TIMA-X

FEG
W
4x EDX Detectors

TESCAN
PERFORMANCE IN NANOSPACE

TIMA-X
TESCAN Integrated Mineral Analyser

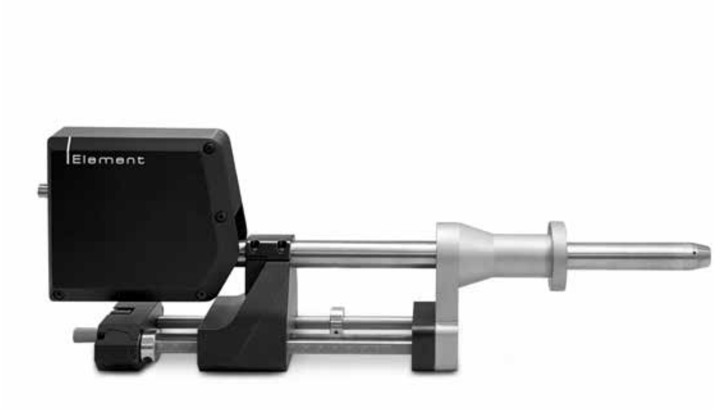
TIMA-X is an **automated mineralogy system for fast quantitative analysis** of samples such as rocks, ores, concentrates, tailings, leach residues or smelter products. TIMA-X **combines BSE and EDX analysis** to identify minerals and create mineral images that are analysed to determine mineral concentrations, element distributions, and mineral texture properties such as grain-size, association, liberation and locking parameters. TIMA-X can also **search for bright phases** containing platinum group, gold, silver, rare earth and other minerals.

TIMA-X uses **up to four EDAX Element silicon drift detectors** and new software to significantly increase both performance and reliability. TIMA-X detectors are a new design that **increases sensitivity to light elements** and maintains stable energy resolution at very high count rates. TIMA-X detectors are fully compatible with both TIMA operation and **EDAX Quantitative EDX systems** and allow the user to enjoy the full speed of TIMA-X while maintaining the capabilities of standard-based quantitative analyses. TIMA-X software has many unique features including a new generation of mineral identification tools and low element detection limits using its patented pixel analysis algorithms.
For high-throughput applications, it can be fitted with the AutoLoader™ - a robotic sample loading system for 24/7 unattended measurement of up to 100 epoxy blocks. AutoLoader increases productivity by transforming mineralogy measurement from a batch to a continuous process by eliminating manual sample exchanges and chamber pump-down.

TIMA-X is the system of choice for geological, mining, and mineral processing. TIMA-X is both an interactive investigative tool and automated 24/7 measurement tool. This makes it an excellent research instrument for use by scientists in a laboratory as well as a production improvement tool for use by engineers at industrial sites.

TIMA Hardware

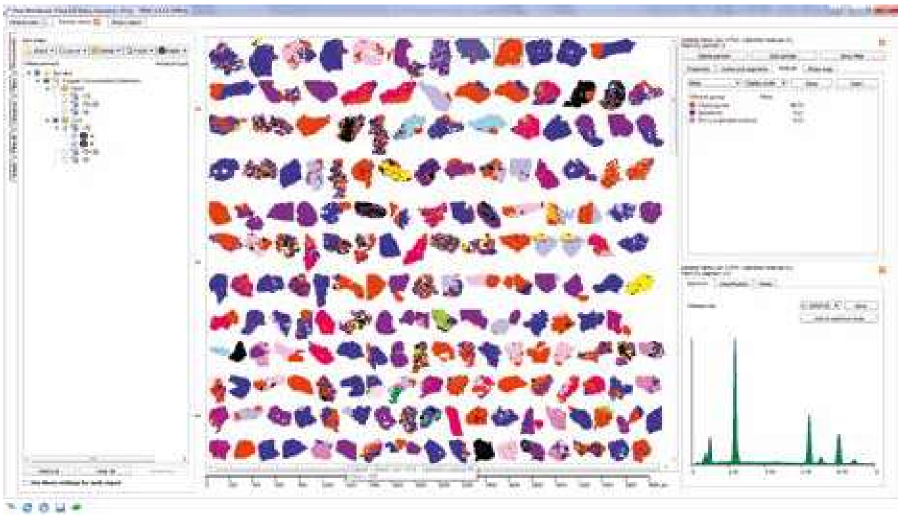
- **Key Hardware Features**
- Based on TESCAN MIRA Schottky field emission or VEGA thermionic emission SEM
- Standard LM or large GM chambers for multiple samples
- Up to four integrated EDX detectors for maximum system throughput performance



- Latest generation of Peltier-cooled SDD detectors
  - New 30 mm^2 SDD CMOS vacuum encapsulated chip
  - Si_3N_4 ceramic window is rugged, non-porous and has high transmissivity
  - Improved sensitivity to low energies for light element detection
- In chamber Faraday cup, BSE and EDX calibration standards for automation, cleanliness and repeatability
- Multiple standard sample holders and custom-built holder options for a range of sample types
- Optional integration of synchronous secondary electron and cathodoluminescence signals
- Compatible with full-function standards-based quantitative EDX analysis
- Optional stand-alone detectors for extended sample analysis: CL, WDX and Raman spectrometry

TIMA Software

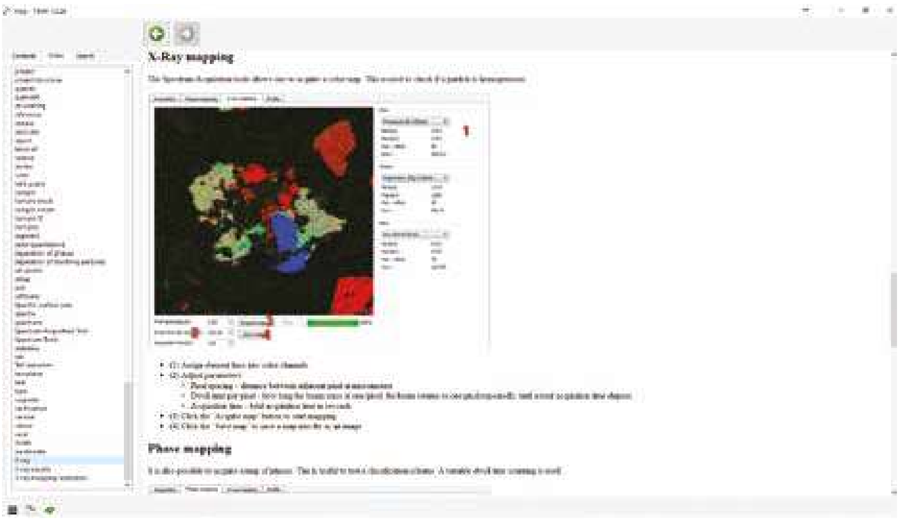
The TIMA software is used for interactive operation, data acquisition, processing, data management and reporting data. The software is available in two versions – online and offline. The online version is needed for interactive use and measurement. The measurement results including all BSE images and spectra are saved so that both versions can process and export all results in common standard file formats.



▲ TIMA-X software at work: TIMA UI Cu Concentrate Analysis – Data structure, particle images, mineral proportions and summed spectrum

Key Software Features

- Comprehensive offline mineral reclassification, investigation, image processing, reporting and interpretation functions
- Built-in application-oriented configurable data management system
- A catalogue of workbooks for saving groups of images, charts and tables
- Automatic backup of reporting meta data
- Accurate SEM field stitching
- Built-in interactive, detailed, context sensitive user help manual



▲ Built-in interactive, detailed user help manual

Online Interactive Tools

The interactive tools are used for the initial mineralogical investigation and for the development of the mineral classification schemes.

- Built-in custom spectral analysis tools to help in identification and composition
- Built-in custom EDX analysis for chemical composition directly from measurements
- Tool kit for easy addition of new phases from measured sum spectra, compositions, formulae and spectral standards
- Mineral composition library look-up from 4700 mineral compositions for suggested mineral names and ZAF corrected synthetic spectra from formulas and compositions
- Rapid reclassification (reanalysis) when "teaching" the system to recognise new materials
- Panorama, field, particle and pixels level views and data of stitched fields can be used to explore the data and export large images

■ **Online Measurement Features and Modes**

Low detection limits for elements by combining multiple low-count spectra using a patented spectrum similarity zonation algorithm

- Built-in EDX quantitative composition analysis from standards and directly from measurement
- Spot mode measurement that integrates high-resolution BSE images with a lower resolution X-ray measurement mode for allowing users to optimise measurement time against accuracy of mineral identification

■ **Key Support Features**

- Continuous improvement
- Free regular software updates
- All components are supplied and maintained by TESCAN, no third party support needed

Unique Features

- **Complete hardware integration of the X-ray acquisition and beam scanning system**
- **AutoLoader™ for 24/7 continuous and unattended automated operations of large sample sets**
- **Summing of low-count spectra for lower detection limits**
- **Direct quantitative EDX analysis of TIMA measured X-ray spectra**
- **Workflow and tools for simpler building of mineral classification schemes**
- **Interactive measurement validations and investigation tools**

TIMA-X Unique Features

■ **Complete Hardware Integration**

TESCAN has integrated the communication of all hardware components of the instrument into the same programming and operational code and hence operating system. The automation of every aspect of the instrument and its operation is seamless. The value of this integration is that, for example, it combines beam scanning and x-ray acquisition to avoid software overheads. The increased speed when combined with up to four modern EDX detectors, makes TIMA-X a very reliable, fast and fully operation system for mineral automation analysis.

■ **Key Advantages**

- Hardware integration of beam scanning and X-ray acquisition
- Designed, manufactured and supported by TESCAN
  - Fast and reliable pulse processors developed by TESCAN
  - Customised multi-channel analyser
  - Combines up to 4 EDX detectors
- High X-ray Output count Count-Rates
- Precise and Accurate Field Stitching

AutoLoader™

The AutoLoader™ automatic sample loading system enables easy, efficient, 24/7 continuous and unattended processing of large sample sets. It is compatible with both thermionic and field emission SEM analysers based on the LM chamber. It consists of three main parts – a sample magazine, sample identification and cleaning module, and, an airlock sample exchange mechanism.

■ **Features**

- Up to 100 carbon coated polished epoxy blocks
- All 100 positions readily accessible
- Sample loading can be according to priority
- 2D bar code attached to the base of each block
- Top and bottom surfaces of the blocks are cleaned of dust with compressed nitrogen
- The cartridge containing the block to be measured is exchanged in an airlock

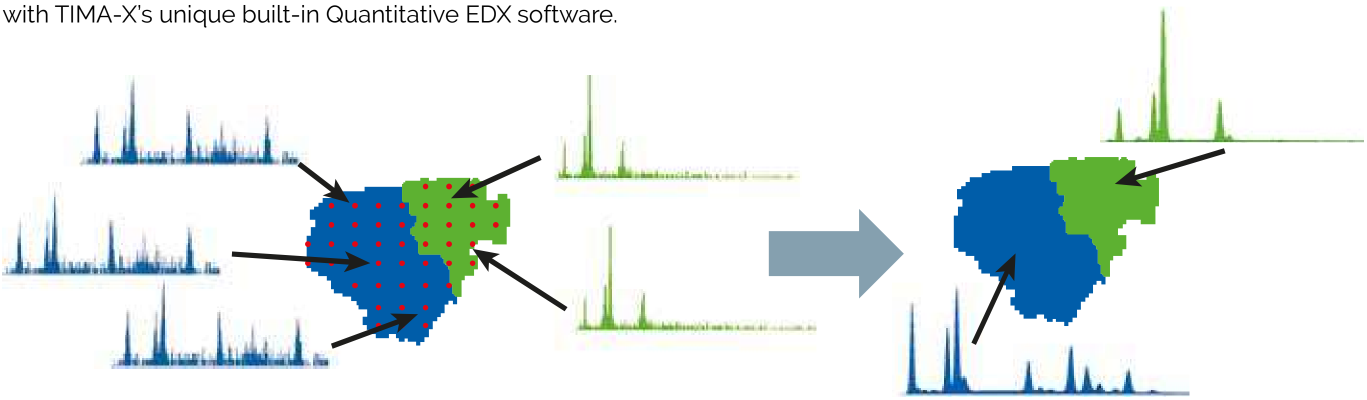
Summing Low-Count Spectra

Automated mineralogy (AM) systems that are based on SEM/EDX must rely on rapidly collected, low-count, high variance spectra during measurement so they can be measured in a realistic time. Typically, each pixel has an X-ray spectrum of 1000 photons collected in about 1 ms. 1000 photons in a spectrum is rather small and limits the accuracy and precision of the mineral identification at each pixel.

To overcome this limitation, a method for summing low-count spectra has been implemented in TIMA-X. This is a novel rapid method for identifying minerals containing minor elements and for discrimination of minerals with similar composition that would not be differentiated using low-count spectra alone. This method consists in a patented spectrum similarity zonation algorithm that combines the data from low-count spectra directly from automatic measurements to create a single high-count and statistically reliable spectrum resulting in lower detection limits. The combined spectra are an excellent average for the mineral, are easy to classify and can be used directly to determine the mineral composition with TIMA-X's unique built-in Quantitative EDX software.

■ **Key Advantages**

- Easy identification of unknown minerals
- Summed spectra are suitable for direct EDX analysis
- Minimises statistical effects that characterise low-count spectra
- Lower detection limits
- Better mineral discrimination



▲ Summing low-counting spectra

Integrated Quantitative EDX Analysis

TIMA-X's built-in Quantitative EDX analysis greatly simplifies the workflow for training the system. The integrated EDX system automatically calculates the mineral composition from the combined spectra; adds it as a mineral property automatically and the time required by the experienced mineralogist is dramatically reduced.

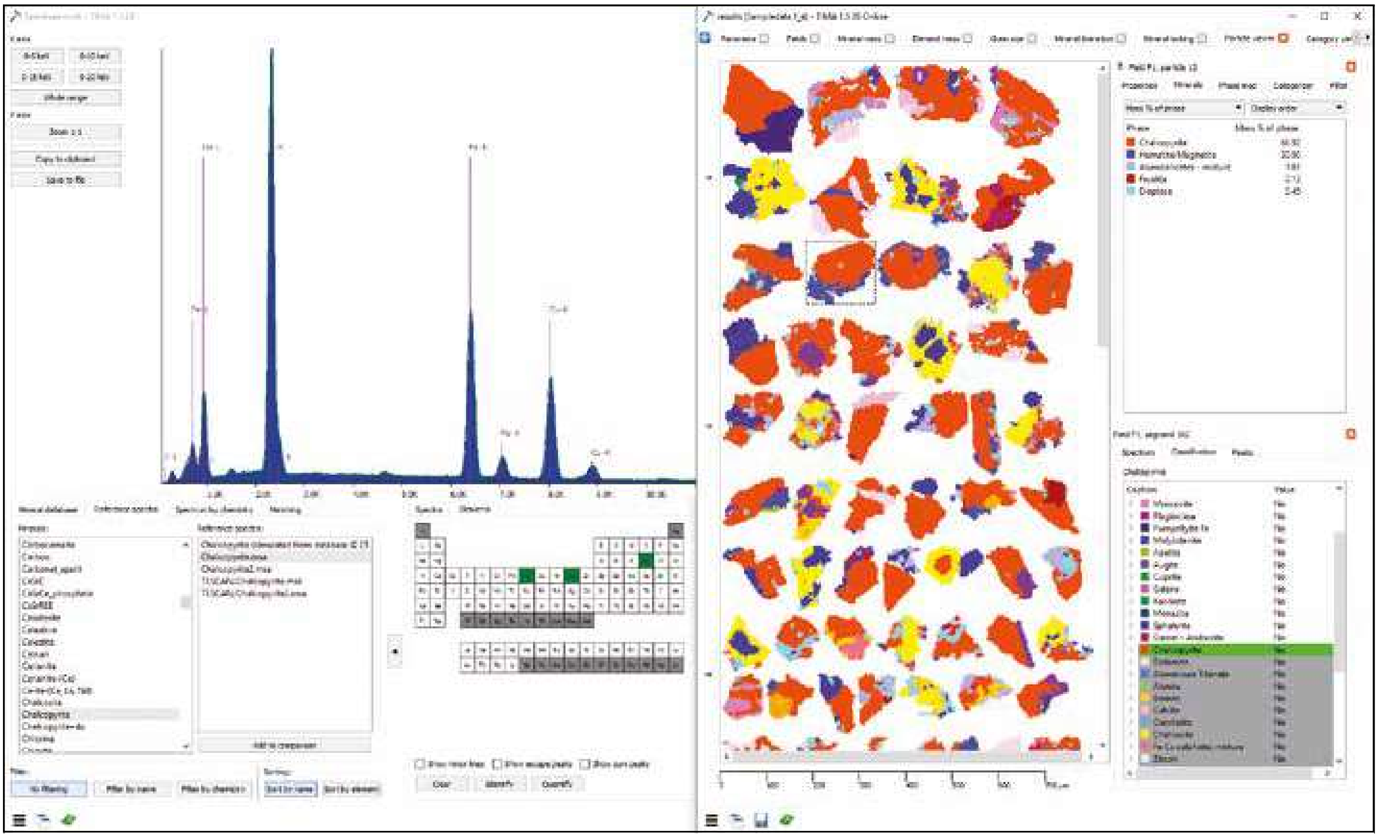
One of the most difficult, skilful and time-consuming requirements in the application of all AM systems is obtaining a reliable value for the composition of each mineral in the sample. The mineral name is not sufficient as there is wide variation in composition for correctly named minerals. This phase of the work is interactive, can be very time-consuming and needs an experienced mineralogist. The best value for the composition of the mineral in the sample is obtained from the sample. Historically, this is done using third party WDX or EDX quantitative systems, textbook composition values, or approximate chemical formulae for training the system to recognise and provide mineral composition.

■ **Highlights:**

- Element auto identification
- Optional element manual identification
- P/B ZAF correction, Phi-Rho-Z identification
- Background subtraction
- Peak deconvolution
- Sum peak subtraction, escape peak subtraction
- Specimen tilt correction
- Multiple-detector operation

Mineral Classification Training

TIMA-X's tools for training the system to recognise minerals and assign a composition derived from the sample are very comprehensive, easy to use and give accurate answers because of the built-in quantitative EDX analysis and its application to the summed spectra. These two novel capabilities greatly simplify and speed up the workflow for training the system on a new mineral set. Another difficulty and time-consuming workflow in the application of AM systems is the on-going need to train the system to recognise minerals in the sample and obtain their composition from EDX spectra. There are two requirements for precise and accurate identification – to classify (name) the mineral spectrum and to obtain a reliable value for its composition. This phase of the work can be very time-consuming and needs an experienced mineralogist. EDX chemical analysis has lateral and depth resolution of about 1 µm, and is sensitive enough to detect light elements including beryllium in concentrations of 1000 ppm.

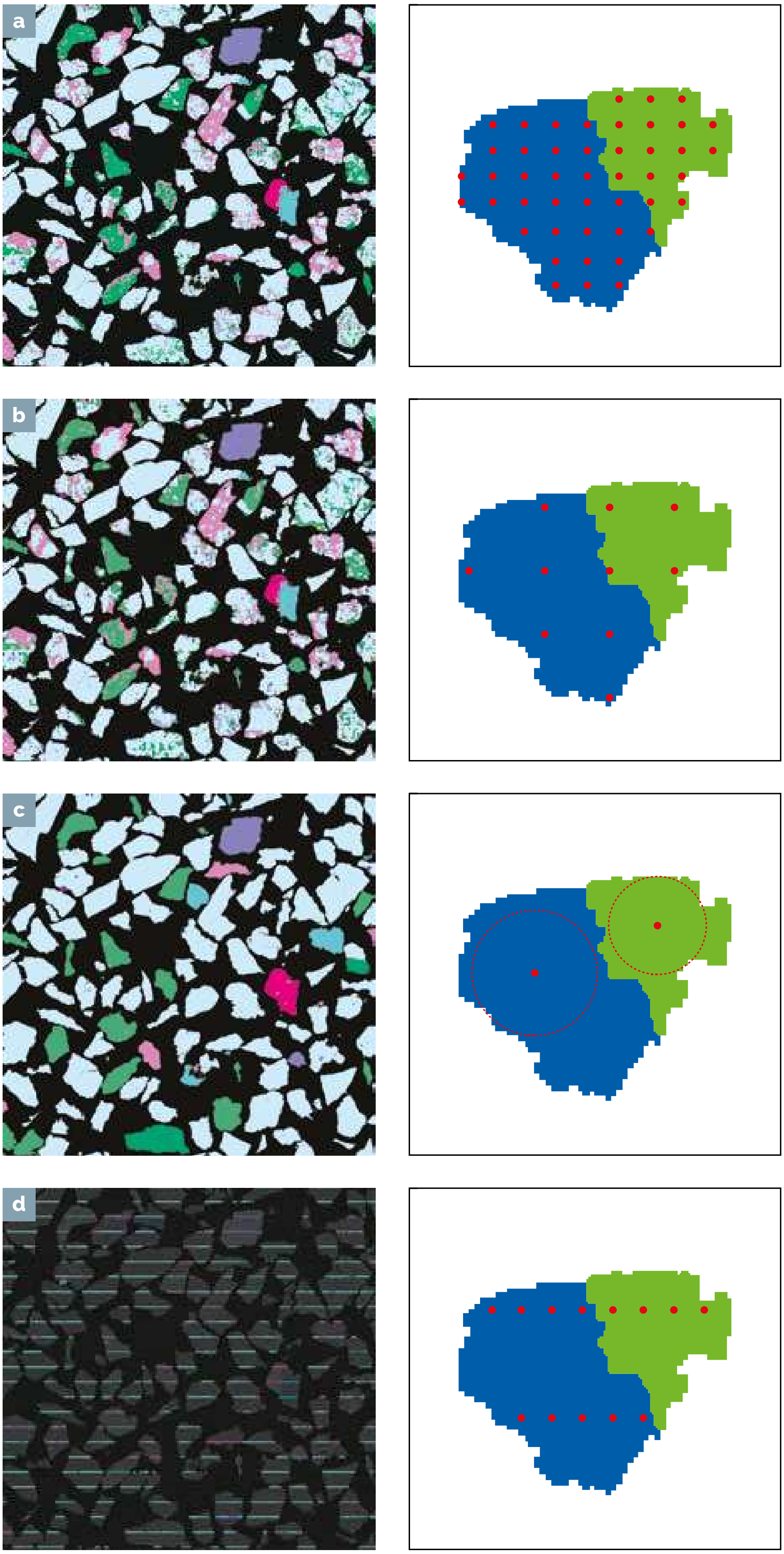


▲ Particle classification workflow: Spectrum matching with mineral database, elemental composition, concentrates.

Interactive Investigation and Measurement Validation Tools

TIMA-X's comprehensive set of interactive tools make TIMA-X an advanced SEM/EDX instrument. Such tools are used to facilitate the detailed investigation of the mineralogy and to support the quality control of its fully automatic operation. The investigative tools include a built-in X-ray spectral display and element identification system together. In addition, a wide range of panorama, field and particle image display modes for combining BSE and X-ray images, displaying X-ray maps, filtering and grouping subsets for detailed investigation. The measurement validation tools are used for quality control to ensure that the results of automatic use are mineralogically correct and statistically reliable. These include particle, mineral and operational statistics and assay reconciliation reports.

- **The following mapping modes are available:**
  - **High resolution mapping.** The BSE image and EDX data are collected simultaneously. Both BSE and EDS data are used to detect boundaries between phases. **The most precise mode but slow .**
  - **Dot mapping.** The BSE imaging is carried out first at high resolution. The BSE image is used to detect boundaries between phases and to locate a central point inside each phase. Each phase is covered by a lower resolution mesh of X-ray points. **A compromise between precision and speed.**
  - **Point spectrometry**. The BSE imaging is carried out first. The BSE image is used to detect boundaries between phases. Then, the software acquires one spectrum per each phase. **Less precise but very fast mode.**
  - **Line mapping.** The BSE imaging is carried out first. Then, the software acquires the EDX data along horizontal lines. **The best statistics but limited texture.**



▲ Mapping modes. **(a)** High-resolution mode. **(b)** Dot mapping. **(c)** Point spectrometry. **(d)** Line mapping.

Mineral Applications

TIMA-X is both a **Production Improvement** tool for use by metallurgical engineers at industrial sites and a **Research Instrument** for use by **geoscientists in research laboratories**.

Metallurgical Application Examples

Plant and metallurgical laboratory samples are used in developing improvements in production.

Base metal ore characterisation

Low prices in raw materials in the last years have been the driver for making major efforts to bring the costs of base metal production down by optimising processing plant efficiency. Automated mineralogy is an analytical solution that delivers quantitative answers to increase efficiency of a wide range of operations. Automated mineralogical analysis is used to evaluate the performance of the ore beneficiation process of all streams with particular emphasis on the tails. Such analysis often reveals either insufficient liberation or inefficiency in the collection of particles in the recoverable size range. Changes in the mineralogy of the ore can have a substantial impact on the recovery process. A good mineralogical characterisation of blocks of reserves by automated mineralogy can prevent losses to great extent.

Another factor that can have a negative effect on plant efficiency is the presence of penalty elements such as antimony, arsenic, and mercury. Automated mineralogy can be used to identify and quantify penalty elements in minerals. Based on that analysis, smelters can reject minerals or the phases locking problematic minerals to the tailings.

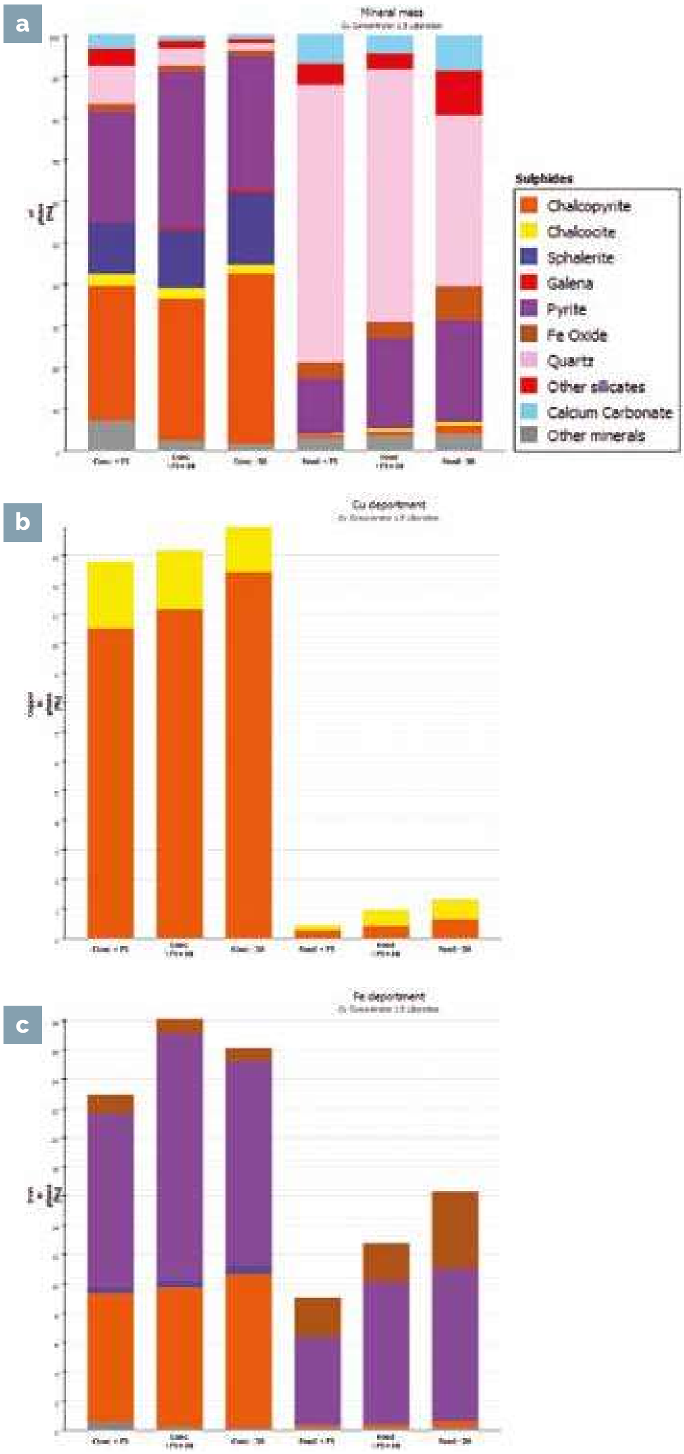
Automated mineralogy is also used to monitor gangue minerals. Gangue commonly accounts for more than 90 % of common base metals ores and has a major influence on the beneficiation process.

TIMA-X Bulk Analysis of a Copper/Zinc Plant

Average bulk properties can be measured for particles and rocks. The general mineralogy and bulk mineral properties are not available through chemical analysis. Commonly used bulk properties are mineral identification, proportions (modal analysis), average texture and elemental distributions between minerals.

Iron Deportment in a Zinc/Copper Concentrate

Chemical assays cannot easily identify the source of a diluting element such as iron in a concentrate when the element is a chemical combination with the valuable mineral and where it is contained in a mineral with no valuable elements.



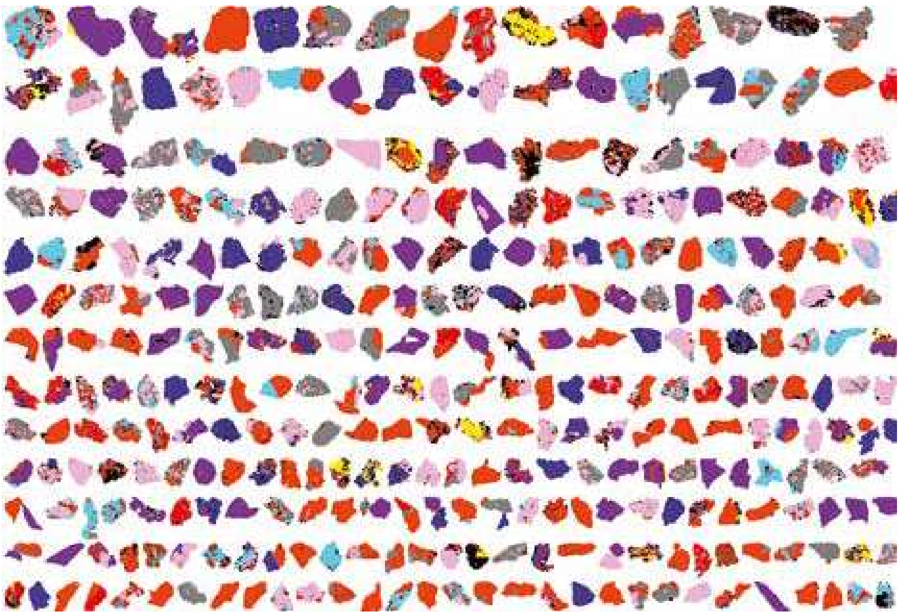
▲ Bulk Properties of Concentrate and Feed, **a)** Bulk mineral distribution, **b)** Copper Deportment - Chalcopyrite & Chalcocite, **c)** Iron Distribution – Chalcopyrite, Sphalerite, Pyrite & Fe Oxide

TIMA-X Particle-by-Particle Analysis

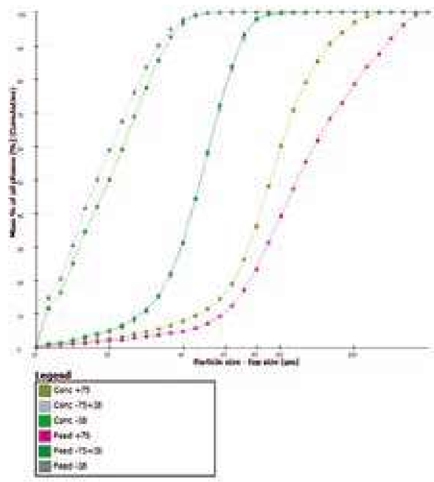
TIMA-X's combination of size-by-size and particle-by-particle measurements and analysis create a powerful system for the systematic diagnosis of plant and unit operations.

Size-by-Size Dilution of a Copper/Zinc Concentrate

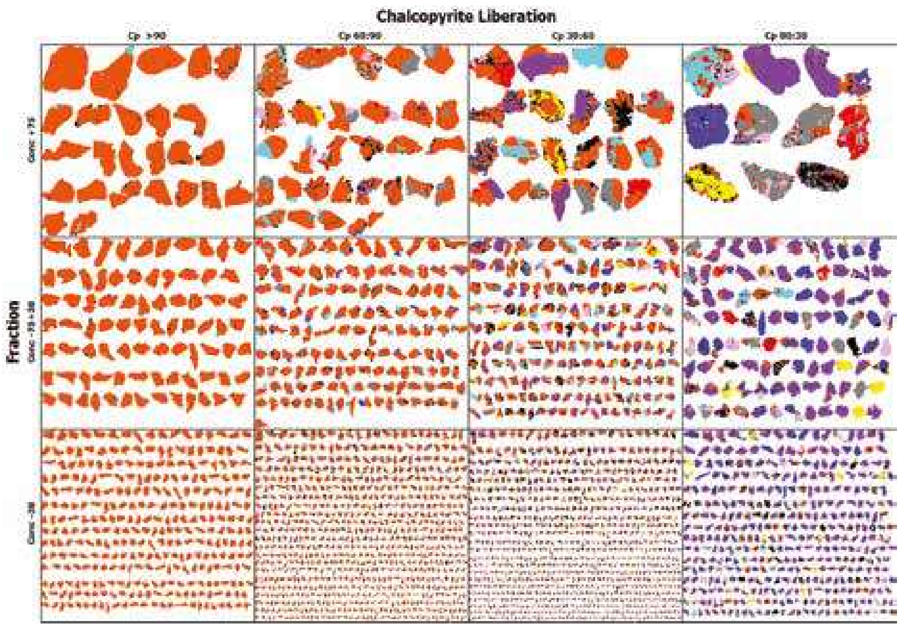
Coarse concentrate fractions are generally diluted by the valuable copper and zinc mineral being locked with other minerals. These need regrinding and that may be uneconomical. Fine concentrate fractions are often diluted by fine liberated gangue particles recovered by entrainment in the water surrounding the bubbles.



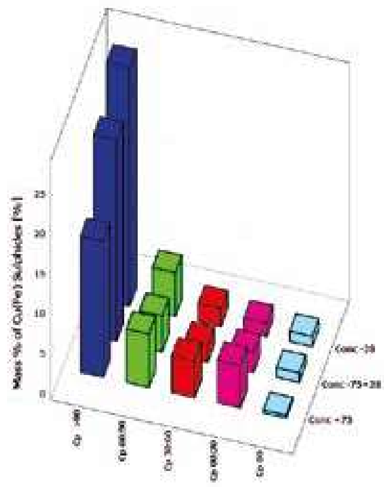
▲ Copper/Zinc Concentrate - Particles



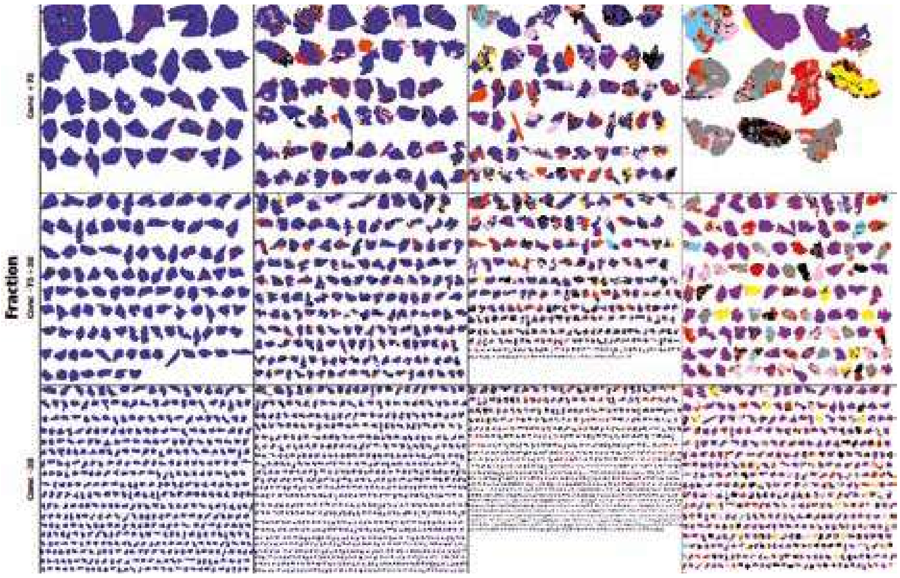
▲ Copper/Zinc Concentrate - Particle Section Area Distribution



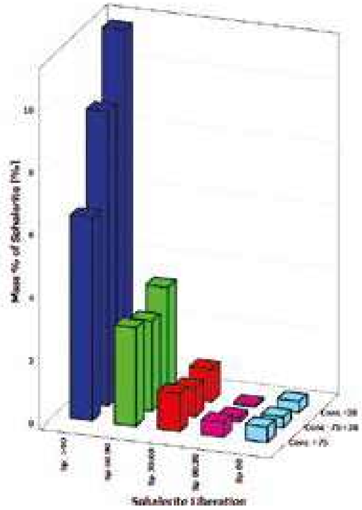
▲ Copper/Zinc Concentrate – Chalcopyrite Liberation by Size



▲ Chalcopyrite Liberation - Mass of Copper in Class



▲ Copper/Zinc Concentrate - Sphalerite Liberation by Size

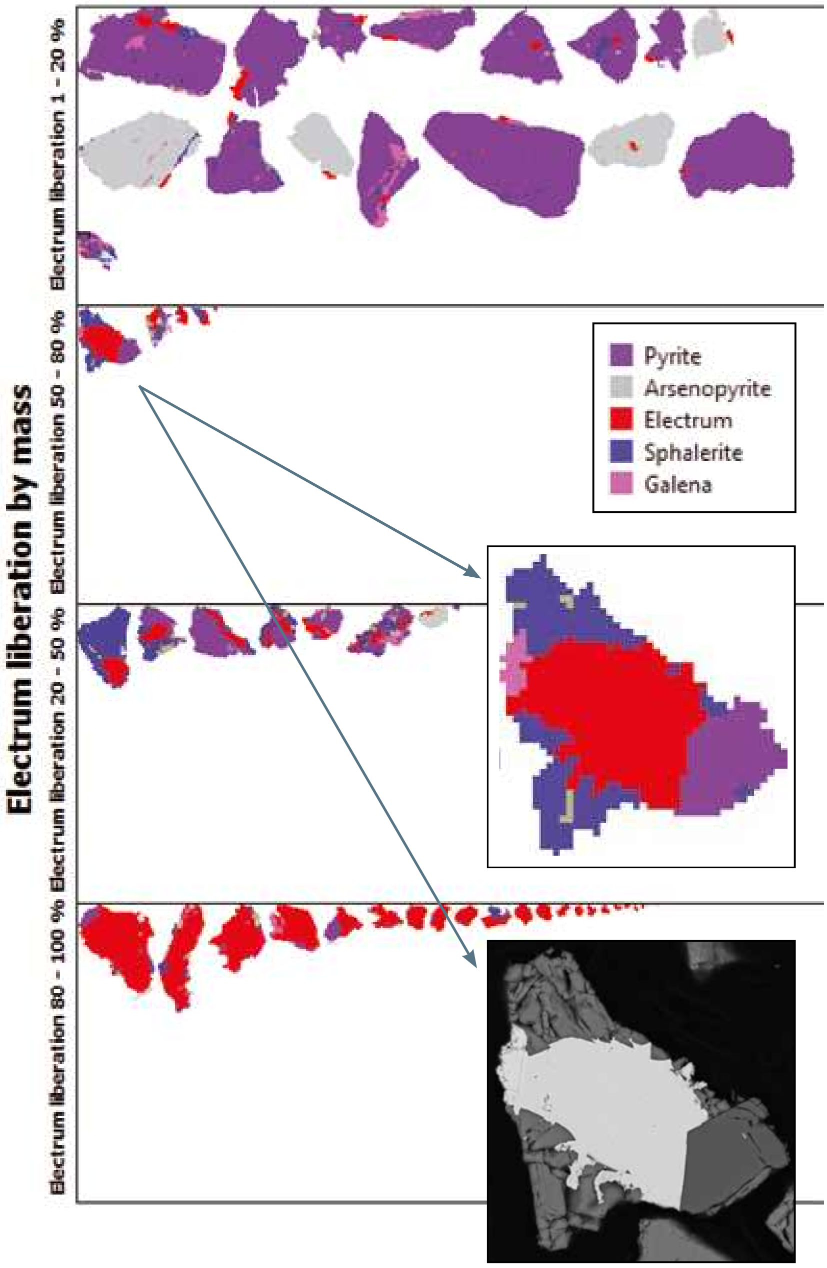


▲ Sphalerite liberation - mass of zinc

■ Tracking and prevention of gold losses with TIMA-X

Recovering gold from ores is one of the most complex tasks in mineral processing. Traditional methods of plant optimisation rely on fire assays of different fractions when processing streams. However, this approach provides only basic information and the mineralogy of the gold-bearing phases – usually by elemental proxy.

TIMA-X is commonly applied to the identification of the causes of gold losses in ore processing. It is important to know the degree of liberation, the host phase and the surface exposure. Gold often forms inclusions in gangue minerals which are difficult to recover by flotation processes. TIMA-X's Bright Phase Search mode can be successfully applied to low grade ores, tailing or leaching residues where gold concentrations in the range of sub-ppm are common.

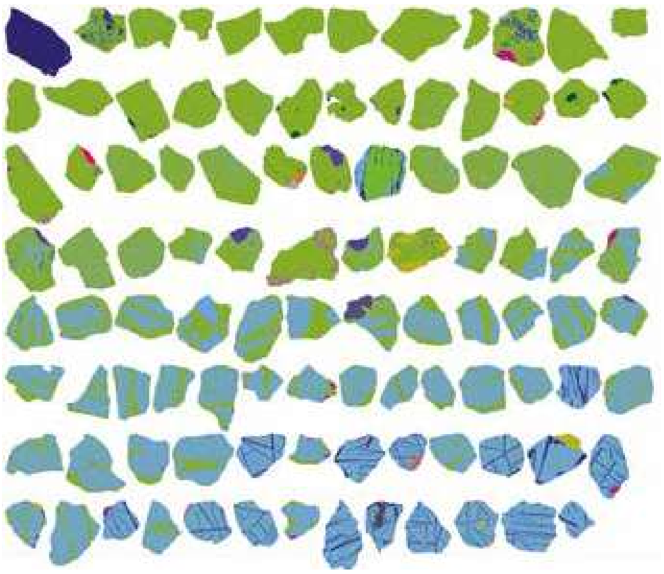


▶ Different degrees of gold mass liberation in the concentrate. The inset images show the phase map and BSE image of the selected particle.

Heavy mineral sand characterisation

A reliable mineralogical evaluation is of key importance for heavy mineral and sand operations. A round sample with a diameter of 30 mm can host up to several thousand particles in the sand fraction; this is an order of magnitude larger than can be practically evaluated by optical microscopy. Automated mineralogy identifies specific phases which remain unresolvable by other techniques. This is the case of minerals forming fine intergrowths and identification of individual end-members of solid solutions. TIMA-X is sensitive enough to distinguish solid solutions members based on the dominant rare earth elements (REE).

Automated mineralogy can be used in the mineral prospecting stage to obtain information on heavy mineral content. For this purpose, TIMA-X has an integrated mineralogical database of chemical compositions and densities of individual minerals. TIMA-X is capable of simulating the particle density even for complex particles. The percentage of recoverable particles above a specified density threshold can thus be provided. The same approach can be applied for processing stream samples. The users can define filters based on minerals groups of categories corresponding to specific properties of minerals. It is then possible to predict the content of minerals recoverable by different processing techniques.



▲ Heavy minerals sorted by titanium content

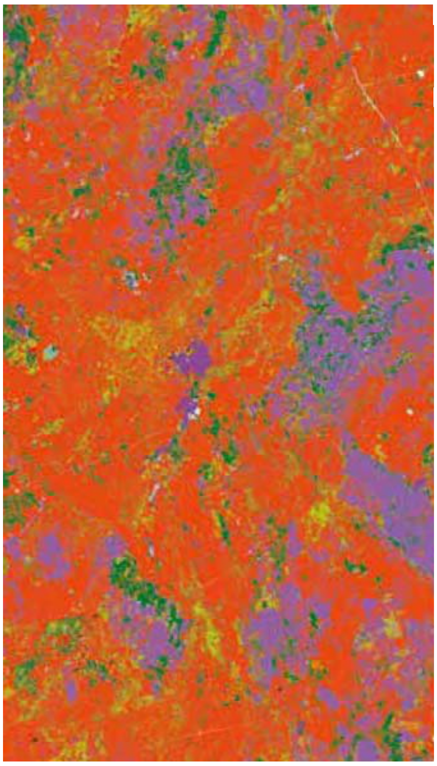
Mineralogical and Petrographical Studies

Thin sections and polished sections are the basic samples used in mineralogical and petrographical research. Their standard dimensions are 27 × 47 mm for thin sections and up to 30 mm diameter for polished sections. Unusual sizes and shapes from drill cores, rock chips, etc. can also be easily accommodated.

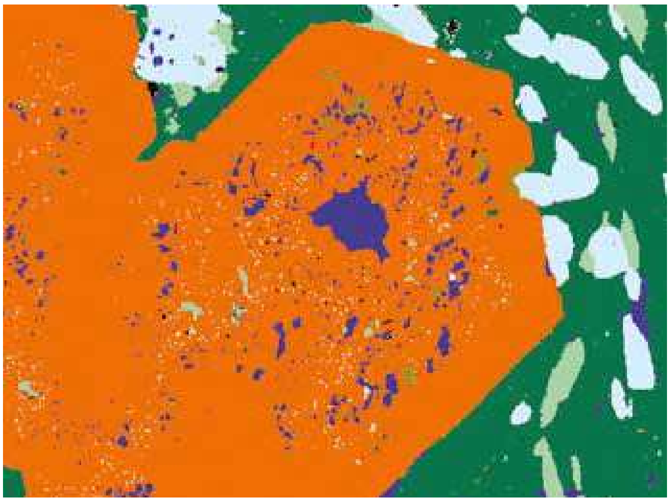
In addition to the basic identification of minerals and their textures, TIMA-X can be used to visualize and quantify alterations, contact zones, fractures, veining, exsolution structures, deformation-recrystallization phenomena, inclusions, intergrowths and many other features.

Rare Earth Elements in Carbonatites

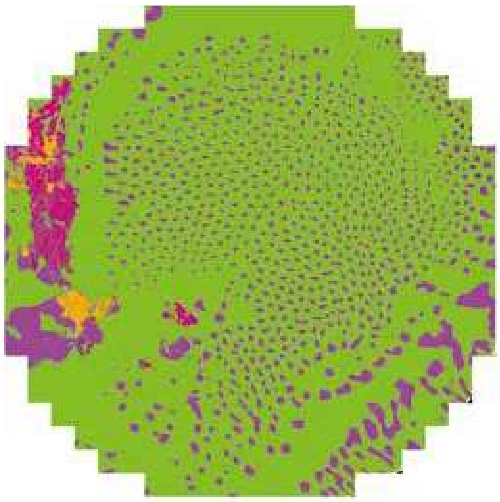
Several examples of scientific research in the study of the origin and genesis of the Rare Earth Element (REE) rich carbonatites. Carbonatite magmatism related deposits together with alkaline magmatism and hydrothermal related origin are the most important sources of REE in the world. Understanding the processes of their formation significantly contributes to finding new deposits of this indispensable raw material.



▲ REE Examples **a, b)** Bayan Obo (China) – Carbonatite rock from the largest rare earth deposit yet found



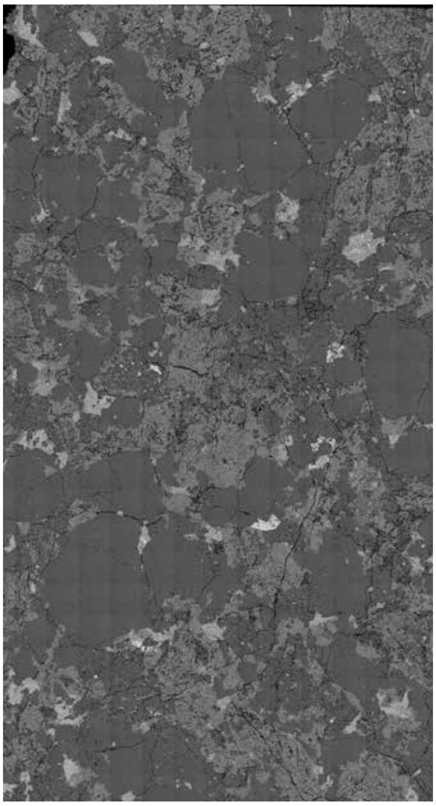
▲ **Fengzhen (China)** – A new type of super-metamorphic rock, recovered as a xenolith from a depth > 300 km

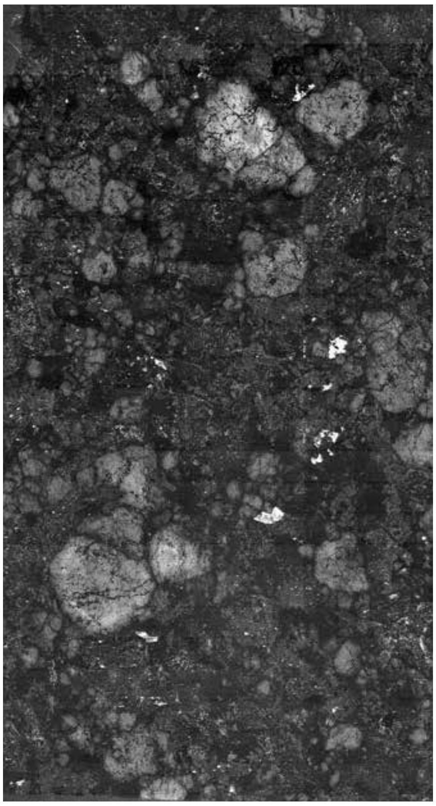


▲ **Lugiin gol (Mongolia) –** Exsolution of fluorite in carbonatite illustrating immiscibility of high and low REE magmas during the formation of the deposit.

Automated mineralogy in petrology

The classification of rocks is based on their modal composition. The number of petrologists with sufficient patience and skill to perform optical microscope based point counting has shrunk significantly over the past decades. Automated mineralogy offers a solution in this field. Unlike the traditional approach, it is capable of providing added value such as the chemistry of individual minerals or representative grain size distributions. A petrographic description is often the starting point for further research. Modern analytical methods such as laser ablation or ion microanalysis are used to characterise the trace element composition of minerals or for geochronological dating. Localising analytical points of these highly sensitive techniques has to be done with regard to the variability of the sample which is well below the capabilities of both optical microscopy and EDX spectrometry. TIMA-X offers an additional layer of automated mineralogical data – Cathodoluminiscence. It can be used to track trace element zonation or alterations necessary for the correct placement of analytical spots.





▲ Cathodoluminescence of different minerals in a granitic rock

Technical specifications

Electron Optics	TIMA-X (Thermal Emission Gun)	TIMA-X (Field Emission Gun (FEG))
Electron gun	Tungsten heated cathode with excellent emission stability and filament lifetime (typically 2500 hours)	High brightness Schottky emitter
Resolution	**High Vacuum Mode** SE: 3.0 nm at 30 keV 8.0 nm at 3 keV **Low Vacuum Mode** BSE, LVSTD: 3.5 nm at 30 keV	**High Vacuum Mode** SE: 1.2 nm at 30 keV 1.5 nm at 15 keV 2.5 nm at 3 keV 4.5 nm at 1 keV BSE: 2.0 nm at 30 keV In-Beam SE (option): 1.0 nm at 30 keV 1.2 nm at 15 keV 2.0 nm at 3 keV 3.5 nm at 1 keV In-Beam BSE (option): 2.0 nm at 15 keV **Low Vacuum Mode** BSE: 2.0 nm at 30 keV LVSTD: 1.5 nm at 30 keV 3.0 nm at 3 keV
Electron beam energy	200 eV to 30 keV	
Probe Current	1 pA to 2 µA	2 pA to 200 nA
Magnification at 30 keV	2 × – 1,000,000 × (LM chamber) 1 × – 1,000,000 × (GM chamber) (for 5'' image width in Continual WideField/Resolution)	
Field of View	12 mm at $WD_{analytical}$ 15 mm 24 mm at WD 30 mm	9.8 mm at $WD_{analytical}$ 15 mm 20 mm at WD 30 mm

Chamber and sample holders:	LM	LM with AutoLoader	GM
Internal size	Ø 230 mm	Ø 230 mm	340 mm (W) × 315 mm (D)
Door	148 mm (W)	148 mm (W)	340 mm (W) × 320 mm (D)
Number of ports	13+	12+	20+
Chamber suspension	Pneumatic or optionally active vibration isolation system	Integrated active vibration isolation system	Integrated active vibration isolation system
Specimen Stage	Compucentric fully motorised	Compucentric fully motorised	Compucentric fully motorised
Movements	X = 79 mm (-25 mm to +54 mm) Y = 29 mm (-14.5 mm to +14.5 mm) Z = 29 mm	X = 79 mm (-39.5 mm to +39.5 mm) Y = 59 mm (-29.5 mm to +29.5 mm) Z = 19 mm	X = 130 mm (-65 mm to +65 mm) Y = 130 mm (-65 mm to +65 mm) Z = 100 mm
Rotation	360 continuous	-	-
Sample holder	Standard: 2-sample holder for 7 resin blocks Ø 30 mm. BSE/EDX calibration standard and Faraday cup fixed on stage. Optional: Additional sample holder for 7 resin blocks Ø 30 mm. Adapters for samples Ø 25 mm. Sample holder for 2 thin sections 27 × 47 mm. Adapter for 20 standard specimen holders Ø 12.5 mm.	Standard: 2-sample cartridges, each for single sample, exchanged by the AutoLoader system. BSE/EDX calibration standard and Faraday cup fixed on stage.	For 15 resin blocks, Ø 30 mm +BSE/EDX calibration standard + Faraday cup.

+Configuration and number of ports can be modified to customer's needs
*Note: The range of the movements can be dependent on WD and configuration. *W- width, D- depth*

Detectors*

Detectors*	LMH/GMH	LMU/GMU	(FEG) LMH/GMH	(FEG) LMU/GMU
SE detector	☑ / ☑	☑ / ☑	☑ / ☑	☑ / ☑
Retractable BSE[1]	☑ / ☑	☑ / ☑	☑ / ☑	☑ / ☑
In-Beam SE Detector	⊘ / ⊘	⊘ / ⊘	☐ / ☐	☐ / ☐
In-Beam BSE Detector	⊘ / ⊘	⊘ / ⊘	☐ / ☐	☐ / ☐
In-Beam LE-BSE Detector	⊘ / ⊘	⊘ / ⊘	☐ / ☐	☐ / ☐
Low Vacuum Secondary Electron TESCAN Detector (LVSTD)[2,3]	⊘ / ⊘	☐ / ☐	⊘ / ⊘	☐ / ☐
Compact CL	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐
Rainbow CL (Compact)	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐
Al-coated BSE[1]	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐
EDX[4]	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐
WDX[4,5,6]	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐

[1] Motorised mechanics as an option (Motorised mechanics standard in GM chambers)
[2] Up to 500 Pa
[3] Additional options for TIMA-X (Tungsten): up to 1000 Pa (N2 conditions) / up to 1000 Pa (water vapour/N2 conditions)
[4] Fully integrated third party products
[5] Integrated active vibration isolation necessary
[6] Modification on sample holder necessary in GM chamber

Optional Accessories*

Optional Accessories*	LMH/GMH	LMU/GMU	(FEG) LMH/GMH	(FEG) LMU/GMU
pA Meter	☑ / ☑	☑ / ☑	☑ / ☑	☑ / ☑
Touch Alarm	☑ / ☑	☑ / ☑	☑ / ☑	☑ / ☑
IR TV Camera	☑ / ☑	☑ / ☑	☑ / ☑	☑ / ☑
Beam Blanker	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐
Control Panel	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐
Optical Stage Navigation	☐ / ☐	☐ / ☐	☐ / ☐	☐ / ☐
Water Vapour Inlet	⊘ / ⊘	☐ / ☐	⊘ / ⊘	☐ / ☐

☑ standard, ☐ option, ⊘ not available,
*Possible combinations of optional detectors and other accessories must be discussed with TESCAN

TIMA-X EDX Detector Specifications

Detectors	Up to 4 Silicon Drift Detectors (SDD)
Chip Type	Cube CMOS
Chip size	30 mm^2
Detection range	Be to Am
Window	Si_3N_4 < 100 nm thick
Cooling system	Peltier
eV/channel	10 eV/ch
Energy resolution (eV)	129 eV Mn Kα, 30 mm^2 – best resolution
X-ray Input	1,000 kcps each detector
Analytical WD	15 mm
Elevation angle	35°
Operating conditions	5° to 50° C, 20 – 80 % RH non-condensing

Vacuum system	TIMA-X	TIMA-X (FEG)
Chamber vacuum	High vacuum: < 9×10^{-3} Pa* Low vacuum: 3 – 500 Pa** Optional: 3 – 2000 Pa**	High vacuum: < 9×10^{-3} Pa* Low vacuum: 7 – 500 Pa**
Gun vacuum	< 3×10^{-5} Pa	< 3×10^{-7} Pa
Pumping time after specimen exchange	< 3 minutes (LM chamber) < 3.5 minutes (GM chamber)	< 3 minutes (LM chamber) < 3.5 minutes (GM chamber)

*Pressure < 5×10^{-4} Pa can be displayed with an optional WRG vacuum gauge (on request)
**With a low vacuum aperture inserted

SEM Software Extensions

Standard	Optional
Analysis & Measurement	**Particles Basic**
Histogram	**Particles Advanced**
Image Processing	**Sample Observer**
3D Scanning	**Image Snapper**
Hardness	**3D Metrology (MeX)**
Multi Image Calibrator	**System Examiner**
Object Area	**Cell Counter**
Switch-Off Timer	**Coral (Correlative microscopy module for Life Sciences)**
Tolerance	
X-Positioner	
Live Video	
EasySEM™	

TIMA Software

- Online version – Acquisition Software
- Offline version – Processing Software

Standard

Modal Analysis module
Liberation Analysis module

Optional

Bright Phase Search module

TESCAN
PERFORMANCE IN NANOSPACE

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