



A practical guide to improving mining
and mineral operations

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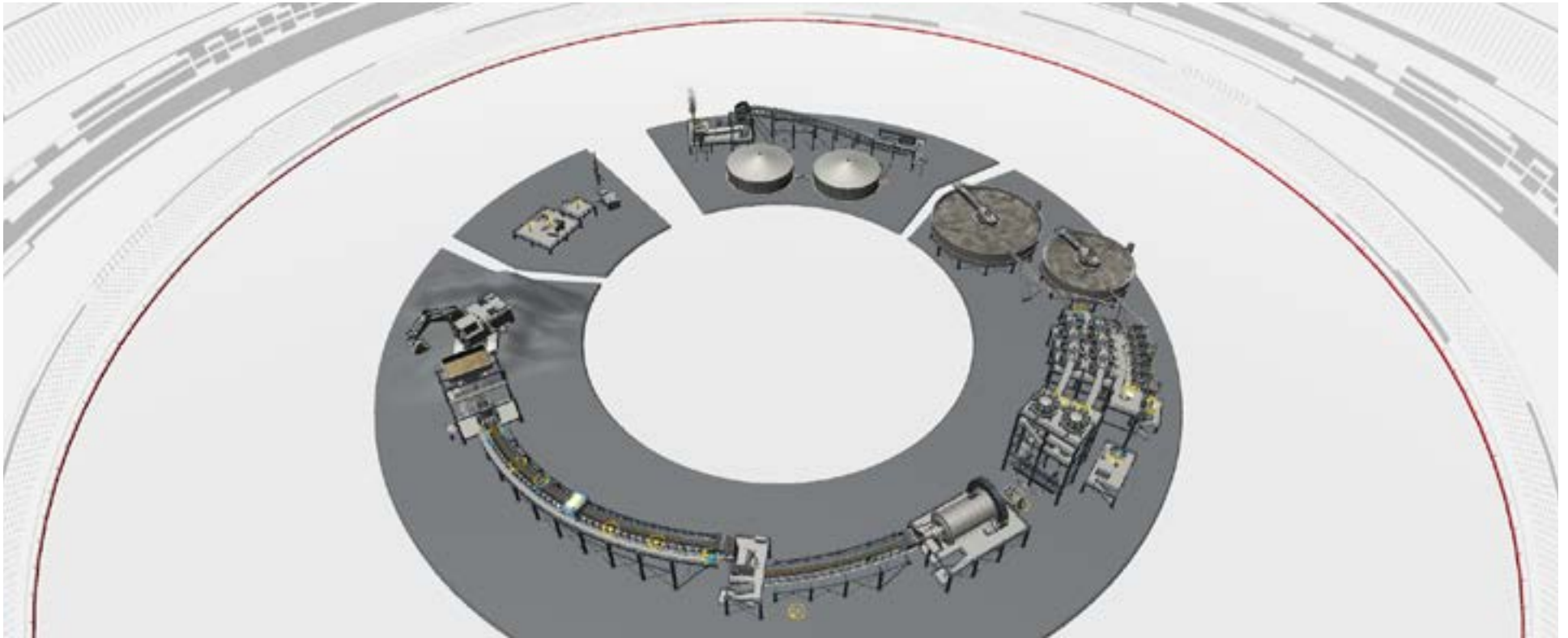
Overview

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Mining solutions overview

From mineral analysis to complete bulk weighing monitoring and sampling systems to informatics, read on to discover the latest equipment and technology to help optimize your mining operations, and keep coal, cement, or mineral processing operations running efficiently, safely, and profitably.



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View the [interactive mining app toolkit](#)



The mineral workflow



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Exploration

At the exploration stage, a quick, non-destructive analysis is often required for outcrop and soil analysis, advanced exploration and drilling, core sample analysis, mine mapping, grade control, and cuttings analysis for mud logging and reservoir characterization. This data will often enable geologists and miners to make data driven decisions on locations & sites.



Technology: XRF analysis allows you to take assay analysis in real time, and can be used in mine mapping, ore grade control, and environmental compliance. Elemental analysis is critical to the exploration and mining of a wide variety of base metals, precious metals, rare earth elements, mineral fuels, industrial minerals, and gas-bearing strata samples.

Safety: Dangerous radiation is often found in mines. Personal radiation monitors can detect and locate radiation sources. Fugitive dust from coal and minerals is hazardous to both personal health and the environment. Personal dust monitors help monitor and alert miners regarding the level of dust.

Exploration

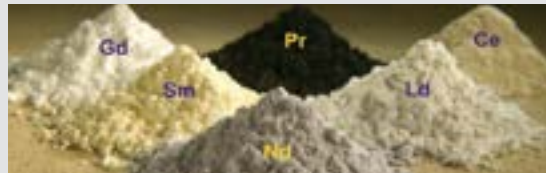
Core drilling



During mud logging, geologists examine rock chips that are brought to the surface by the circulating drilling media (most commonly mud). They look for any evidence to identify downhole lithology (rock type), mark positions of hydrocarbons with respect to depth, monitor natural gas entering the drilling mud stream, and create well logs.

[Download application note >](#)

Rare Earth Elements (REEs)



Rare earth elements (REEs) are natural elements with an atomic number from 57 to 71. These elements are classified into two groups: light REEs (LREEs), representing lanthanum (La) to samarium (Sm), and heavy REE (HREE), representing europium (Eu) to lutetium (Lu). Scandium (Sc) and yttrium (Y) have similar chemical properties and tend to occur in the same ore deposits as REEs, particularly HREEs. Although REEs are not as rare as precious metals, their mining and extraction technology is very costly.

[Download application note >](#)

Continuous and longwall coal mining



The continuous miner technique, which is also known as room and pillar mining, uses equipment to cut a series of paths, or “rooms”, leaving sections of uncut coal approximately 20 feet square to support the overhead structure (also known as “pillars”).

The longwall mining technique involves using a continuous miner to create two tunnels, in which conveyor belts are installed and which also provides a conduit for inbound and outbound ventilation.

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Material handling

The ore from the mine must be sent to the concentrator in an efficient and safe way via conveyor belts.



Technology: Belt scales attach to conveyors and supply real-time volume by weight information to assist with the accounting of material received from the mine. They also assist in the control of feed into the milling circuit.

Tramp metal detectors are used to identify unwanted metal, such as broken pieces of equipment that enter the material stream, so they can be removed and equipment damage can be avoided.

Cross-belt elemental analyzers that utilize Prompt Gamma Neutron Activated Analysis supply minute-by-minute analysis of the quality of ore received from the mine, helping to ensure the best stockpile management.

Safety: Belt misalignment and safety pull switches should be part of conveyor safety. Switches can trigger an emergency stop when a conveyor belt runs off the idlers due to misalignment; this action can help prevent injury to workers or expensive damage and downtime. Safety pull switches are generally connected to a cable installed on the side of conveyors, and can initiate an emergency stop when the cable is pulled by a worker as needed.

Material handling

Important conveyor instruments

Belt scale systems



A belt scale system consists of three major elements: the weighing carriage with load cell(s) measures the weight of material on the belt; the belt speed sensor and electronic integrator joins the output signals from the scale load cell(s); and a speed sensor to monitor the rate of material flow and the total material passed over the scale.

Additional Resources:

- [Blog article: Which belt scale system is best for your bulk material handling operation? Here's a guide.](#)
- [Belt scale maintenance checklist](#)

Tramp metal detectors



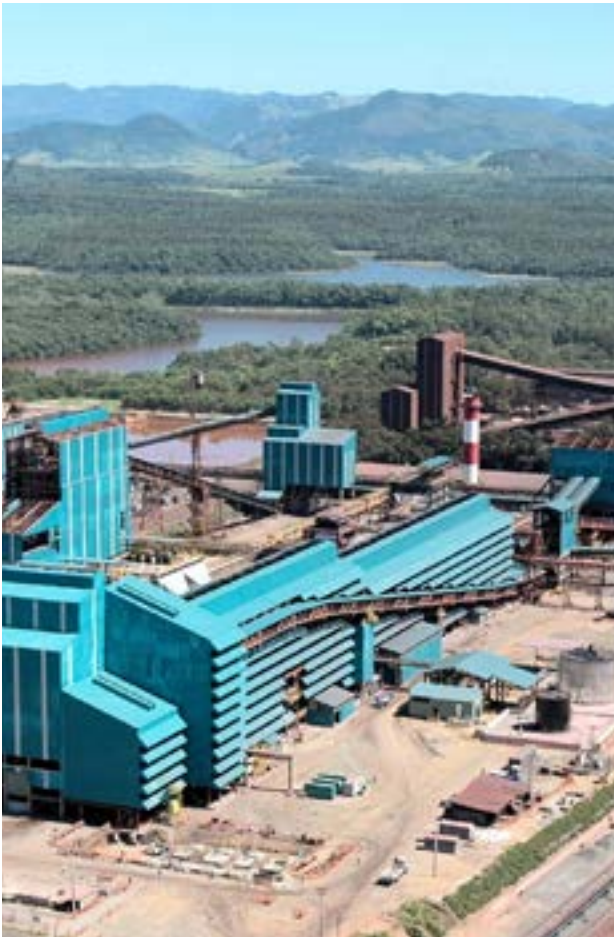
A tramp metal detector provides an economical and reliable method of protecting expensive shredders, crushers, conveyors and other mining bulk weighing, monitoring, and sampling equipment from potentially costly damage from these unwelcome metals.

Additional Resources:

- [Frequently asked questions about tramp metal detectors](#)
- [Tramp metal detectors product comparison table](#)
- [15 features to look for in a tramp metal detector](#)

Beneficiation

During the mineral processing stage, the ore must be crushed, milled, separated, screened, and treated to remove impurities and help ensure the highest quality of material. Continuous online analysis and monitoring of raw material composition is key to improving product quality and integrity, maximizing resources, and meeting customer specifications.



Technology: Slurry process control systems and metallurgical sample preparation equipment supplies companies with reliable, accurate data and critical input for metallurgical accounting and particle size analysis. Particle size monitors utilize an ultra sonic attenuation technique and supplies a minute-by-minute analysis of particle size distribution, which can be used in grind control optimization to ensure that over or under grinding does not occur. These technologies allow operators to optimize their process and recovery, realize significant savings, and improve profitability.

Safety: Non-contact nuclear density gauges measure the density or percent solids of a liquid or slurry in a pipe and are used for applications containing a high temperature, highly toxic or highly corrosive process. This helps to ensure accurate process control and optimum productivity.

Beneficiation

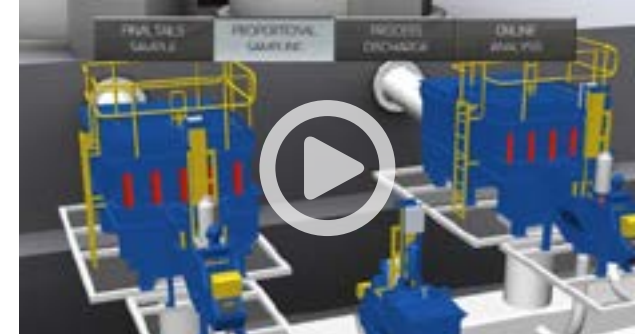
Featured minerals mining and processing videos



Cleaner solutions



Feed solutions



Tailings solutions

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View the [minerals beneficiation product comparison table](#).



Air monitoring

Because mining sites are usually remote, they often utilize coal-fired power plants to supply power to a mining site. To comply with environmental guidelines, emissions should be continuously monitored for toxic fumes and other pollutants.



Technology: Continuous Emissions Monitoring Systems (CEMS) help mining operations monitor SO₂, NO_x, CO, O₂, HG (mercury), PM 2.5/ 10. comply with environmental standards (including U.S. EPA Part 60 or Part 75 performance standards, as well as other U.S and International ambient and source air monitoring standards).

Safety: Fugitive dust, which could be hazardous to health, refers to particulate that is lifted into the air either by man-made or natural activities in large open areas. Fugitive dust is typically the result from activities such as the physical movement of soil, vehicles traveling over unpaved surfaces, heavy equipment operation, blasting, and wind – all found in mining operations. Dust monitors utilize highly sensitive light-scattering photometer (nephelometer) technology and provide continuous measurements of the concentrations of airborne particles.

Air monitoring

Helping protect miner health



Real-time, accurate coal mine dust measurements are critical toward providing data to the miner to permit them to take appropriate action to minimize their exposure to coal dust. **Personal dust monitors** help ensure the shift-average respirable dust exposure does not exceed regulatory limits, which is the first line of defense in preventing devastating long-term health effects such as Black Lung Disease.



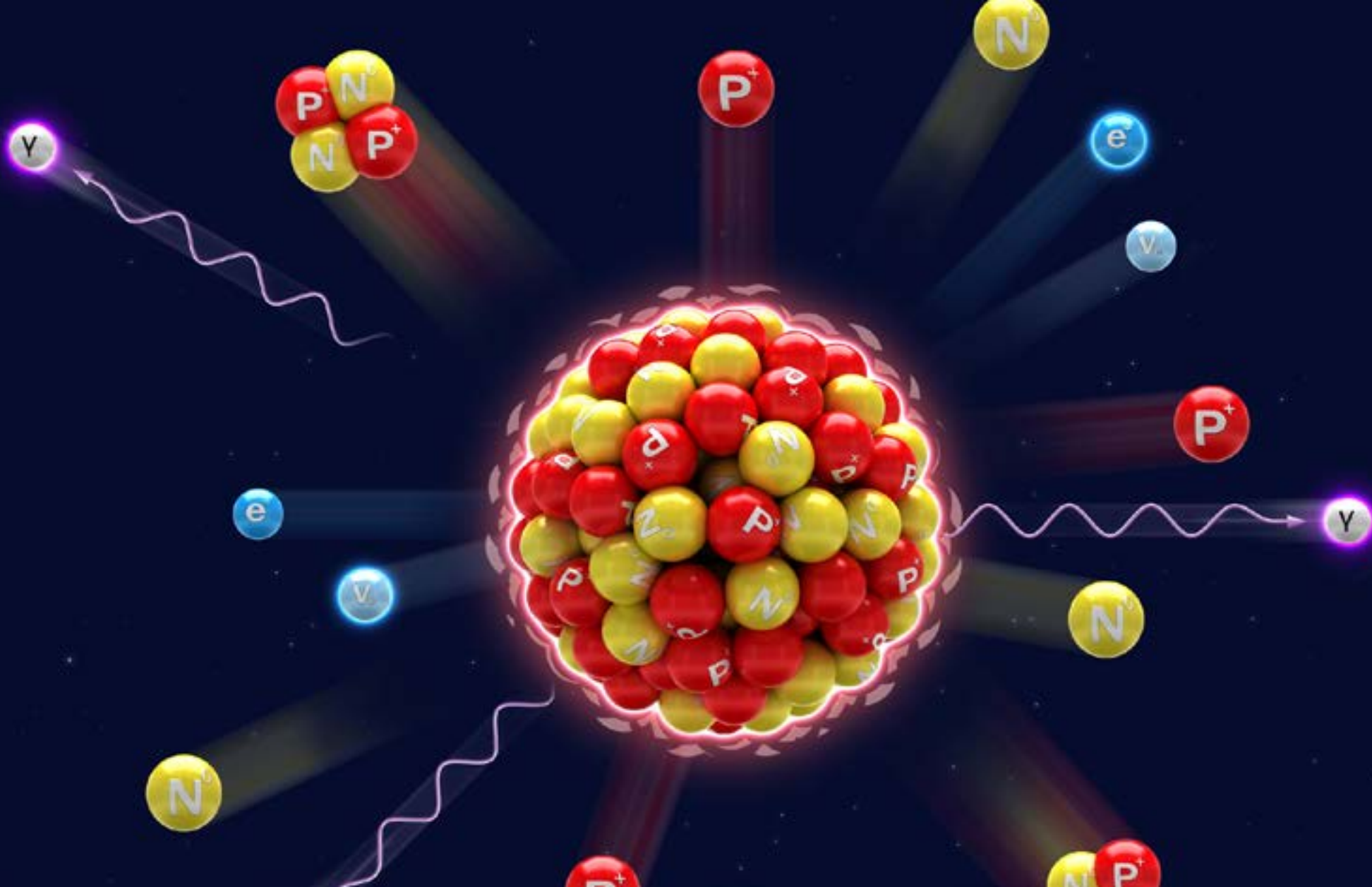
Read our blog:

Continuous Coal Dust Monitoring Critical to Help Prevent Black Lung Disease



Click here to access our **environmental resource library**.





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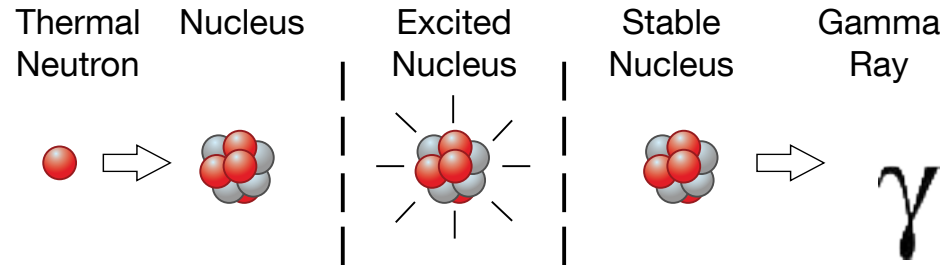
Technology

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PGNAA and PFTNA technology

Prompt gamma neutron activation analysis and pulsed fast thermal neutron activation are based on a subatomic reaction between a low energy neutron and the nucleus of an atom. When a thermal, or rather low energy neutron (<0.025 eV) approaches near enough to, or collides with, a nucleus of an atom, an interaction between the neutron and the nucleus takes place. Energy from the neutron is transferred to the nucleus and temporarily elevates it to an excited energy state. The energy is then released, nearly instantaneously, in the form of a gamma ray. The gamma-ray given off has a distinct energy associated with the atom from which it was released. In essence the gamma-ray emitted is like a “fingerprint” of the element. The emitted gamma-rays are detected and an energy spectrum generated which can then be analyzed for elemental composition.



Learn more about **PGNAA** and **PFTNA** technology.



X-ray fluorescence (XRF)

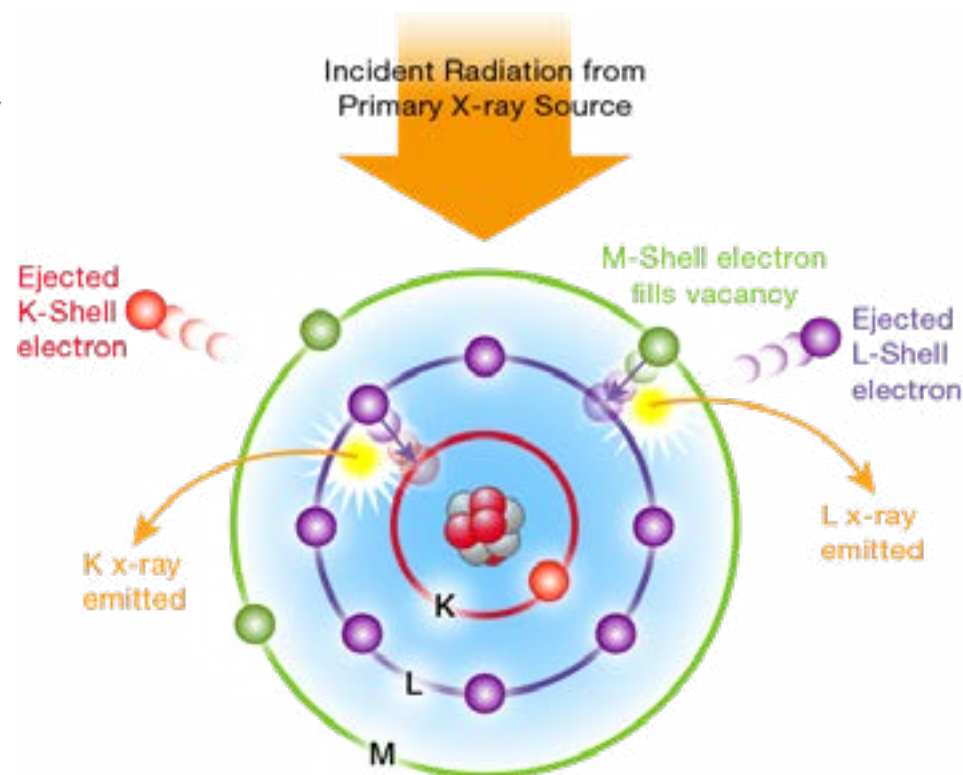
XRF (X-ray fluorescence) is a non-destructive analytical technique used to determine the elemental composition of materials. XRF analyzers determine the chemistry of a sample by measuring the fluorescent (or secondary) X-ray emitted from a sample when it is excited by a primary X-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent X-rays (“a fingerprint”) that is unique for that specific element, which is why XRF spectroscopy is an excellent technology for qualitative and quantitative analysis of material composition.



X-ray fluorescence (XRF)

The X-ray fluorescence process

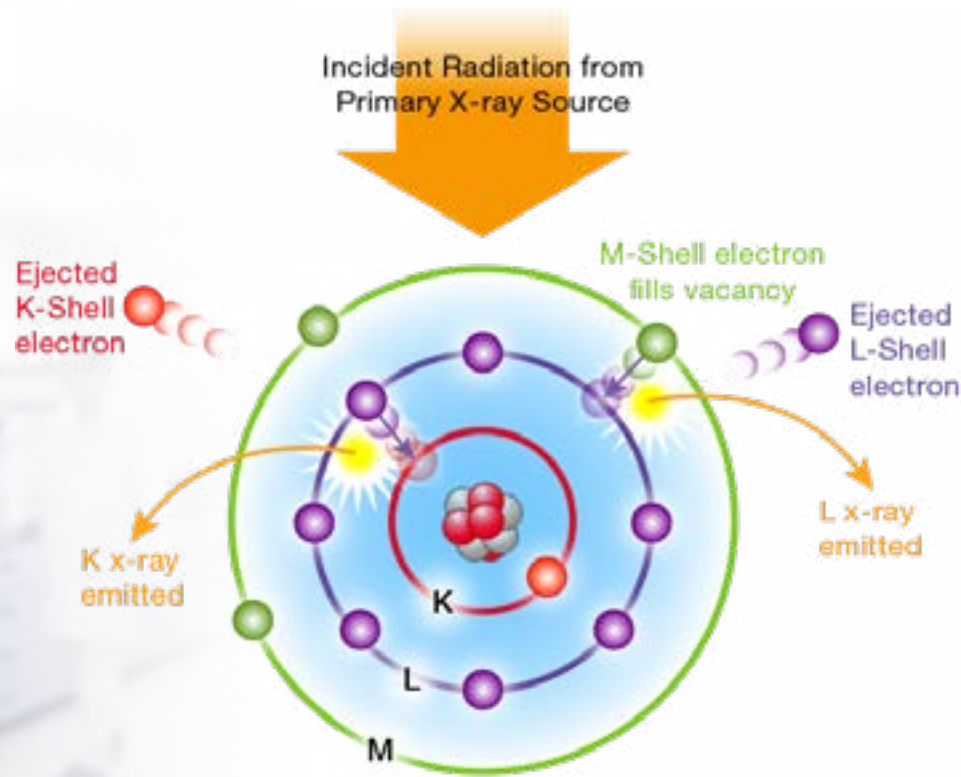
- A solid or a liquid sample is irradiated with high energy X-rays from a controlled X-ray tube.
- When an atom in the sample is struck with an X-ray of sufficient energy (greater than the atom's K or L shell binding energy), an electron from one of the atom's inner orbital shells is dislodged.
- The atom regains stability, filling the vacancy left in the inner orbital shell with an electron from one of the atom's higher energy orbital shells.
- The electron drops to the lower energy state by releasing a fluorescent X-ray. The energy of this X-ray is equal to the specific difference in energy between two quantum states of the electron. The measurement of this energy is the basis of XRF analysis.



Click here to download the eBook: **XRF Technology in the LAB**



Wavelength dispersive X-ray fluorescence for mining laboratories



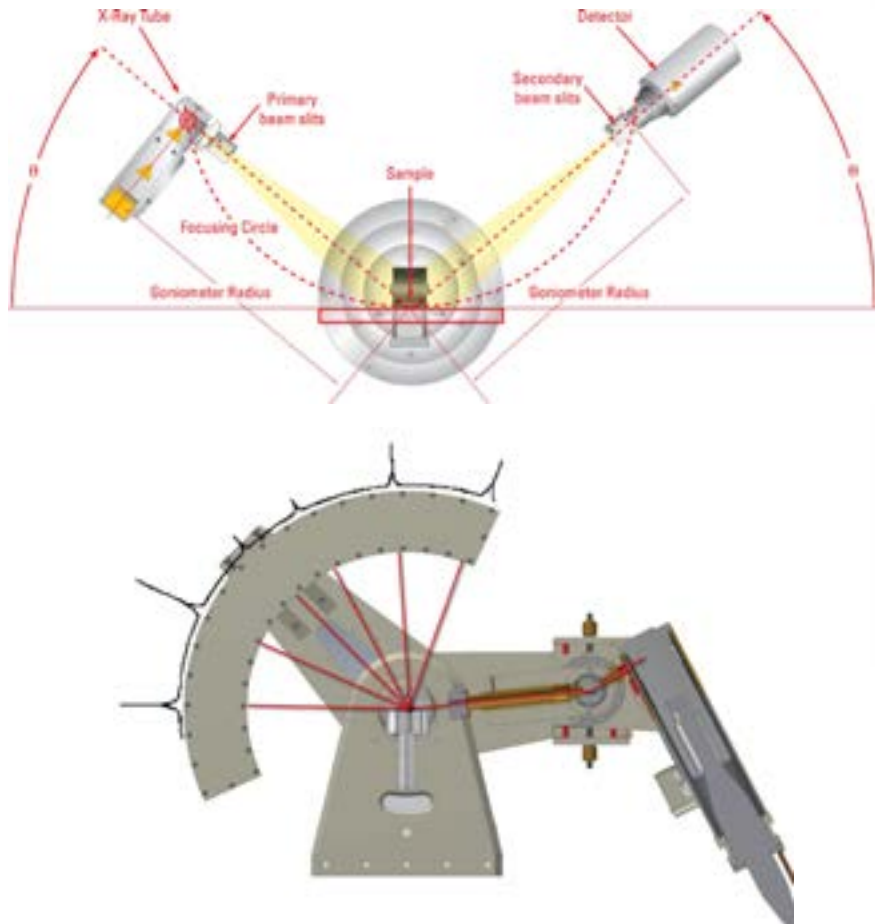
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Learn more about **x-ray diffraction**.



Powder X-ray diffraction for mining laboratories



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Learn more about **x-ray diffraction**.



Toxic vapor analysis technology

Photoionization Detector (PID)

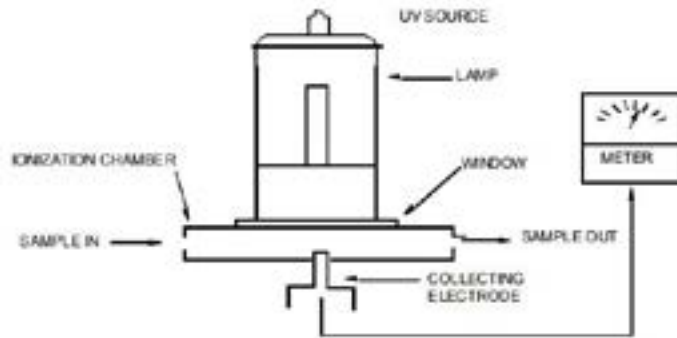


Figure 1-2. Typical Photoionization Detector



Read our blog: [How Does Photoionization Detection Help Identify Toxic Vapors?](#)

Flame Ionization Detector (FID)

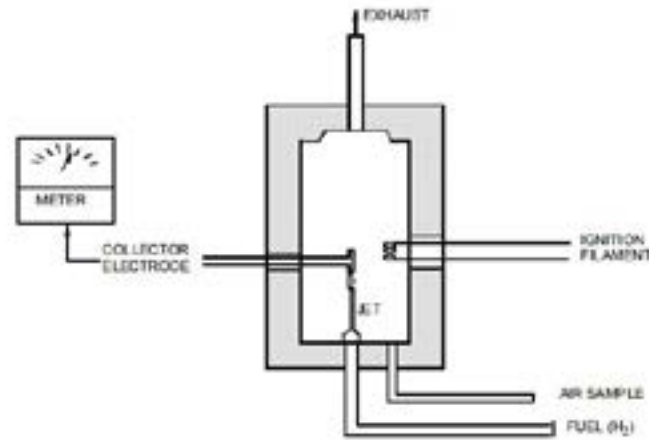


Figure 1-1. Typical Flame Ionization Detector



Read our blog: [How Does a Flame Ionization Detector Work in Toxic Vapor Analysis?](#)

Dust monitor and TEOM technology

Particulate matter monitoring systems that employ tapered element oscillating microbalances (TEOM) technology are “gravimetric” instruments that draw (then heat) ambient air through a filter at a constant flow rate, continuously weighing the filter and calculating near real-time mass concentrations of particulate matter.

The TEOM monitor technique relies upon an exchangeable filter cartridge seated on the end of a hollow tapered tube. The wider end of the tube is fixed. As the air passes through the filter, particulate is deposited. The filtered air then passes through the tapered tube to a flow controller. The tapered tube with the filter on its end is maintained in oscillation in a clamped-free mode. The frequency of oscillation is dependent upon the physical characteristics of the tapered tube and the mass on its free end.

As particulate deposits land on the filter, the filter mass change is detected as a frequency change in the oscillation of the tube. The mass of the particulate matter is thus determined inertially, i.e. directly. When this mass change is combined with the flow rate through the system, the monitor yields an accurate measurement of the particulate concentration in real time. The major advantage of this method is that any changes in aerosol characteristics will not influence the accuracy of the mass measurement.



Click here to watch the video:
PDM3700 Personal Dust Monitor and TEOM Technology



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Equipment



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Mining and minerals solutions

From exploration through processing, our solutions help optimize mining performance and improve throughput & recovery while driving sustainability and safety.



Exploration & elemental analysis

- Handheld XRF



Weighing, monitoring, blending & processing

- OES, XRD, & XRF analysis
- PGNA and PFTNA technology



Throughput, recovery, efficiency

- Real-time elemental analysis
- Real-time Particle size analysis
- Sampling



Safety

- Personal and fugitive dust Monitoring
- Conveyor switches

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Solutions for exploration



Thermo Scientific™ Niton™ XL5 Handheld XRF Analyzer

Niton portable X-ray fluorescence (XRF) analyzers are making a critical difference in mining exploration and production. Designed for rugged field environments, our analyzers provide rapid, on-site qualitative screening directly in-situ or lab-quality quantitative analysis on prepared samples, bypassing the costly and time-consuming process of sending samples to off-site laboratories and waiting days, or even months, for critical data. With rapid sample analysis, you get real-time geochemical data to guide drilling decisions, enable high-productivity operations, and gain a competitive advantage.

[Product details >](#)

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Thermo Scientific™ Niton™ XL3t Ultra Analyzer

Find elusive oil and gas deposits and avoid drilling in the wrong spot, which is expensive and time consuming. The Niton XL3t Ultra Analyzer provides rapid sample analysis in the field so that you can quickly find where deposits are and which ones will prove the most productive. This high-functioning tool offers the superior light element detection required for gas shale applications without helium purge or vacuum.

[Product details >](#)



Thermo Scientific™ RadEye™ SPRD Personal Radiation Detector

The pocket-sized RadEye SPRD Personal Radiation Detector alerts workers to potential radiation exposure at greater distances without increasing false alarms so they can respond quickly and decisively to real radiation threats.

[Product details >](#)



Thermo Scientific™ PDM3700 Personal Dust Monitor

Monitor real-time coal dust exposure with a respirable, personal dust monitor designed specifically for U.S. based mining applications. The PDM3700 Personal Dust Monitor is equipped with waterproof battery protection, PC-based software for data downloading and reporting, integral charger with download and station for PC interface.

[Product details >](#)

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Solutions for material handling in mining operations



Thermo Scientific™ Ramsey™ Oretronic IV Tramp Metal Detector

Prevent damage of expensive downstream equipment from tramp metal on conveyor belts. Can detect all types of metallic scrap, including bucket teeth, manganese steel mantles, bore crowns, bar scrap chains, tools, and more.

[Product details >](#)



Thermo Scientific™ Ramsey™ Series 14 Belt Scale System

Ramsey belt scale systems monitor steel raw material feed to crushers, mills, screens, preparation plants, and coal-fired power plants to help ensure precise feeding of process materials and maintain product quality.

[Product details >](#)



Thermo Scientific™ Ramsey™ Model 90-150 Low Capacity Weighbelt Feeder

Accurately control process material feed rates. Weighbelt Feeders help reduce material waste, maintain blend consistency, increase profits, and meet customer specifications.

[Product details >](#)

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Lab equipment in mining laboratories



Sample preparation

Laboratory Information Management Systems (LIMS) and Chromatography Data Systems (CDS) for the mining industry provide the foundation for a complete laboratory automation solution by integrating with instruments and laboratory and business systems, including PIMS, MES, and ERP solutions. A LIMS is a critical component of any mining operation for quality control, efficiency optimization, throughput of continuous processes, and compliance with product and environmental safety standards.



Sample analysis

Efficient analytical techniques such as X-ray fluorescence (XRF) and X-ray diffraction (XRD) help mining laboratories make faster decisions and produce more value-added products. XRF is a well-established elemental analysis technique for geological materials. XRD adds value by determining mineralogy and phase composition. Both XRF and XRD can identify and quantify undesirable elements which can adversely affect the final product or the environment.

Measurements such as viscosity, elasticity, processability, temperature-related mechanical change, and the yield stress value of mining tailings can be extracted easily from a simple measurement using a rheometer. Those values can then be easily correlated with the pumpability of a specific tailing formulation with given solids mass fraction.



Quality control

Meet relevant standards and regulations for quality assurance and quality control (QA/QC) with instruments that ensure the integrity of all equipment, materials, structures, components and systems used in the manufacturing and operation of all types of mining facilities. Verify materials, parts, and final output through inspections and audits off line and onsite during production process.

Chemical and mineralogical analysis of geological materials using XRF and XRD



Thermo Scientific™ ARL™ PERFORM'X Sequential X-Ray Fluorescence Spectrometer

- High performance WDXRF for the chemical analysis of ore bodies, enriched minerals and processed products
- Analysis of elements from B to U from trace levels to %
- General Oxide Calibration Program for accurate analysis of all types of geological materials
- Advanced Mapping and Spotting capability to identify mineral species in rocks and minerals
- High throughput with large XY-sample loader for unattended batch operation and flexibility

Thermo Scientific™ ARL™ EQUINOX 1000 X-ray Diffractometer

- Complete Mineralogical/Phase analysis in all types of geological materials and minerals almost in real-time
- Full X-ray Diffraction pattern simultaneously measured in few seconds to minutes using Position Sensitive Detector technology
- Qualitative and Quantitative Phase analysis using Rietveld programs
- Convenient and High-Performance Powder XRD for the analysis of solids and powders
- High throughput with large 30-position sample loader and unattended batch operation



Learn more about **geologic and mineral analysis.**

Solutions for beneficiation



Thermo Scientific™ CB Omni™ Agile Online Elemental Analyzer

The CB Omni Agile offers not only enhanced configurability through its modern modular industrial design to suit your application, but a lighter, easier to install analyzer, with the same industry leading performance that you have come to expect.

[Product details >](#)



Thermo Scientific™ AnStat-330 Online Sampling and Elemental Analysis Station

The AnStat-330 Online Sampling and Elemental Analysis Station incorporates multiple stages to progressively sub-sample the slurry stream before delivering metallurgical accounting quality composite samples through a final stage metallurgical sampler. The dedicated and continuous in-stream analysis allows operators to quickly respond to process upsets and changing conditions.

[Product details >](#)



Thermo Scientific™ MSA-330 Multi-Stream Slurry XRF Analyzer

Get reliable, accurate, cost-effective elemental analysis of up to 12 slurry streams with the MSA-330 Multi-Stream Slurry XRF Analyzer. Each stream is kept in a separate analysis zone, ensuring no cross-contamination. With no multiplexer required, the MSA analyzer has low head loss, saving elevation in the plant which can lead to significant savings in engineering and installation.

[Product details >](#)

Solutions for air and energy monitoring



Ambient Gas Monitoring

We offer a variety of analyzers for the ambient monitoring of the criteria pollutant gases, including CO, NOX, SO2, and others such as CH4 and CO2.

[Product details >](#)



Continuous Emissions Monitoring Systems (CEMS)

Comply with regulatory guidelines while meeting your own specific air quality monitoring needs. These systems are designed to meet US EPA 40CFR Parts 60 and 75 standards while providing unsurpassed sensitivity, accuracy and reliability.

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