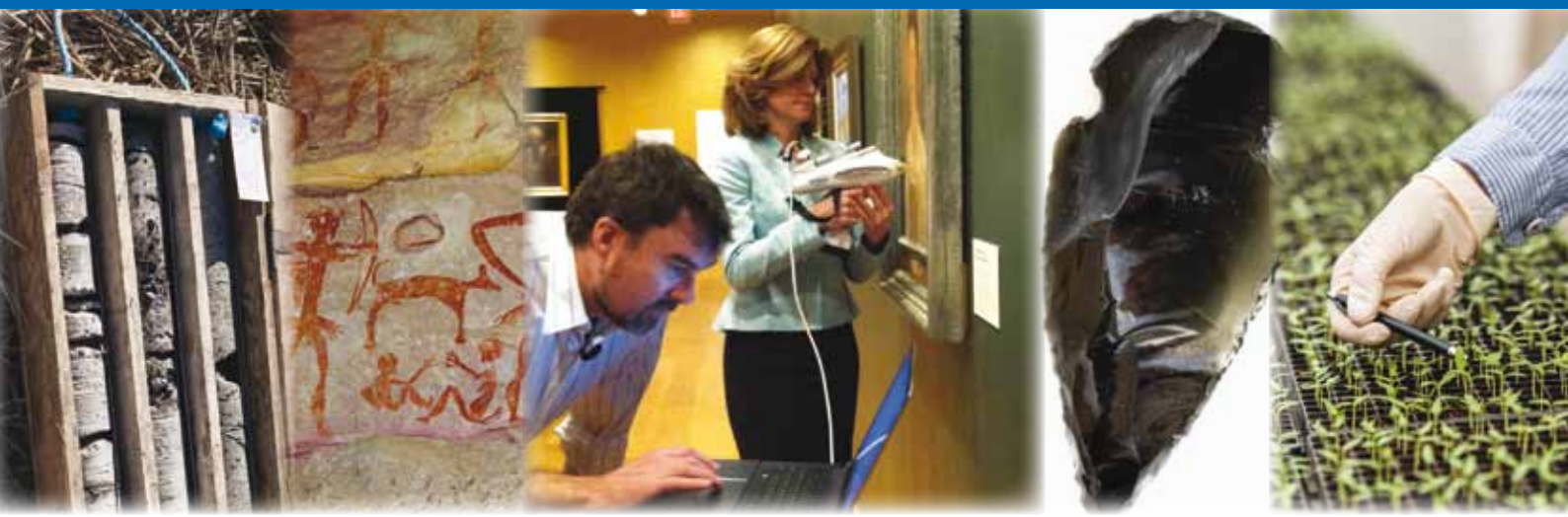


Tracer XRF Spectrometer

Dynamic, Versatile and Contextual Elemental Analysis

- Identify and Compare Elements in Objects and Materials
- Analyze Complex, Heterogeneous and Non-Uniform Samples
- Characterize Materials within the Context of their Environment
- Perform Laboratory Energy Dispersive X-Ray Fluorescence (EDXRF) Anywhere

Perform Laboratory EDXRF Anywhere

The Tracer helps identify and compare elements in objects and materials in the context of their environment. Its versatile configuration and powerful analytical software provide dynamic insight into the specimen under observation.

The Tracer is unique in its flexibility to investigate not only homogenous samples, but also complex, heterogeneous and non-uniform materials for advanced research.

Art Authentication and Conservation

Conservationists authenticate objects of cultural, historical and financial value to ensure appropriate conservation and restoration treatments.

Elemental analysis of pigments helps authenticate paintings and determine an appropriate course of action for treatment. Many pigments have well known dates for introduction; the presence or absence of these can be used to identify when artwork was produced. It can also identify if such artwork is a modern replica or if it has undergone past restoration. For example, when mercury and sulfur are predominant in a red pigment, it indicates vermilion which is synthesized HgS. However, if it is cadmium red which produces a similar range of hues, the primary elements observed will be cadmium, sulfur, and selenium.

One of the greatest challenges in art conservation is correctly identifying materials, whether for the purpose of studying and understanding an object, for the purpose of conserving an object for future generations, or for the purpose of restoring an object that has been damaged or degraded over time. Elemental analysis helps to ascertain fabrication technology and distinguish between original and non-original materials, which in turn helps to determine the course of treatment.

Archaeological Studies

Archaeologists use elemental analysis to supplement existing archaeological knowledge to learn more about trade routes, cultural or commerce exchange, and manufacturing processes. For example, strontium and rubidium are traces that can be used for obsidian, lithic, or ceramic sourcing; iron can reveal past pigment use or a metal worker's shop; and lead can indicate metallurgical activity and casting.

Dynamic, Versatile and Advanced Elemental Analysis

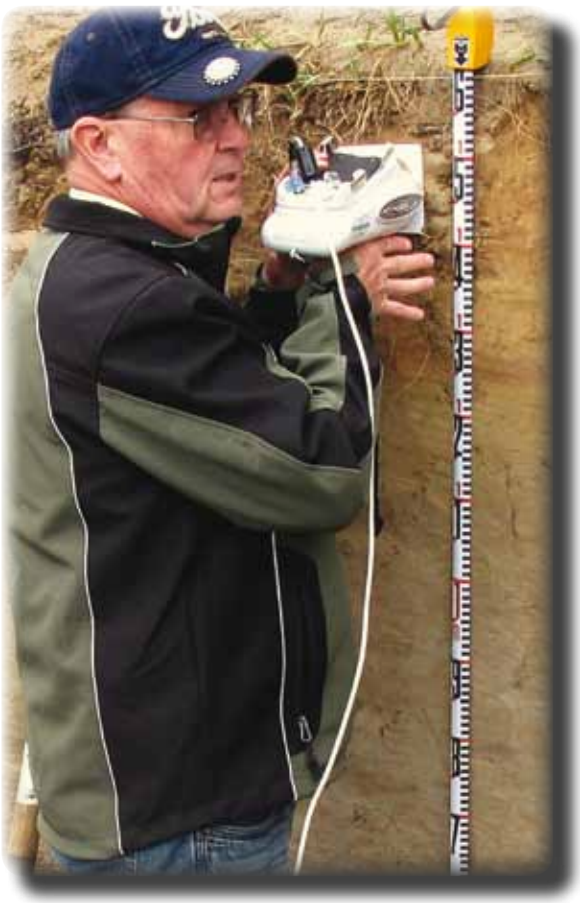
Exploratory GeoScience

Even in the most remote locations, Tracers are used to analyze the geochemistry of soil, sediment, ores, mudrock, drill cuttings and concentrates. Its light element measurement capability extends the reach of handheld XRF from base metals and major/trace elements to critical element ratios with sodium, aluminum, silicon, potassium and calcium.

The Tracer's sophisticated XRF spectral analysis capabilities help scientists successfully work through challenges of wide ranging elemental content and high variability in geomaterial matrices. Although more widely known for use in mining applications, Tracer Core Scanner Systems are also used with core samples collected for energy sources, major construction, military projects, chemostratigraphy and climate research. And, it can even be used to screen for heavy metals during reclamation and cleanup.

Applied AgriScience

Field Portable XRF Spectrometry helps with healthy and nutritious crop management, including the efficacy of fertilizers, pesticides, fungicides and other treatments. The Tracer's light element measurement and sophisticated XRF spectral analysis capabilities enable scientists to better understand plant uptake and mobility of nutrients, such as magnesium, phosphorus and sulfur. Portable XRF is also used to study the effects on farming of migratory heavy metals caused by climate change, anthropogenic pollution, and catastrophic geological or extreme weather.



Social Responsibility Directives

Many common objects and materials contain elevated levels of toxic metals, such as arsenic, lead and mercury that can pose danger to those who have direct contact. Screening for these heavy metals helps determine the safest way to transfer, remediate or dispose of them. Additionally, Tracer elemental measurements can enhance bioavailability studies.

Science Education and Research

The Tracer is the ultimate teaching and research tool to analyze objects and materials in the field, classroom or laboratory. This multidisciplinary, hands-on technology engages students with relevant, interesting applications of science.

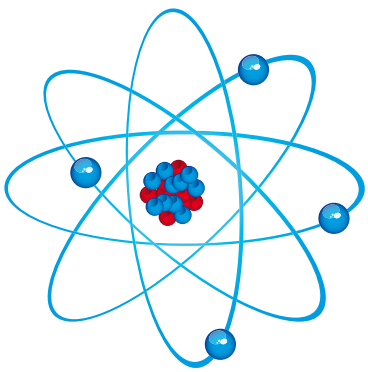
EDXRF Spectrophotometry

Materials consist of elements, both metallic and non-metallic, that are combined and structured in ways that result in unique properties and characteristics. Likewise, elements have varied atomic structures that result in unique properties and characteristics, including their interaction with photon energy.

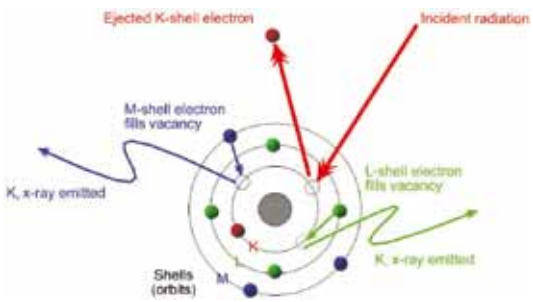
The Tracer's X-ray tube generates photons with enough energy to interact with the innermost electrons of an atom. The Tracer's detector can then identify elements by measuring the energy of the X-ray photons emitted by this process. The Tracer's analytical software processes all of the information to characterize the material.

It's Elementary - Photons and Electrons Interact Energetically to Give You Answers

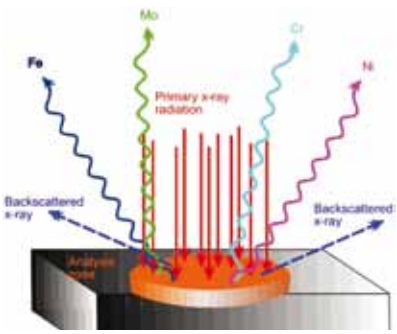
In a stable atom, electrons occupy discrete energy levels (shells/orbits) with specific binding energies.



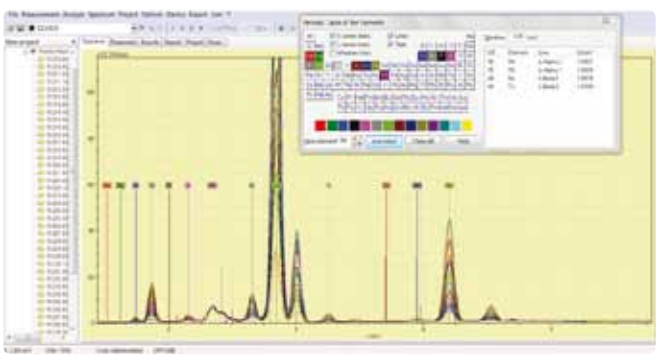
The electron vacancy created at the inner shell will be filled by an outer shell electron to regain stability for the atom. Fluorescence occurs when energy is released while an outer shell electron moves into an inner shell.

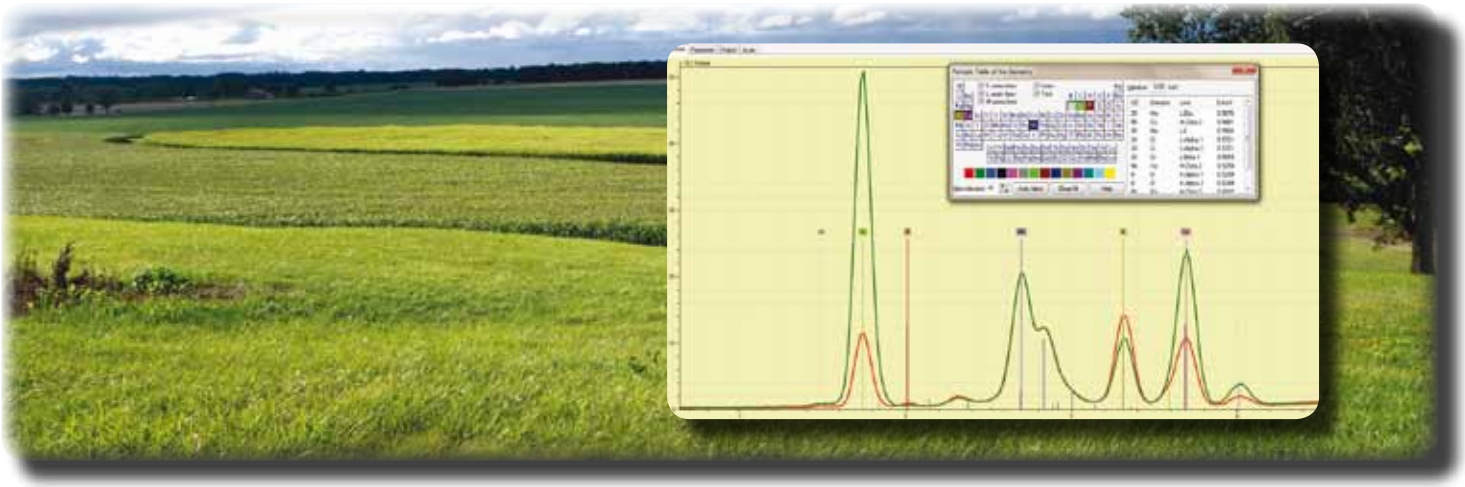


X-ray tubes can generate enough photon ionization energy to eject an inner electron from its shell.



Fluorescence energy peaks identify elements; and, peak intensity is proportional to the element concentration.





It's About the Science of Light

Human Vision: We characterize an object by "capturing" what we see at a molecular level when light shines on it - shape, size, texture, color – and processing that data with stored knowledge.

Tracer Vision: The Tracer characterizes an object by "capturing" what it sees at an elemental level when light shines on it – photon energies and intensities – and processing that data with stored knowledge.

Human and Tracer Views of Corn Crops

Molecular observations of leaves from two corn seed brands indicate differences in color - dark green and light green. Elemental observations indicate the dark green leaves have more aluminum, silicon and calcium and the light green leaves have more phosphorus and potassium.

The combination of observations and Tracer measurements, along with knowledge of fertilizers, nutrients and contaminants takes the world of precision agriculture to new levels.

Elemental Analysis Objectives

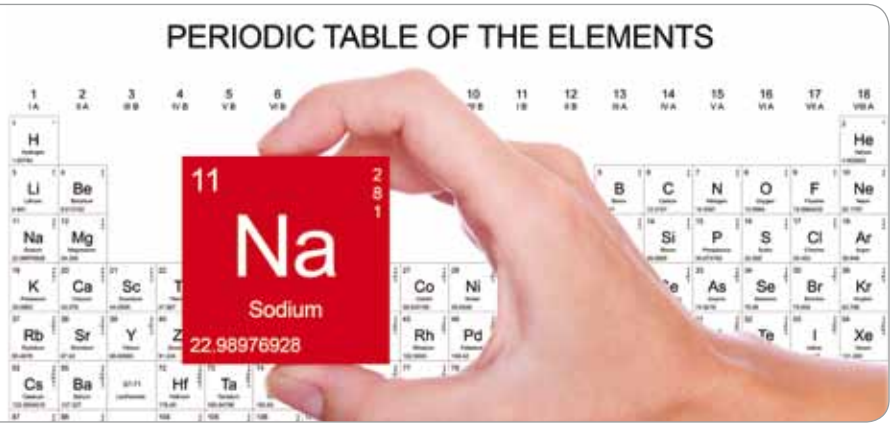
Analysis objectives range from determining the major and trace elements of a single specimen to fully characterizing the elemental composition of sets of related samples and determining their relationships. Tracers provide the hardware and software necessary to achieve analytical objectives of multiple sample types and applications.

Comprehensive ED-XRF Data Analysis

Qualitative analysis determines elements in a sample. Semi-Quantitative analysis determines approximate amounts of the elements with respect to previous knowledge. Quantitative analysis determines elemental composition with accuracy and precision proportional to the standards and procedures used. Tracer Systems provide the full data analysis range.

Tracers are advanced laboratory EDXRF analyzer systems with comprehensive elemental analysis features in a handheld configuration.

Tracers can be configured to analyze elements as light as sodium to as heavy as plutonium, providing scientists with a powerful research tool.



Analyze Complex and Unknown Samples

Tracer Spectrophotometers are advanced laboratory EDXRF systems with comprehensive features ideal for dynamic and versatile analyses of multiple materials and applications. They are optimized for thorough and highly accurate analytical measurements that are not time sensitive and do not require commercially available standards.

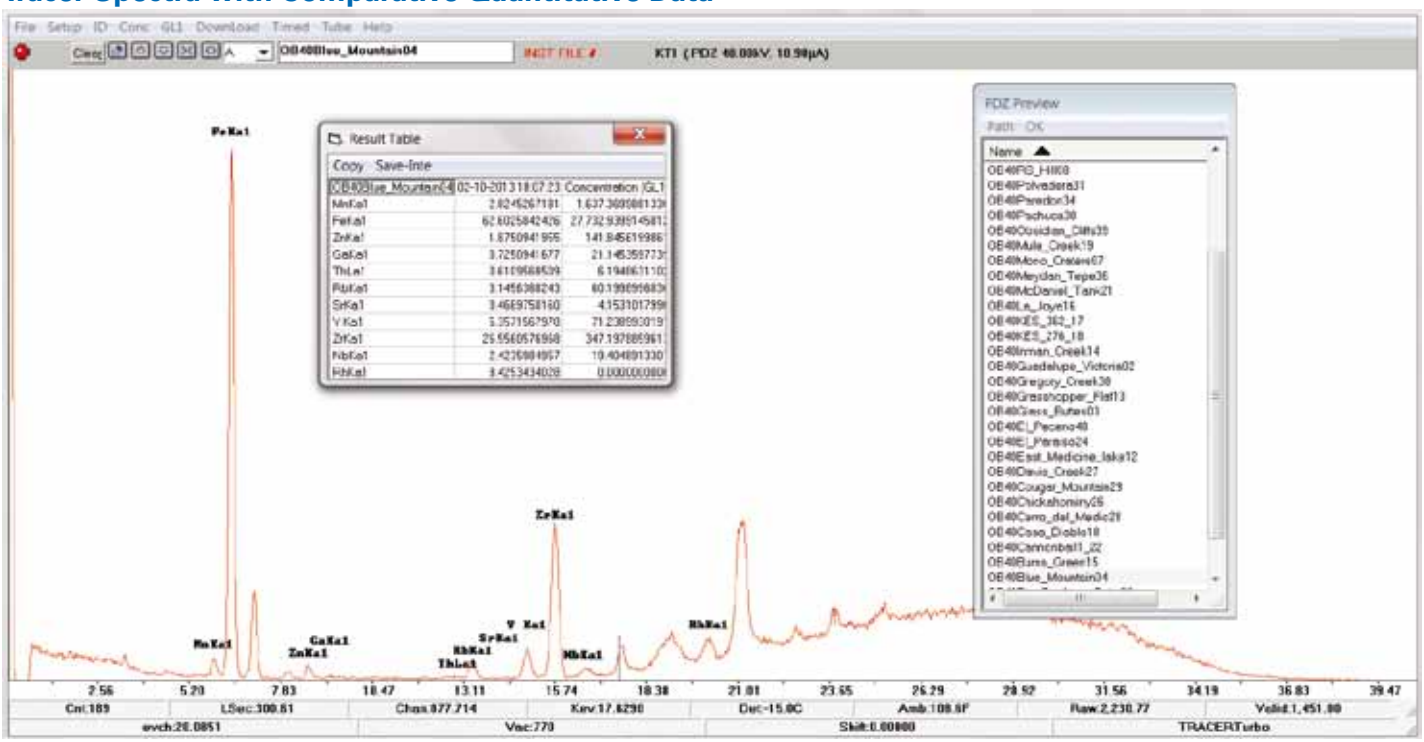
Typical point-and-shoot handheld XRF instruments are configured for a single-purpose application such as scrap sorting or alloy identification. They provide fast answers using factory installed calibrations based on modern day, commercially available, clean, smooth and homogenous standards. They can compare results to hundreds of standards' values that are stored in reference libraries enabling yes/no, pass/fail, and positive/negative ID results.

Tracer Spectrophotometers are not only capable of identifying and comparing elements in homogenous objects and materials; they can also analyze complex and unknown samples. Even though each atom emits a unique energy or color pattern and the intensity of that pattern gives one the relative number of atoms present, it is difficult

for computer algorithms alone to accurately identify each element present and determine their quantities in a complex or unknown sample.

Tracer data analysis software can take the raw XRF photon spectrum of a complex unknown material and de-convolute it by interjecting human pattern recognition knowledge to influence the outcome. This is accomplished using the Bayesian method of inference which updates the probability estimate for a hypothesis as additional evidence is acquired, provided or accessed. This process ensures the correct answer.

Tracer Spectra with Comparative Quantitative Data



Tracer EDXRF Advantages

The Tracer's key features combine to make it the most unique portable elemental analyzer commercially available. The overall user experience and the vast global network of diverse experts who use the Tracer make it the analyzer of choice for scientific researchers and educators the world over.

Features	Advantages	Benefits
Adjustable Tube Power	Capable of manual or automated tube voltage / current adjustments	Provides maximized sensitivity for any element, sodium to uranium, in any matrix
Beam Filter Change and Fabrication	Capable of manual changes of standard or user-fabricated filters; or optionally an automatic filter changer with preset filters.	Provides maximized sensitivity for any element, sodium to uranium, in any matrix
SDD and SiPIN Detector Options	Optimized configuration for varied analyses	Provides low cost option when light element analysis is not required
Vacuum Environment / Helium Flush Capable	Enables higher photon transmission than through an air path	Provides maximized sensitivity for light elements, such as sodium
Camera Option	Enables photographing the analysis spot and surrounding area	Provides a visual record of the analysis spot and surrounding area
Real-Time Spectral Monitoring	Lap top connectivity to Bruker's Raw Spectral Analysis Software	Provides rapid, real-time relative content determination of any element in any matrix
Bayesian Peak Deconvolution Inference Statistics	Less sensitive to errors in peak position, widths, and α/β ratios	Improves success in analysis, especially for complex and unknown samples by interjecting human pattern recognition knowledge to influence the outcome
Empirical Calibrations	Accurate empirical calibrations are available for ceramics, metals, mud rock, obsidian and soil	Provides point-and-shoot capability for selected empirical calibrations on like samples
User Generated Empirical Calibrations	Users can generate their own calibrations of any material from their own reference standards; Fundamental Parameters (FP) calibrations are also available	Provides point-and-shoot capability for user-generated empirical calibrations - gas, liquid, solids or powders; FP provides semi-quantitative analysis when standards are unavailable
Handheld Configuration	Portable for handheld or tripod mounted in-situ measurements	Provides capability of identifying and comparing sample elements within the context of their environment

Tracer Model Comparison and Accessories

Tracer Configurations	Detector	Capable of Vacuum / He flush	Filter	Camera
Tracer III-V+	Si-PIN	Yes	Manual filter changer	Not avaliable
Tracer III-SD	SDD	Yes	Manual filter changer	Optional
Tracer IV-SD	SDD	Yes	5 position automatic filter changer	Not available

Vacuum Ensemble:
The Vacuum Pump Ensemble provides maximized sensitivity for light elements, such as Na.

Tripod Ensemble:
Tripod Ensembles support the analyzers and are articulated on all three axes to provide precision measurement adjustments.

Sample Prep Kit:
The Sample Prep Kit helps optimize soil, rock and other geological materials for analysis.

Sample Changer:
The Sample Changer Carousel enables unattended operation of multiple samples.

Geo-Core Scanner:
The Geo-Core Scanner supports the analyzer to scan geological cores.

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