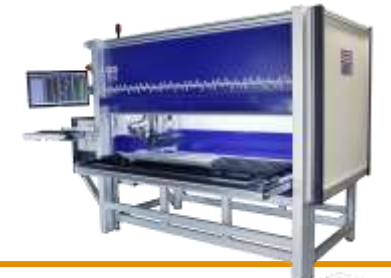
XZ Multi-Sensor Core Logger (**MSCL-XZ** and **MSCL-XZXRF**)

- Bench-top core logging platform
- Surface core measurements
- Main use for split or slabbed core samples



XYZ Multi-Sensor Core Logger (**MSCL-XYZ** and **MSCL-XYZXRF**)

- Multiple core workstation
- Accepts core boxes
- Surface core measurements
- Main use for split or slabbed core samples



X-ray CT Machines (**XCT**, **RXCT**, **VXCT**, **PXCAN**)

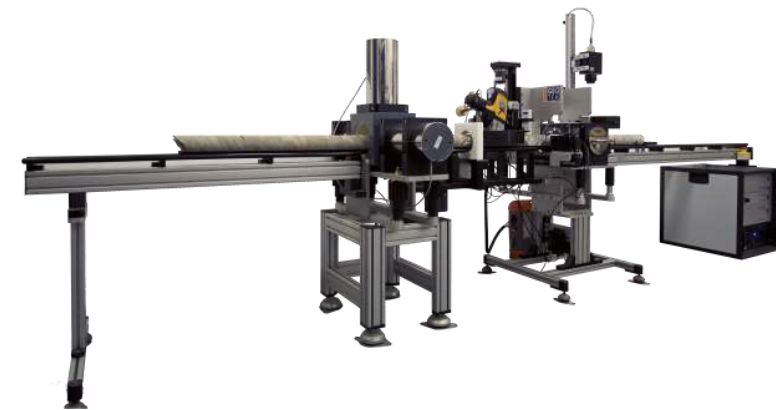
- Accepts nearly any form of core material
- High resolution (35 microns to 250 microns)
- Cabinet-based systems



Available Sensor Technology for MSCL Systems

Sensor	Compatible MSCL System
Attenuated Gamma Density and Porosity	MSCL-S
P-wave Transducers	MSCL-S
Non-Contact Electrical Resistivity	MSCL-S
Magnetic Susceptibility (loop* or point**)	MSCL-S* **, MSCL-XZ**, MSCL-XYZ**
Spectral and Total Natural Gamma	MSCL-S
Color Spectrophotometer	MSCL-S, MSCL-XZ, MSCL-XYZ
Olympus Vanta XRF	MSCL-S, MSCL-XZ, MSCL-XYZ
He-flushed Geotek XRF	MSCL-XZ, MSCL-XYZ
VIS and VNIR/SWIR Point Sensor	MSCL-S, MSCL-XZ, MSCL-XYZ
SpecCam 4 VNIR/SWIR Hyperspectral Camera	MSCL-S, MSCL-XZ, MSCL-XYZ
Geotek linescan camera Visible and UV	MSCL-S, MSCL-XZ, MSCL-XYZ

- **Multiple** sensors can be installed onto one MSCL system
- MSCL systems are **modular** and sensors can be added or removed as required
- MSCL systems can be **upgraded** with sensor technology in the future



MSCL-S with 9 sensors incl. XRF

MSCL-S: Standard Multi-Sensor Core Logger

- Flexible geometry for **whole and split cores**
- Capable of logging **lined and unlined cores**
- **Automated and Simple** software control
- Cores are pushed passed sensors
- **Multiple sensors** (up to 9) can be installed
- Depth co-registration of data
- Data are collected **simultaneously**
- Variable acquisition resolution



Provision of continuous high resolution physical and geochemical stratigraphy

MSCL-S: Rock and Sediment Core Logger

Rock Core Set-up

- Cores are logged exposed
- Whole or slabbed cores
- Up to 1.5 m in length
- 5 cm to 15 cm in diameter



Sediment Core Set-up

- Cores are logged through the liner
- Whole or split cores
- Up to 1.5 m in length
- 5 cm to 15 cm in diameter



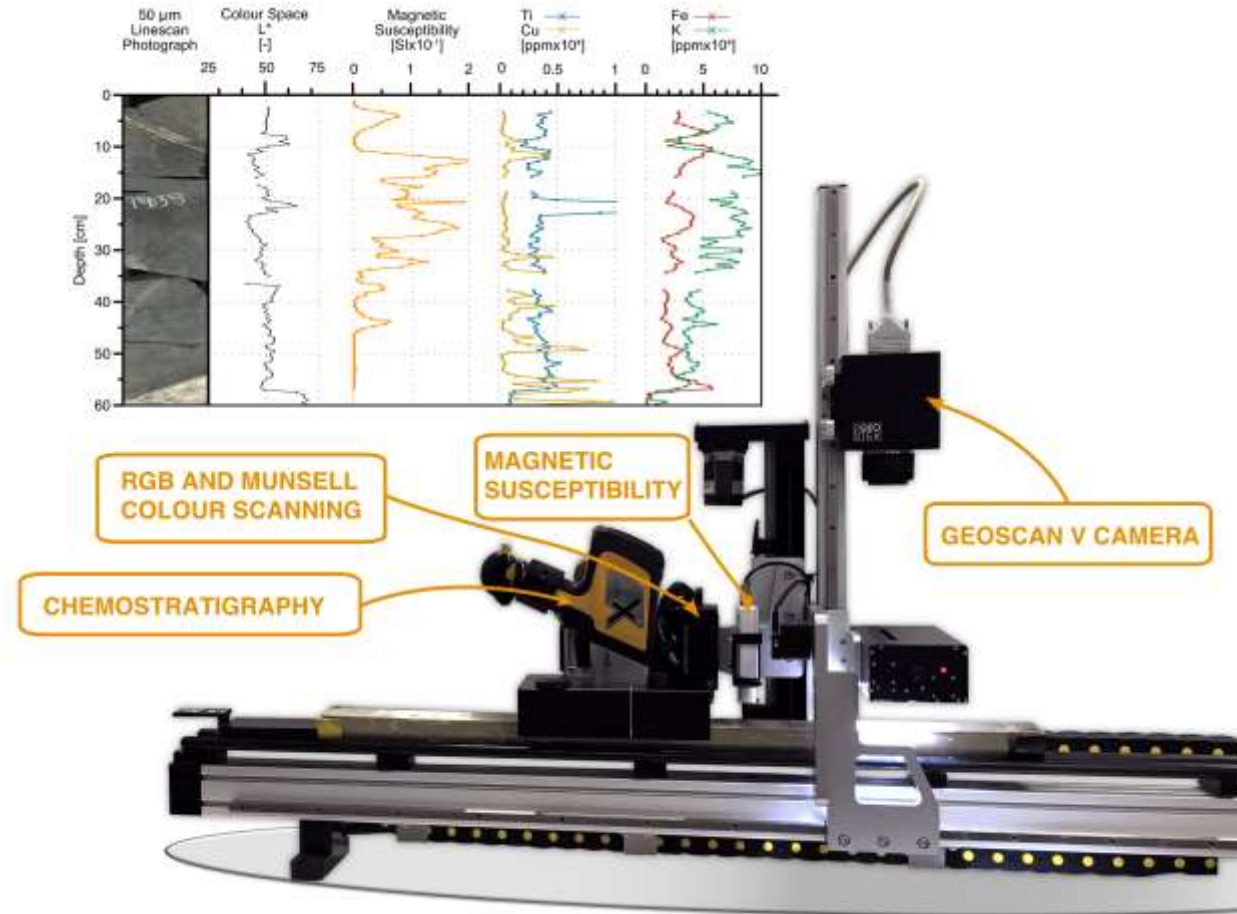
Split/slabbed Core Set-up

- Accepts split sediment cores or slabbed rock cores
- Acquires both surface-based measurements (XRF and NIR) and physical measurements (e.g. gamma density)
- Perfect for logging/scanning of archived core material



MSCL-XZ Benchtop Core Scanner

- **Automated** core logging platform
- Sensor move over core surface and touch down
- Measurement geometry is **constant**
- **Multiple sensors** (up to 4) can be installed at once
- Depth co-registration of data
- **Data** are collected **simultaneously**
- Variable resolution
- Inclusion of **X-ray fluorescence measurements**



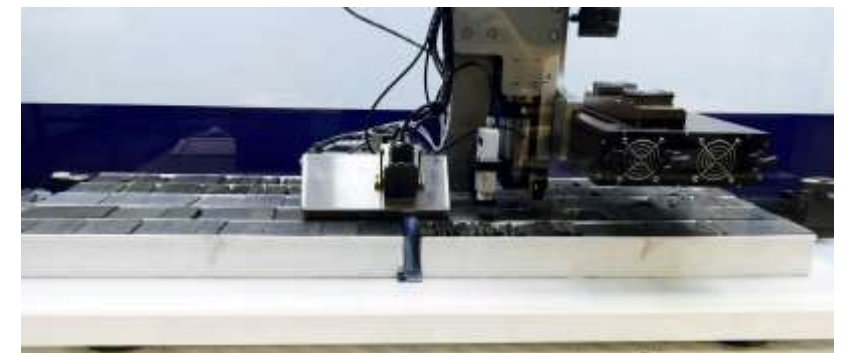
MSCL-XZ: Integration of Handheld XRF onto Benchtop Track



MSCL-XYZ: Core Workstation

- Integrated core workstation for large core laboratories and core volumes
- Multiple core sections or certain core boxes can be loaded into the system
- Data are **depth coregistered** and acquired **simultaneously**
- **Sensors move** over the core surface
- Can include **Hyperspectral Core Imaging** and **XRF** measurements

An **integrated** imaging and spectroscopy core analysis workstation for **mineralogical** and **chemostratigraphical** studies

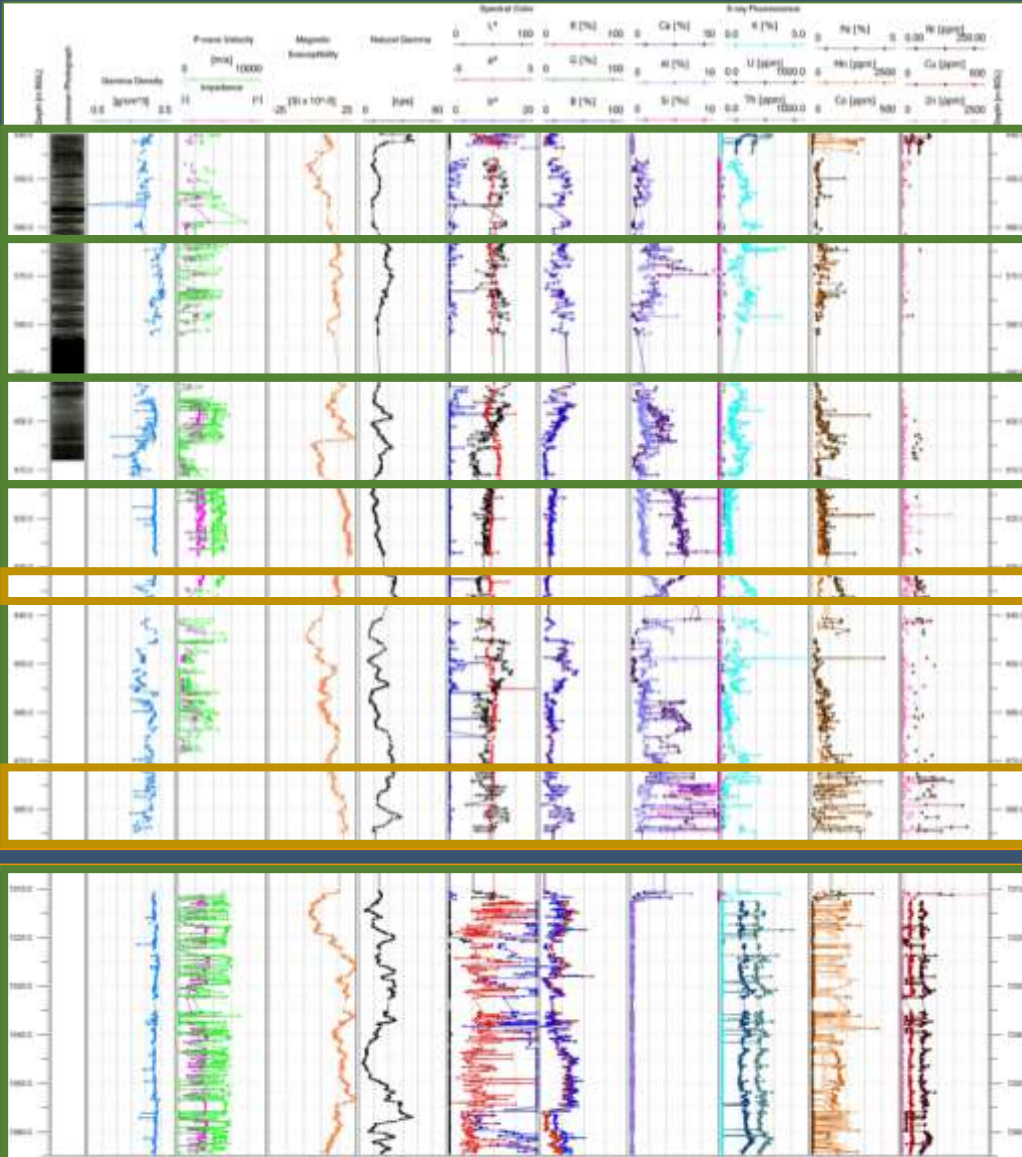


BoxScanner – Fit for purpose XRF Core Scanning

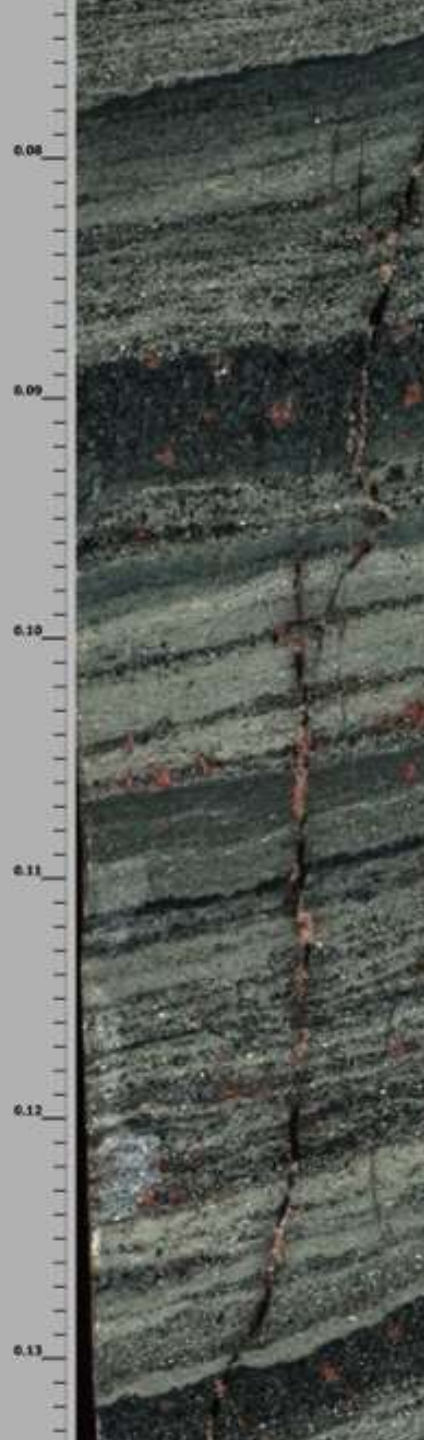
- **Dedicated core scanning system** for automated HH XRF measurements
- **Accepts all types of core boxes** with simple core loading process
- **Dedicated table or sits on a bench top**
- **Sensor technology available:**
 - Olympus Vanta XRF
 - 2D Laser Profiler
 - 5K Geoscan V linescan camera (UV and VIS Light)
 - Point Magnetic Susceptibility



Continuous Profiles of Physical and Geochemical Parameters



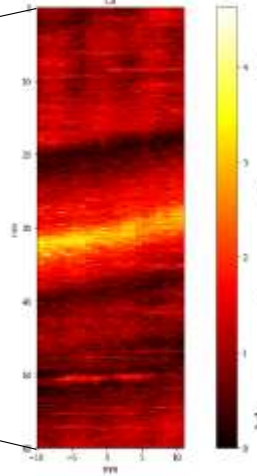
- Measurements are acquired **non-destructively** and **simultaneously**
- Data could be used
 - Utilised ahead of visual logging to **guide** geo's to key geological horizons or stratigraphy
 - **Continuous** and **accurate** density measurements
 - **Model** the geology or physical properties
 - **Characterize** hydrothermal alteration
 - Provide **chemostratigraphic** understanding



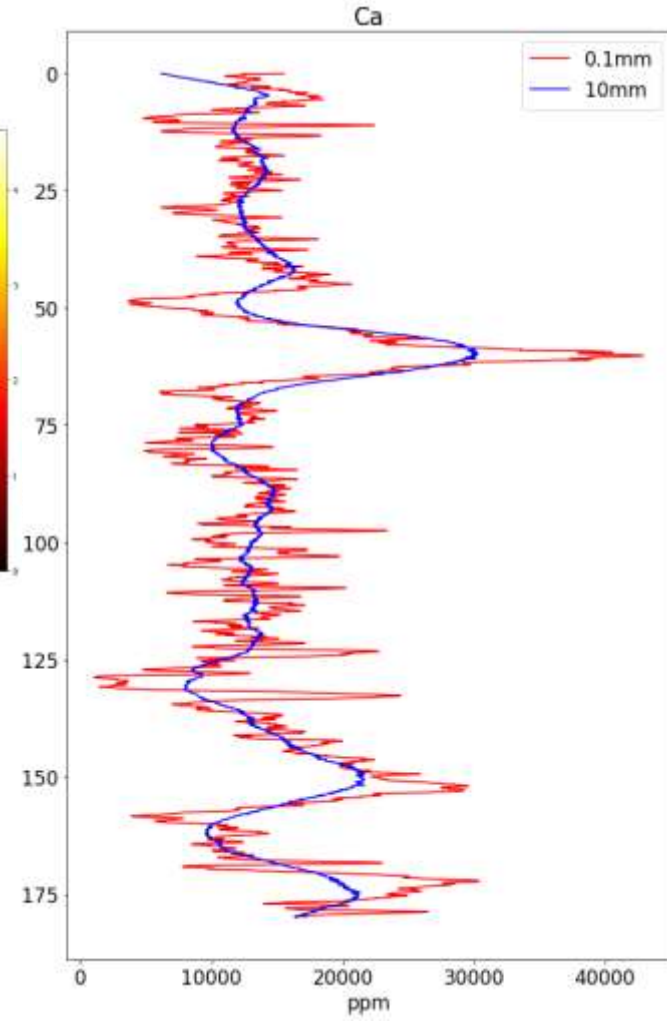
20 μm Image



6 x 2 cm Map (Ca %)



10mm and 0.1 mm Downcore Resolution Profiles (Ca ppm)



Note:
The white box indicates the area of the surface map.
The white line indicates the position of the downcore profiles.

VNIR and SWIR Hyperspectral Camera Semi-Quantitative Mineralogical Maps

High resolution very near infrared (VNIR) and short wavelength infrared (SWIR) hyperspectral camera - SpecCam 4

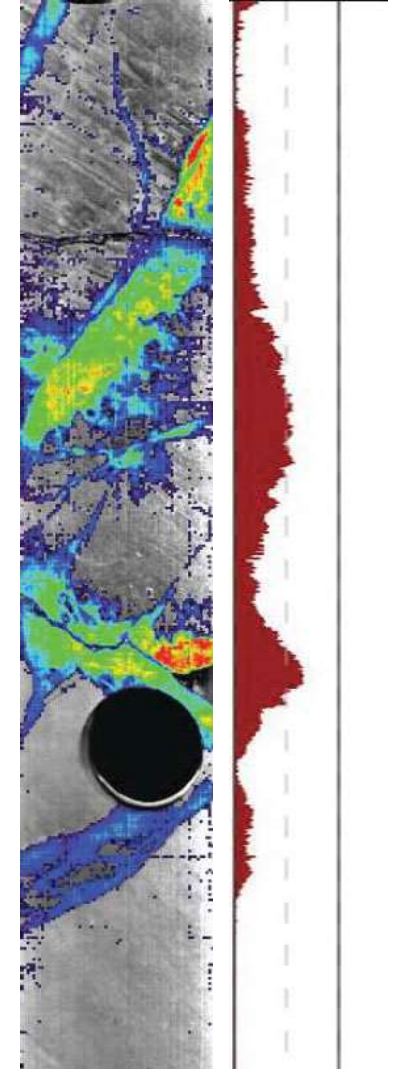
Hyperspectral MSCL can include:
XRF, Mag. Sus., or ASD

Interpretation software **identifies, semi-quantifies** to produce **mineral profiles or maps:**

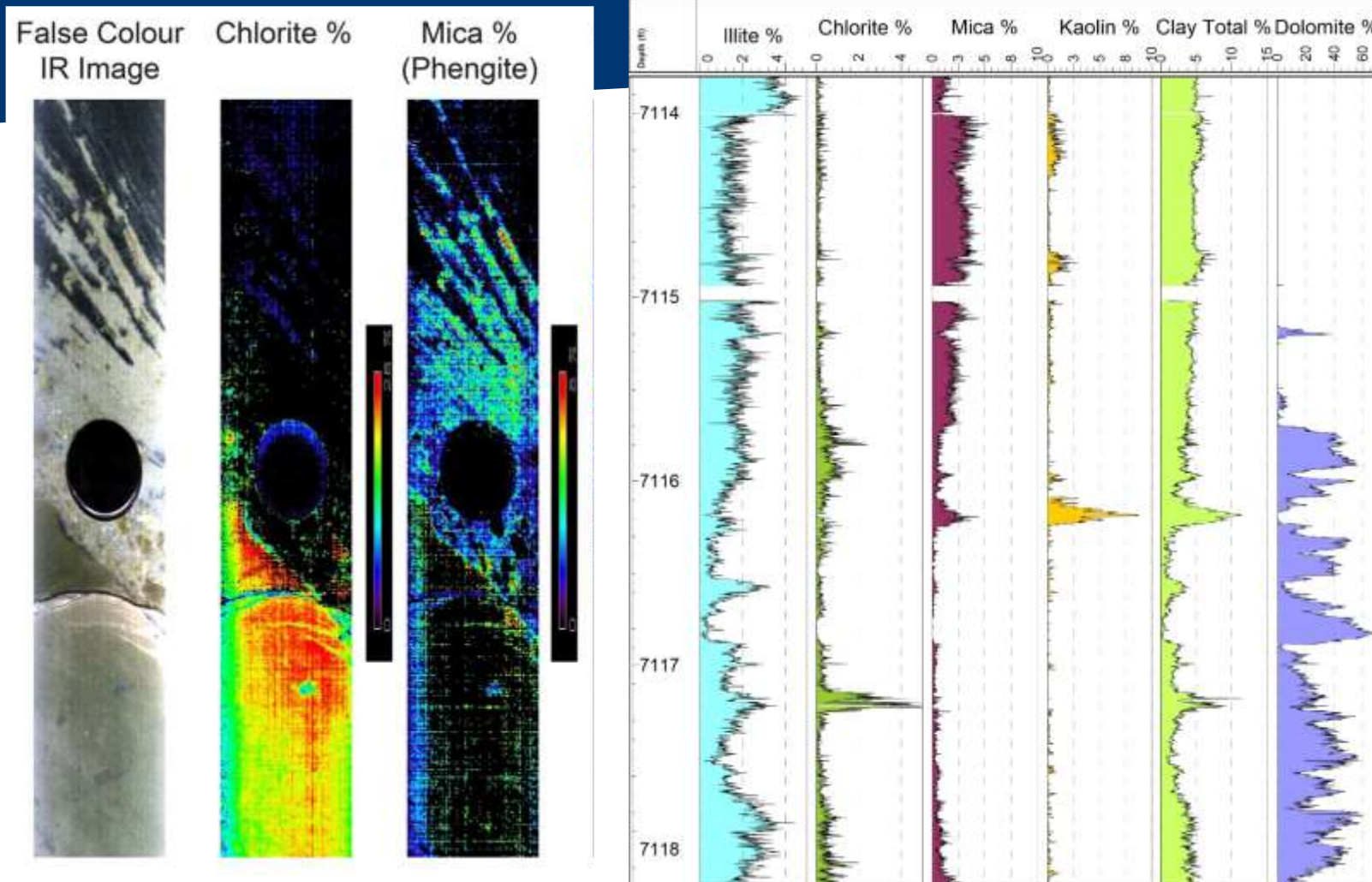
- Specific mineral types
- Mineral chemistry
- Zones of mineral alteration
- Liquid and solid hydrocarbons
- Contaminants

- Spectral range offered 400 nm to 2500 nm
- Electronically controlled wavelength separation for superior spectral resolution
- Continuous coverage high image resolution is (0.5 mm x 0.5 mm)
- Accurate % data derived for the minerals
- Can be used on chips and drillcore

Semi-Quantitative Mineral Maps and Log Profiles



Hyperspectral MSCL Technology: Applications to the Minerals Industry



Multi-Sensor Core Scanning with a unique integration of mineralogy, elemental abundance and physical properties

- Identification of minerals and their polymorphs
- Identification of mineral assemblages
- Clay crystallinity
- Mineral abundances (%) calculated, which are comparable to other analytical methods

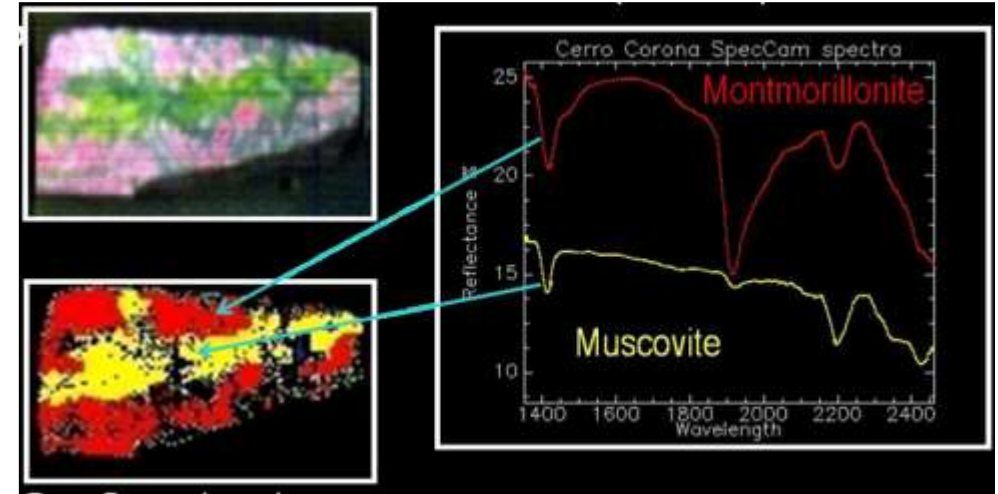
Hyperspectral Case Study at Cerro Corona Mine, N Peru

Project Aims

- Assist in development of better defined clay model
- Improved and more precise clay definition for metallurgical processes
- Clay zone definition and quantification of suitable material for construction of tailings dam
- Assist pit design and geotechnical modelling

Project Summary

- Total of 43 km of core analysed
- Enhanced existing clay model with 17 clay minerals identified over the original 2 from visual observation alone
- Identification of Kaolin and various types of mica improved understanding of mineralised zones
- Identification of swelling clays to improve pit design and geotechnical logging

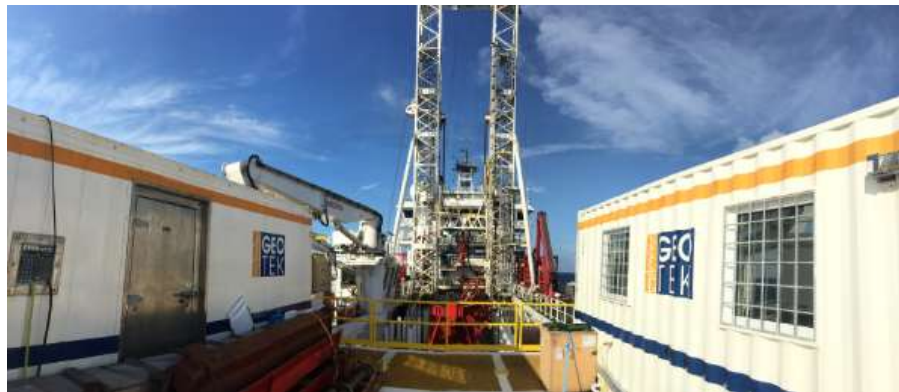


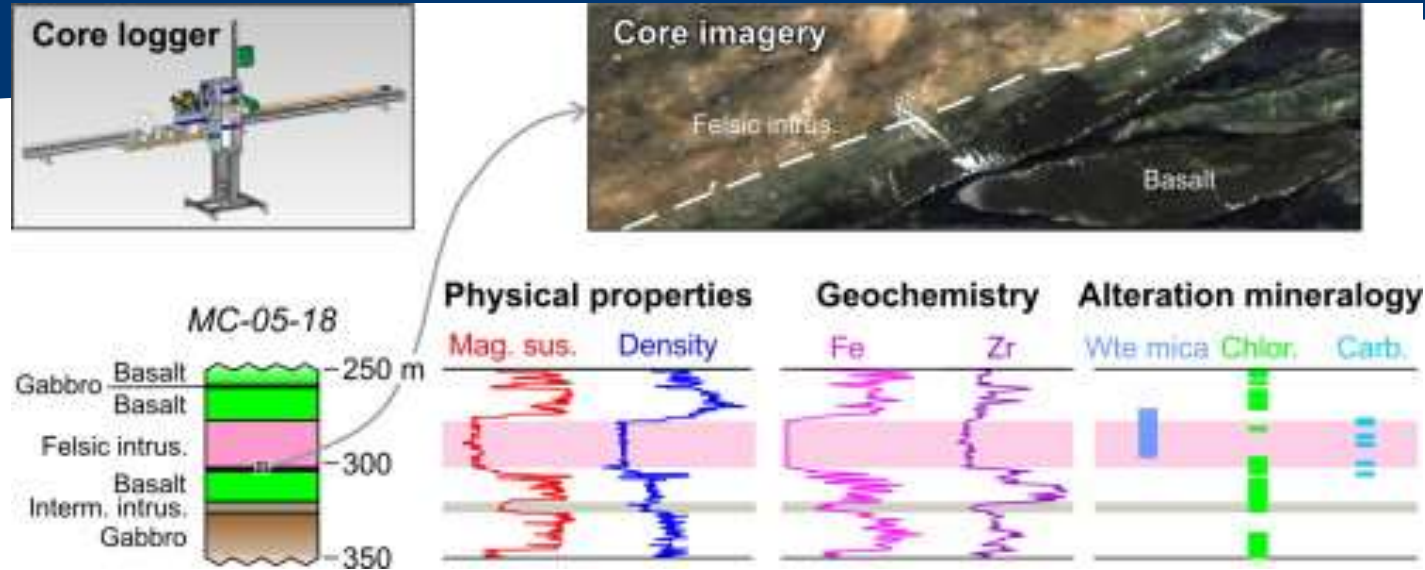
SpecCam 4 from 2 stockpile samples

- Top left image is a 3 band False Colour Composite (FCC)
- Bottom left image has each pixel colour coded if a particular mineral is present. Pixels are colour coded red if the spectrum is characteristic of montmorillonite or yellow if muscovite is present; spectral plots of each mineral are shown on right side.

Drillsite Deployable Core Scanning

- Often drillsites and/or core repositories are in remote locations, and it is difficult and expensive to move core – **So take the logging to the core**
- MSCSL equipment can be installed into either **20ft or 40ft self-contained laboratories, or in trailers**
- **Ruggedized** equipment and laboratories that are **field-proven**

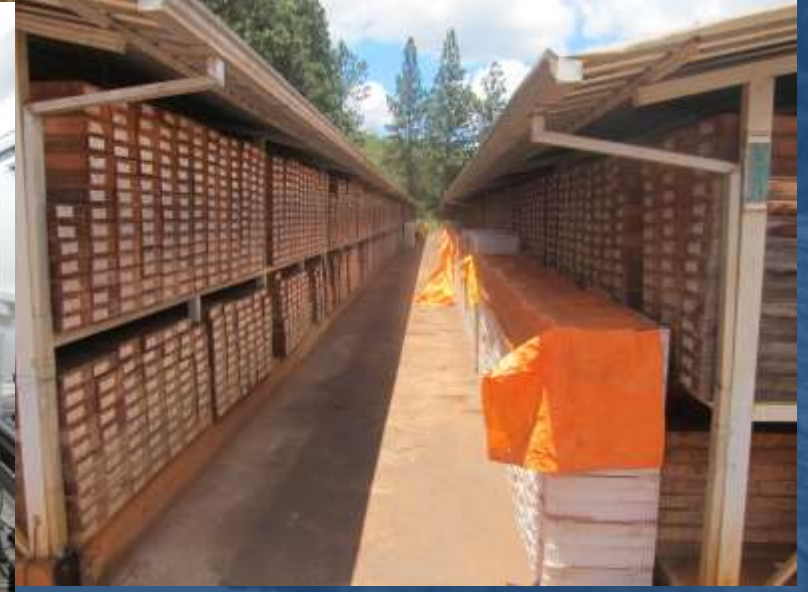
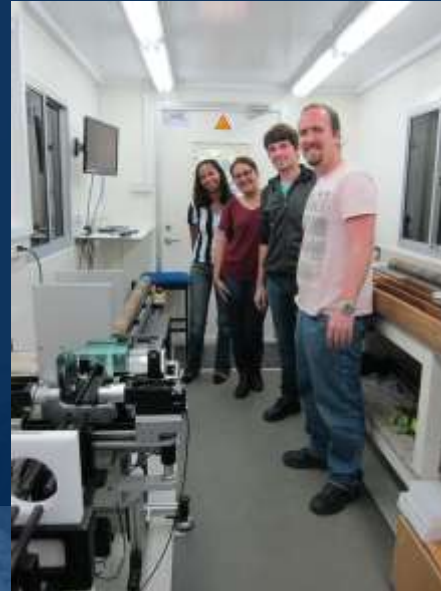




- Transported across Canada to undertake mineral exploration research
- MSCL system used undertake **automated mesoscale ARDI evaluations**, provide **lithological discriminators**, assess **chemostratigraphy** and provide necessary **physical properties to evaluate resource**

Weatherford and Vale Long term lease in Brazil

- Geotek provided a 20ft containerised lab to the core repository in Belo Horizonte, Brazil
- Geotek trained Weatherford and Vale staff to operate the equipment and then supported remotely
- Iron-ore deposit, using the MSCSL to identify new reserves and to help **maximize the resource potential**



Summary

Multi-Sensor Core Logger (MSCL) instruments to **non-destructively** acquire continuous **physical and geochemical** parameters from mineral exploration drill cores

Time is of the essence – scan the core at the drillsite with mobile core labs

What more can we learn? – scan cores at the repository and rescue lost data from archived core

~~Under-Utilized~~
Resource of Information

