Malvern Panalytical

Mining & Metals Analytical Toolbox

Measure. Learn. Predict. Optimize.




Waste management
Ore processing
Comminution
Exploration

Mining & metals analysis

The mining and metals industries are undergoing a fundamental shift, driven by declining ore grades, increasingly complex deposits, growing demand for critical minerals and the need for more sustainable, energy-efficient production. Fast, reliable analytical insight is essential to improve productivity, recovery, quality and resource efficiency.

Malvern Panalytical provides analytical solutions across the entire value chain — from exploration, resource evaluation and grade control through beneficiation, refining and metals production to recycling and waste management.

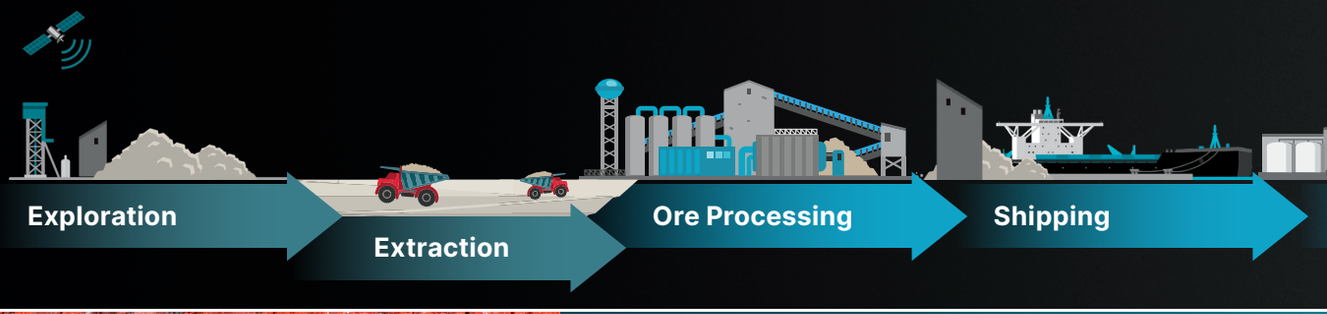
Our portfolio combines elemental, mineralogical and physical characterization with field, laboratory, at-line and real-time process analysis, helping customers understand materials and optimize processes.

From portable field analysis and automated laboratories to on-line sensors and process control, our technologies support faster decisions, improved recovery and more efficient use of energy, water and reagents. XRF, XRD, NIR, LIBS, particle-size and physical-property analysis can be combined to monitor materials, optimize processing and ensure consistent product quality.

For metals producers, our solutions extend from raw-material control and process monitoring to casting, rolling, coatings, metal powders and recycling, helping improve quality, efficiency and sustainability.

With decades of mining and metals expertise, Malvern Panalytical combines analytical technology, process knowledge, automation and digital solutions to help you extract more value from every tonne — safely, efficiently and sustainably.







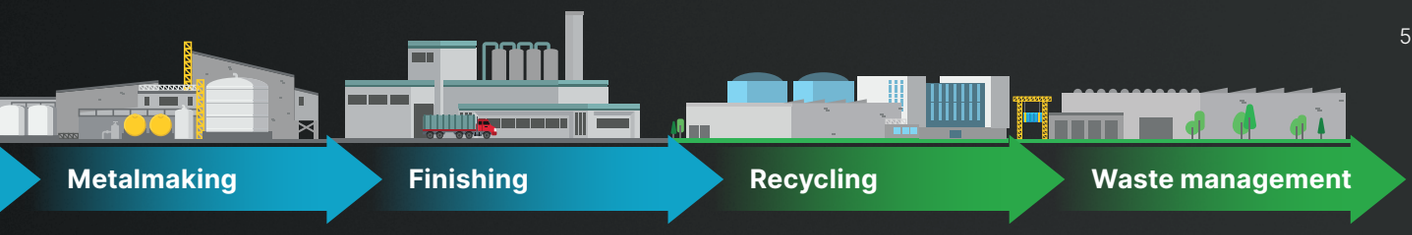
Elemental composition





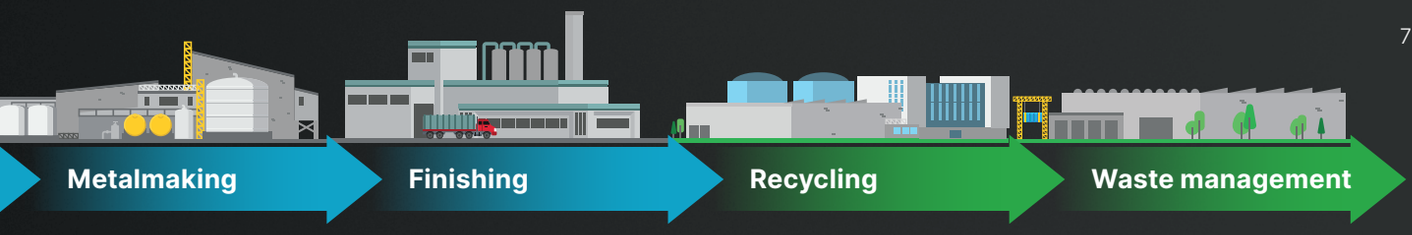


Z-Series	X-Series	Powerhouse
Laser Induced Breakdown Spectroscopy (LIBS)	X-ray fluorescence (XRF)	X-ray fluorescence (XRF)
Exploration, shipping, metalmaking, recycling	**Exploration, shipping, metalmaking, recycling**	**Exploration, precious material analysis**
• In-field exploration of critical minerals, especially lithium and other light-element-bearing deposits • On-site ore identification, grade control and geochemical mapping for mining operations • Rapid alloy identification and material verification in the metals industry and metal recycling • Fast analysis of lithium brines with the Z-9 Liquidator for exploration, resource evaluation and process monitoring	• In-field geochemical exploration and ore characterization, including base metals, precious metals, critical minerals and pathfinder elements • Rapid grade control and elemental mapping of ores, rocks, soils and concentrates directly at the mine site • Metal identification and sorting for recycling, including rapid screening and verification of scrap and secondary raw materials	• REE exploration and characterization — rapid field analysis of both light and heavy rare earth elements • Precious-metal analysis of Au, Ag, Pt and Pd for exploration, grade control and material assessment • On-site analysis of ores, concentrates and geological samples, bringing laboratory-level capabilities closer to the mine site
• Rapid analysis of light elements (e.g. Li, Be, B, C, F, Na) not accessible by conventional handheld XRF • Superior LIBS performance with integrated argon purge, laser rastering and patented multi-spectrometer technology for improved sensitivity and precision • Complete field solution with rugged handheld analyzers and the Z-9 Liquidator for fast on-site analysis of lithium brines	• High-performance handheld XRF with SDD detector, optimized X-ray tube/detector geometry and application-specific element packages for mining and geochemistry • 3-beam X-550 Geochem option combines different excitation conditions for a broad element range, including major elements and selected light REEs, with advanced Compton normalization and Fundamental Parameters algorithms • Lightweight, rugged and fast — X-550 is around 3 lb, with integrated camera/QR-barcode capabilities and real-time connectivity for field documentation and data management	• Two dedicated models: PowerHouse X for REEs and PowerHouse PM for precious metals, each optimized for its specific application • PowerHouse X: unique 80 kV X-ray tube enables practical field analysis of heavy REEs such as Tb, Dy, Ho, Er and Yb, while also covering light REEs and key pathfinders. • PowerHouse PM: portable, battery-powered benchtop XRF designed specifically for fast, precise and safe precious-metal analysis in the field.



	Epsilon 1	Epsilon 4	Revontium	Zetium Minerals edition	Axios FAST	Product
						
	X-ray fluorescence (XRF)	X-ray fluorescence (XRF)	X-ray fluorescence (XRF)	X-ray fluorescence (XRF)	X-ray fluorescence (XRF)	**Technology used**
	Exploration, waste management	**Ore processing, shipping, recycling, waste management**	**Ore processing, shipping, recycling, waste management**	**Exploration, ore processing, metalmaking, finishing**	**Ore processing, metalmaking, finishing**	**Where in the process?**
	• In-field / near-mine elemental screening and quantification of rocks, ores, drill cores, stream sediments and blast-hole samples • Rapid ore and material identification for exploration and mine-site decision-making • Quick elemental QC with little or no sample preparation, bringing laboratory-style XRF analysis closer to the point of need	• Fast elemental analysis of ores, minerals and rocks for exploration, grade control and process monitoring • Analysis of ores, concentrates, metals, scrap and metal powders for production and recycling applications • At-line analysis close to the mine, processing plant or recycling operation for rapid process feedback • Major and minor element analysis of powders, fused beads, slurries and other sample types for quality control and material sorting	• Rapid elemental analysis of ores, concentrates, minerals, metals, metal powders, scrap, wear metals and other geological materials for grade and quality control • At-line analysis close to the process to monitor changing material composition and support faster process decisions • Light- and heavy-element analysis for applications including iron ore, base metals, critical minerals and recycled materials • Coating and thin-film analysis, including elemental composition and film-thickness measurement	• Major, minor and trace element analysis of exploration samples, ores, concentrates, slags, tailings and recycled materials • Grade and quality control across mining, mineral processing, metals production and recycling workflows • Analysis of iron ore, base and precious metals, REEs, bauxite and phosphates, as well as metals, alloys, slags and secondary raw materials for recycling and material recovery	• Rapid elemental analysis of ores and concentrates, including iron ore, nickel ore and other geological materials • High-throughput quality control and grade determination in metals making, casting, alloy production and downstream processing • Fast analysis of metal powders, alloys and recycled materials for material identification, quality control and process monitoring	**What is it used for?**
	• Small, fully integrated and X-ray safe benchtop system with very low installation requirements — ideal for mine-site offices, quarries and remote locations • Standardless Omnian analysis enables quantification across a wide range of sample compositions without requiring dedicated calibration standards • Low operating cost and minimal operator dependence, with no additional chemicals or operating gases required—making sophisticated elemental analysis accessible outside a central laboratory	• Near floor-standing XRF performance in a compact benchtop system, with elemental analysis from F to Am and concentrations from sub-ppm to 100% • Designed for remote and at-line mining applications with low infrastructure requirements and no need for vacuum in many applications • Mining-specific WROXI calibration enables accurate major and minor oxide analysis of a wide range of rocks, ores and minerals using fused beads	• Near floor-standing XRF performance in a compact benchtop system — up to 20 samples/hour with 4× faster detection and a footprint of only 0.4 m^2 • Two dedicated configurations: Heavy Elements for Na–Am and the new Light Elements Boost, providing up to 6× higher light-element sensitivity and 3× faster light-element throughput versus conventional benchtop XRF • Low infrastructure requirements and high stability — only 400 W power consumption, no external cooling, and 5× lower drift, making it particularly attractive for remote or at-line mining laboratories	• Exceptional elemental range and sensitivity — from Be to Am and from sub-ppm to 100 wt%, with dedicated solutions such as WROXI, Pro-Trace and REE applications • Unique WDXRF + EDXRF combination (SumXcore) enables high sensitivity together with faster measurements and rapid small-spot mapping / unexpected-element detection • Built for 24/7 mining laboratories with excellent long-term stability, high throughput, automation readiness and robust operation in demanding environments	• Up to 28 elements measured simultaneously in seconds, from ppm to 100% concentrations — ideal when sample throughput and speed are critical • Designed for continuous high-throughput operation, with up to 168 sample positions, continuous loading and automated sample identification • High uptime and robustness for demanding laboratories, with ZETA technology, HiPer channels, dust protection and automation capabilities	**What's special about this product?**

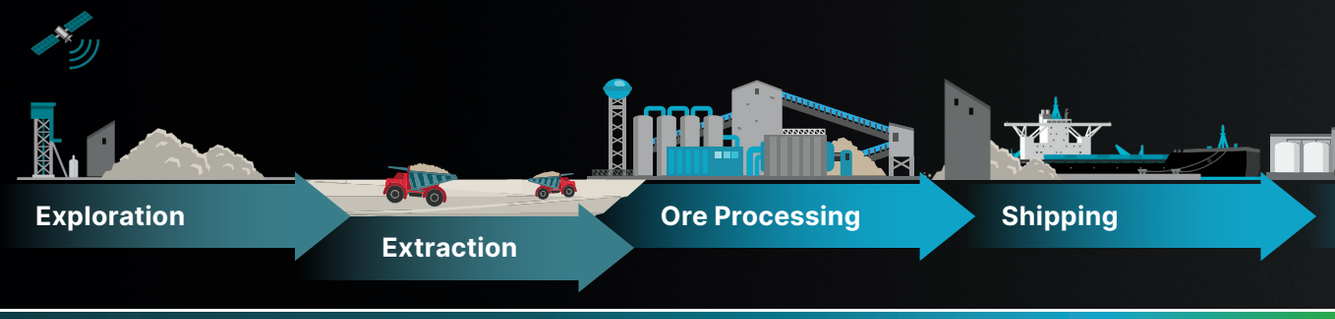

Exploration
Extraction
Ore Processing
Shipping





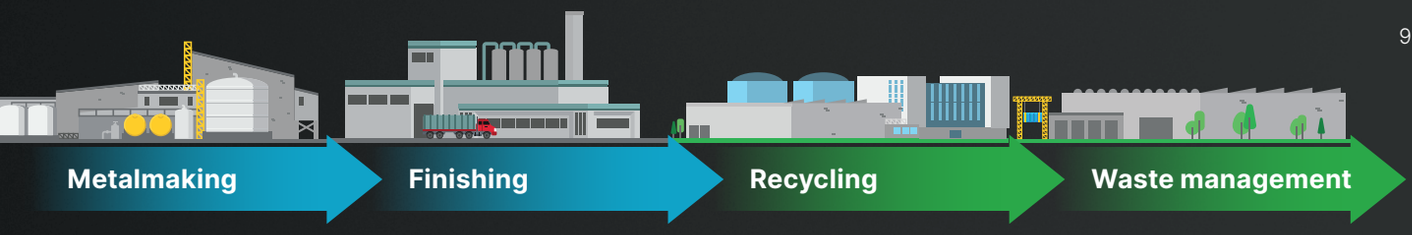
Mineralogical composition & crystalline structure

					
	ReveNIR	**TerraSpec4**	**Aeris**	**Empyrean**	**Product**
	Near infrared (NIR)	Near infrared (NIR)	X-ray diffraction (XRD)	X-ray diffraction (XRD), computed tomography (CT)	**Technology used**
	Exploration	**Exploration, ore processing, waste management**	**Exploration, ore processing, metalmaking, finishing**	**Exploration, metalmaking, finishing**	**Where in the process?**
	• In-field mineral identification and alteration mapping during exploration and drilling • Identify clay, carbonate, iron-oxide and other alteration minerals to help vector towards ore bodies • Real-time characterization of drill cores, rocks and outcrops to support exploration and geological decision-making	• In-field mineral exploration and alteration mapping to identify mineral assemblages and vector towards ore bodies • Rapid analysis of drill cores, cuttings and rock samples for mineral identification and geochemical gradients • Identify clay and alteration minerals to support ore-body targeting and improve geological understanding	• Phase and mineral identification and quantification of ores, coal, raw materials, concentrates, iron ore pellets, sinter, DRI, matte, slag and metal powders • Process optimization and geometallurgy by monitoring mineralogy and predicting process-relevant parameters for faster decisions in mining, beneficiation and metals production • Quality and process control in metals plants, including retained austenite analysis in steel (ASTM E975), phase analysis of slags and raw materials, and characterization of materials in steel and aluminium production	• Advanced mineralogical and structural characterization of ores, concentrates, metals and alloys • Microdiffraction and phase mapping for heterogeneous ores, recycled materials and complex samples • Metals & recycling applications: retained austenite, residual stress/strain, crystallographic texture and phase analysis • 3D CT imaging for non-destructive analysis of internal structures, porosity and inclusions • XAS and in-situ studies to investigate oxidation states, local chemical environments and phase changes	**What is it used for?**
	• Key spectral range from 350 to 2510 nm • Mineral spectral library of 250 exploration minerals included • Capability for user spectral additions/ subtractions and converting publicly available USGS SpecLib 7a downloads • Real-time spectral scalars calculations of Al-OH, ISM (Illite Spectral Maturity), Mg-OH, and Fe3t, indicating crystallinity, composition and/or geothermal conditions, as additional vectors to potential mineralization	• Full 350–2500 nm coverage with high spectral resolution (3 nm VNIR / 6 nm SWIR) for detailed mineral identification • Industry-leading SWIR 1 & 2 performance enables identification of low-concentration and low-reflectance minerals, including challenging Fe-bearing minerals such as chlorite and serpentine • Rugged, portable and field-ready, with no sample preparation required and a field-replaceable fiber-optic cable—ideal for remote exploration and core logging	• High-performance XRD benchtop system, delivering high-quality phase identification and quantitative Rietveld analysis in typically less than 10 minutes per sample • Designed specifically for mining and process environments — rugged dust-protected design, no cooling water or compressed air, and industry-standard connectivity • Fully automatable and production-ready, with options for automated sample handling and integration into process control, enabling high-throughput mineralogical monitoring	• One platform combining XRD, microdiffraction, scattering, imaging/CT and XAS — providing complementary information from long-range crystal structure to local atomic and electronic environments • Advanced spatially resolved analysis enables microdiffraction, phase mapping and CT imaging to investigate heterogeneous materials, individual phases and internal structures • Highly modular and configurable, allowing different X-ray techniques and applications to be combined on one platform as analytical requirements evolve	**What's special about this product?**



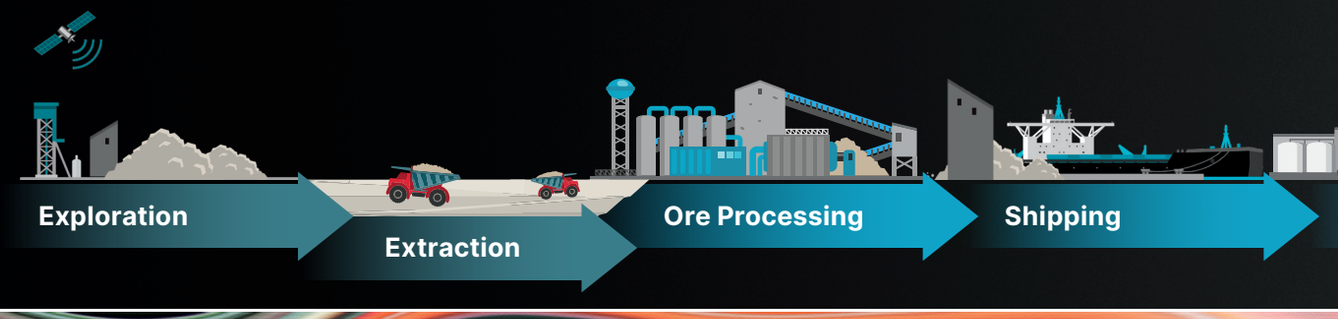
Particle size and shape

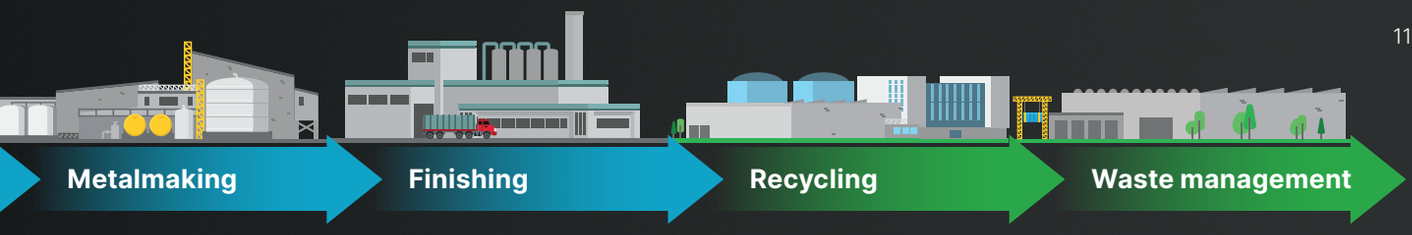
						
Product	**Mastersizer 3000+**	**Sedigraph**	**Insitec**	**Morphologi 4-ID**	**Zetasizer**	
Technology used	Laser diffraction	X-ray sedimentation	Laser diffraction	Image analysis, Raman spectroscopy	Dynamic light scattering	
Where in the process?	**Ore processing, metal making, waste management**	**Ore processing**	**Ore processing, metal making**	**Ore processing**	**Ore processing**	
What is it used for?	• Particle size distribution (PSD) of ores, minerals, concentrates, slurries and ground materials • Optimize grinding and classification by monitoring mill, cyclone and process performance • Characterize feed, product and tailings to improve beneficiation and final product quality • Metal powders & pelletizing: optimize particle size for powder processing, pellet formation and product quality	• Fine particle size analysis of mineral powders, clays and slurries down to the sub-micron range • Characterize settling behavior of fine particles for sedimentation, classification and beneficiation studies • Evaluate clay and fines content to understand their impact on mineral processing and product quality	• Real-time, continuous particle size monitoring of ore slurries and dry materials during mineral processing, as well as metal powders and pelletizing processes • Optimize grinding, classification and flotation, while controlling particle size in metal powder production and pelletizing for consistent product quality • Monitor and control processes in real time to improve recovery, throughput and energy efficiency in mining, and optimize powder and pellet properties in the metals industry	• Characterize particle size and shape of ores, minerals and abrasive materials to understand processing and material performance • Identify individual mineral particles within complex mixtures using Raman spectroscopy • Analyze mineral liberation, particle populations and contaminants to support ore characterization and process optimization	• Characterize mineral surface charge to understand and optimize flotation and mineral separation • Study particle interactions, aggregation and dispersion in mineral slurries and suspensions • Evaluate the influence of pH, reagents and collectors on mineral surface behavior and separation efficiency	
What's special about this product?	• Wide measurement range 10 nm up to 3.5 mm on the Mastersizer 3000+ Ultra, covering everything from fine particles to coarse mineral material in a single system • Fast, high-resolution analysis in seconds, with automated wet and dry dispersion options for different mineral applications • Smart, AI-powered data quality and method development, including Size Sure, Data Quality Guidance and SOP Architect, helping users identify measurement issues and develop robust methods	• X-ray sedimentation technology directly measures particle mass as particles settle through a liquid, based on Stokes' Law • 0.1–300 µm measurement range with a large 50 mL dispersion volume, providing representative analysis of heterogeneous mineral samples • Excellent for fine-particle and clay characterization, with established ASTM B761 methodology and automated analysis of up to 18 samples	• True on-line analysis — delivers complete particle size distributions continuously, enabling rapid process adjustments rather than periodic laboratory measurements • Built for demanding mining environments, with wet and dry configurations covering 0.1–2,500 µm and applications from small streams to hundreds of tonnes per hour • Direct process integration with automated sampling, real-time data transfer and plant control systems, enabling closed-loop optimization of grinding, classification and flotation	• MDRS® combines automated particle imaging with Raman spectroscopy, linking the chemical identity of individual particles to their size and shape in one measurement • Component-specific particle characterization enables hundreds or thousands of particles to be automatically classified, rather than relying on bulk-average measurements • Wide particle size range of 0.5–1300 µm with automated imaging, morphology analysis and Raman identification in a single platform	• Direct measurement of zeta potential provides insight into the surface charge driving mineral–mineral and mineral–reagent interactions • M3-PALS and Constant Current technology improve zeta-potential accuracy, particularly for samples with high ionic strength or conductivity • Combines zeta potential with dynamic light scattering (DLS) for particle-size and dispersion characterization, with advanced options such as MADLS® for high-resolution sizing	



Density, surface area, porosity, powder flow

	Accupyc	Geopyc	Tristar	Autopore V	FT4	Product
						
	Gas pycnometry	Solid displacement pycnometry	Gas adsorption / BET	Mercury intrusion porosimetry	Dynamic Powder Rheometry	**Technology used**
	Exploration, ore processing, shipping	**Exploration, ore processing, shipping**	**Ore processing**	**Exploration, ore processing**	**Shipping, waste management**	**Where in the process?**
	• True and skeletal density measurement of ores, minerals, concentrates and powders • Support mineral characterization, grade calculations and process mass-balance calculations • Determine density of geological materials for ore beneficiation, quality control and material identification • Metal powders: assess raw-material purity and detect occluded porosity from sintering, supporting quality control and final material performance	• Envelope/bulk density measurement of rocks, ores, pellets, cores and other irregular or porous materials • Characterize porosity and pore volume of geological and mineral materials • Support material characterization, process calculations and quality control for mineral products	• BET surface area and pore-size analysis of minerals, ores, concentrates, metal powders and porous materials • Characterize surface properties and porosity for flotation, adsorption, hydrometallurgy and catalyst performance • Evaluate activated carbon, metal powders (AM/PM), catalysts and recycled materials to optimize process performance and product quality	• Pore-size distribution and porosity analysis of rocks, ores, cores, pellets and other porous geological materials • Characterize pore structure, pore volume and density to understand fluid flow and transport through mineral materials • Support reservoir characterization, permeability studies and evaluation of geological materials for mining and mineral processing	• Characterize flow and handling properties of ores, concentrates, mineral powders, metal powders and recycled materials • Evaluate flowability, cohesion, compressibility, permeability and shear behavior to optimize conveying, feeding, storage and processing • Support metals and recycling processes by characterizing powders from crushing, grinding, separation, recycling and metal-production operations	**What is it used for?**
	• High-precision gas displacement pycnometry using helium or other gases to determine true/skeletal volume and density • ±0.02% measurement accuracy, with advanced temperature control and gas modelling for excellent repeatability • Fast, automated and flexible, with multiple sample-cell sizes and gas options for different sample types and applications	• Measures the external/envelope volume including pores, complementing AccuPyc's skeletal/true density measurement • Uses DryFlo™, a dry, non-hazardous medium that conforms to irregular surfaces without penetrating the pores—ideal for irregular geological samples • Non-destructive, fast and automated, with optional T.A.P. analysis for compressed bulk density of powders	• Three-station, fully automated analysis enables high sample throughput while maintaining research-grade accuracy • Measures surface area, pore volume and pore-size distribution using a wide range of adsorption methods, including BET, BJH and DFT • High sensitivity and flexibility, including Krypton analysis for very low surface areas and multiple gas options for different materials	• Very wide pore-size range, from approximately 0.003 to 1100 µm, covering both micro- and macropores in a single technique • High-pressure mercury intrusion with models up to 60,000 psia, enabling detailed characterization of fine pore structures • High-resolution, flexible measurement modes including scanning and time- or rate-equilibrated analysis, providing either rapid screening or highly detailed pore-structure data	• Dynamic powder characterization measures the resistance of powder in motion, providing a more realistic understanding of flow behavior than simple static flow tests • Simulates real processing conditions, including consolidation, aeration, fluidization and shear, to understand how powders behave throughout the process • Multi-faceted testing in one instrument combines dynamic flow, bulk, shear and process measurements, with high sensitivity and excellent repeatability	**What's special about this product?**


Exploration
Extraction
Ore Processing
Shipping



Sample preparation for XRF and ICP

	LeNeo	Eagon2	FORJ	Fluxes	Calibration Packages	Product
						
	Automated borate fusion and sample oxidation	Automated borate fusion and sample oxidation	Automated borate fusion and sample oxidation	Fusion Consumables	Reference materials and standards	**Technology used**
	Exploration, ore processing	**Exploration, ore processing**	**Exploration, ore processing**	**Exploration, ore processing**	**Exploration, ore processing**	**Where in the process?**
	• Prepare homogeneous glass beads from ores, minerals, silicates and geological samples for accurate XRF analysis • Reduce mineralogical and particle-size effects to improve accuracy and repeatability of elemental analysis • Prepare borate and peroxide solutions for ICP and AA analysis, extending its use beyond XRF	• Prepare fused glass beads from ores, minerals and concentrates for accurate XRF analysis • Eliminate mineralogical and particle-size effects to improve elemental analysis accuracy and repeatability • Support routine quality control and high-throughput analysis in mining laboratories	• Prepare homogeneous fused beads from ores, minerals, concentrates and other geological samples for accurate elemental analysis • Improve XRF accuracy and repeatability by eliminating mineralogical and particle-size effects • Support high-throughput routine analysis in mining laboratories, from exploration through production and quality control	• Prepare homogeneous glass beads from ores, minerals, concentrates and geological samples for accurate XRF analysis • Eliminate mineralogical and particle-size effects, improving accuracy and repeatability of elemental analysis • Available for a wide range of mining matrices and applications, including specialized fusion methods for challenging samples	• Calibrate XRF systems for ores, minerals, rocks and concentrates, covering major and minor elements across a wide range of geological materials • Support accurate, reproducible elemental analysis from exploration samples through concentrates and production control • Dedicated WROXI-REE and Base Metal Sulfide packages extend the solution to challenging REE and sulfide-ore applications • Dedicated calibration packages for: Ni, Fe, Co based alloys, Cu alloys and low alloy steels	**What is it used for?**
	• Compact single-position system that is fully automated and easy to operate, with more than 10 predefined fusion programs • Programmable fusion parameters and precise temperature control up to 1200°C for consistent, reproducible fusion results • Safe and user-friendly: automatic safety door locking and fully automated pouring eliminate manual handling of hot vessels	• Two independent fusion positions can operate synchronously or asynchronously, enabling up to 8 glass beads per hour • Fully automated and highly reproducible fusion with programmable temperature, agitation, oxidation, pouring and cooling parameters • Safe, low-maintenance operation with one-touch control, interlocked doors and high-quality ceramic holders designed to minimize contamination	• Consistent, homogeneous fusion with controlled heating and reduced contamination for highly reproducible analytical results • High-throughput design with six fusion positions and an optional tray loader that can increase productivity by up to 25% • Flexible, supporting XRF fusion beads as well as sample preparation for ICP and AA, with integrated sample tracking and monitoring	• High-purity, pre-fused and homogeneous lithium borate fluxes ensure consistent composition and minimize batch-to-batch variability • Available in pure (99.98%+) and ultra-pure (99.995%+) grades, with optional integrated LiBr or LiI non-wetting agents • Bead-form fluxes are anhydrous, non-hygroscopic and dust-free, improving weighing, handling and fusion repeatability	• Synthetic, ISO 17034-certified standards provide homogeneous, traceable materials with consistent composition and reliable long-term availability • WROXI-REE covers all 17 rare earth elements, with up to 40 elements in one calibration, from trace to major concentrations • Dedicated Base Metal Sulfide calibration with optimized fusion recipes and standards for challenging Cu, Zn, Pb, Ni, Mo and other sulfide-ore elements	**What's special about this product?**

About Malvern Panalytical

Malvern Panalytical provides market-leading, material characterization technologies for the world's most innovative companies, academic institutions, and government laboratories to optimize and accelerate the development of advanced materials.

We support our customers through their biggest challenges by uncovering critical insights in material properties. From developing lifesaving vaccines and next-generation therapeutics to advancing clean energy solutions and sustainable industrial processes, we give scientists the confidence to make important decisions that shape the world we live in.

We wake up every day to delight our customers and help them solve the problems that matter. Through innovation, high-quality solutions and workflows, and excellence in customer satisfaction, we help reduce lead times, increase repeatability, and deliver data that is actionable and easily understood.

Our vision is to continue to be a trusted and recognized leader for quality and insights in material characterization, helping our customers navigate complex scientific topics with accuracy and ease.

We win customers with performance and keep them with service and insights. We are the 'Best together.' Our people are experts in their fields, delivering value and innovation for each other and for our customers. With diversity in experience and customer-centric thinking, we are the best choice for researchers and scientists seeking competitive advantage in the market.

We have a high-performance culture - empowering teams, quick decision-making and serving customers more effectively - grounded in agility, clarity and transparency, with speed and focus critical to our success, all shaped by our values: Own it. Aim High. Be True.

We are committed to helping to solve our customers' greatest challenges to make the world cleaner, healthier and more productive for the future.

Service & Support

Malvern Panalytical provides the global training, service and support you need to continuously drive your analytical processes at the highest level. We help you increase the return on your investment, and ensure that as your analytical requirements grow, we're there to support you.

Our worldwide team of specialists adds value to your business processes by ensuring applications expertise, rapid response, and maximum instrument uptime.

- Proactive local and remote support
- Full and flexible range of service agreements
- Compliance and validation support
- Onsite or classroom-based training courses
- e-Learning training courses and web seminars
- Digital services, including MyStore and My Customer Support Portal
- Sample analysis, method development, and applications consultancy

Malvern Panalytical

Grovewood Road, Malvern,
Worcestershire, WR14 1XZ,
United Kingdom

Tel. +44 1684 892456
Fax. +44 1684 892789

Lelyweg 1,
7602 EA Almelo,
The Netherlands

Tel. +31 546 534 444
Fax. +31 546 534 598

www.malvernpanalytical.com

Disclaimer: Although diligent care has been used to ensure that the information in this material is accurate, nothing herein can be construed to imply any representation or warranty as to the accuracy, correctness or completeness of this information and we shall not be liable for errors contained herein or for damages in connection with the use of this material. Malvern Panalytical reserves the right to change the content in this material at any time without notice.
Copyright: © 2026 Malvern Panalytical. This publication or any portion thereof may not be copied or transmitted without our express written permission. **PN260824-766**