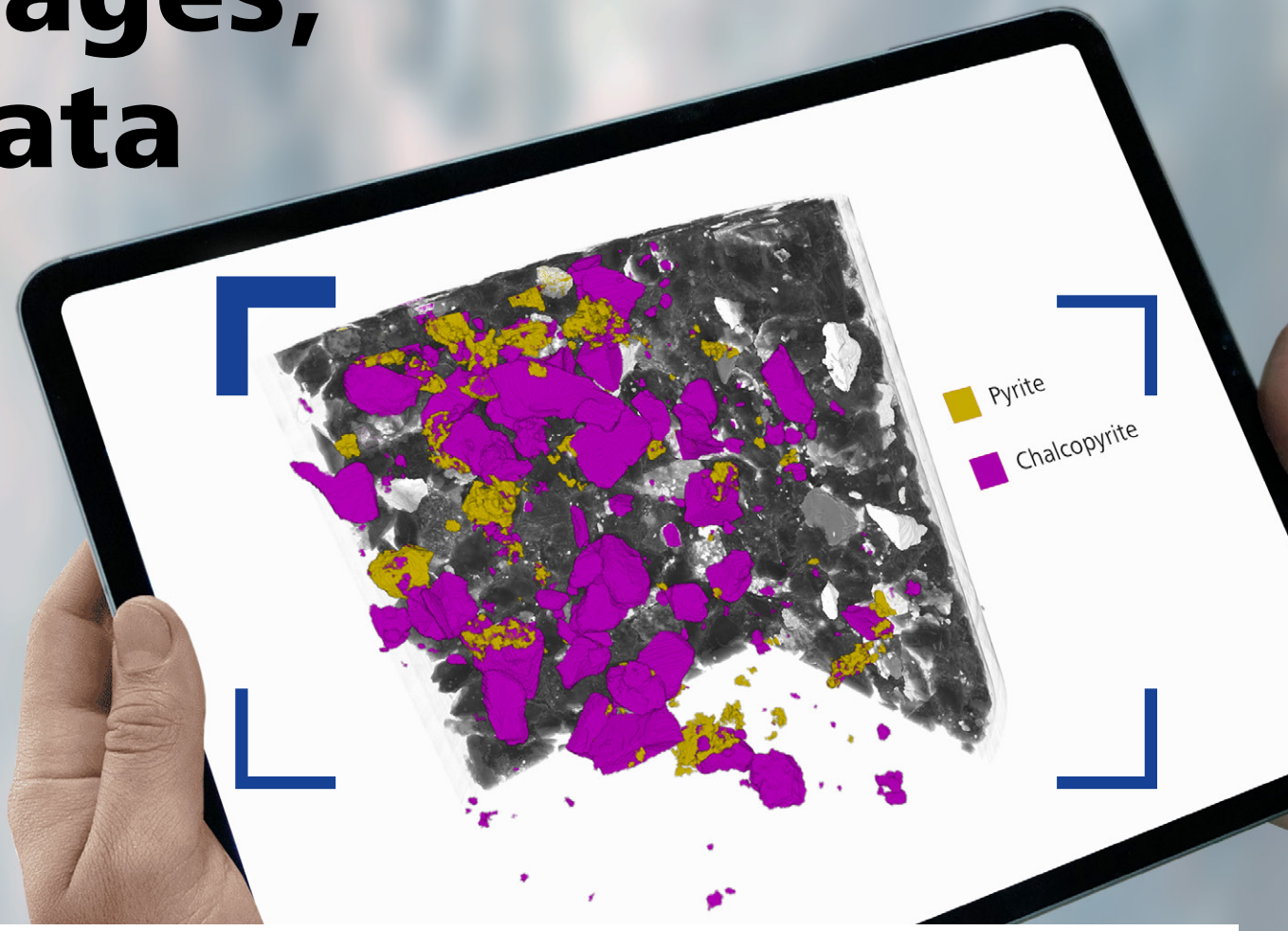
Inspiring Images, Insightful Data



ZEISS Mineralogic

Your Automated Mineralogy in 2D and 3D
for phase identification and textural analysis

zeiss.com/mineralogic

ZEISS

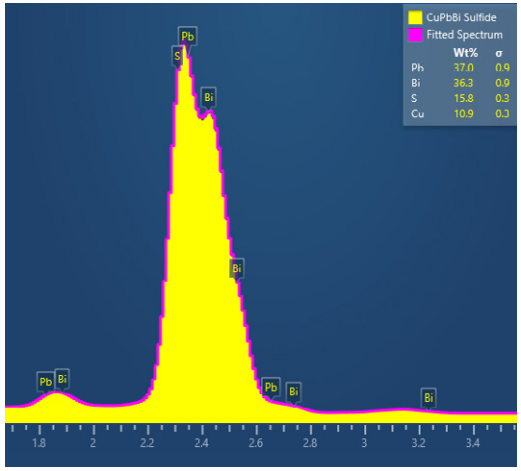
Seeing beyond

› **In Brief**
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› Systems
› Service

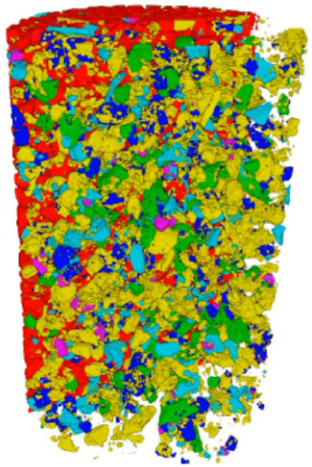
Automated Mineralogy in 2D and 3D: Phase identification, textural analysis

Automation has the potential to liberate individuals and organizations from arduous, time-consuming tasks, freeing them to be more strategic and productive. ZEISS Mineralogic 2D and 3D provide automated quantitative mineral analysis by bringing together cutting edge microscopy with the scanning electron microscope (SEM) and the X-ray microscope (XRM), industry leading energy-dispersive spectroscopy (EDS), and deep learning algorithms to enhance your analytical capability and increase productivity.

ZEISS Mineralogic is the ideal solution for exacting geological interrogation of your samples, from in-depth petrological investigations to high throughput mineral liberation workflows.



Quantitative EDS analysis of a mineral spectrum including peak deconvolution. Courtesy of Oxford Instruments



3D analysis of particulate matter reveals all contained mineralogy and true liberation measurements

Mineralogic 3D: Simpler. More Intelligent. More Integrated.

› In Brief

› **Mineralogic 3D (XRM)**

› Mineralogic 2D (SEM)

› Systems

› Service

Ore Body Characterization

Investigate your sample in its true form, without mechanical alteration, and see 100% of it. ZEISS Mineralogic 3D offers an unparalleled ability to understand composition, mineral relationships, and fabric of the geological materials under scrutiny, including locked grains. Taking advantage of the ZEISS Xradia flat panel detector to obtain a larger field of view, and of deep learning image reconstruction provided by ZEISS DeepRecon Pro, Mineralogic 3D offers unrivaled resolution, mineral classification, and measurement of samples in their natural state. Assumptions on the representativity of the exposed sample are no longer relevant, nor are issues with stereology.

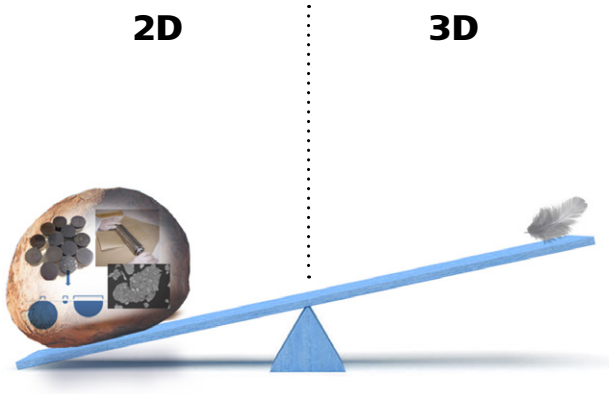
Maximize Throughput

Enjoy rapid analysis throughput with simple sample handling. Dispense with the requirement to mechanically alter your samples in order to expose flat surfaces for analysis and hope to reveal hidden phases. Unlike sample preparation for the SEM where graphite is added to act as a particle separator, Mineralogic 3D analysis of comminuted ore does not demand the use of additives to help maintain particle separation, nor of a resin block to hold particles fixed in space; instead, it makes full use of machine learning to ensure that every particle is understood in its entirety as a sole individual with full evaluation and quantification of exposed surfaces and enclosed mineralogy.

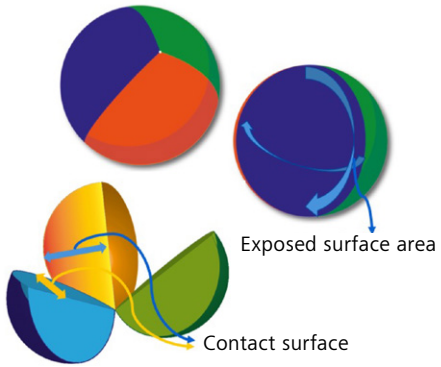
Mineralogy, Liberation, Associations

Understand your mineral processing like never before. Where 2D automated mineralogy offers liberation based on exposed surfaces or edges, associations based on linear contacts, and modal mineralogy based on phases exposed on the surface of the sample mount, Mineralogic 3D measures liberation based on the volume of the grains and their exposure on the surface of the unaltered particle. Associations are based on full mineral surface contacts with other phases, and modal mineralogy accounts for all grains: those exposed on the surface of the particles and those obscured within.

Mineralogic 3D combines X-ray microscopy with advanced machine learning to provide a true measurement of the sample with no obscured phases of interest



The much lighter sample preparation requirements for Mineralogic 3D compared to 2D automated mineralogy



3D evaluation of mineral particles delivers an un-obfuscated view of associations, liberation, and modal mineralogy

Mineralogic 3D: Your Insight into the Technology Behind It

› In Brief

› **Mineralogic 3D (XRM)**

› Mineralogic 2D (SEM)

› Systems

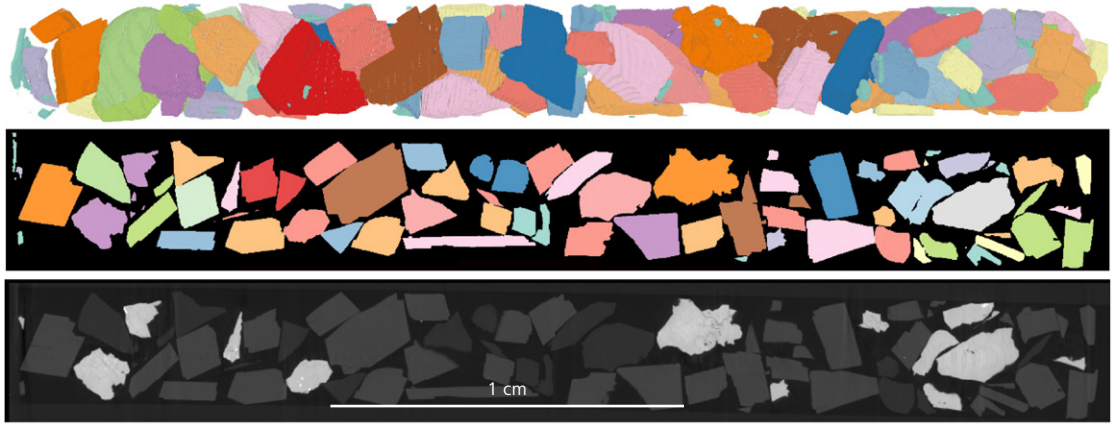
› Service

Particle Segmentation and Measurement

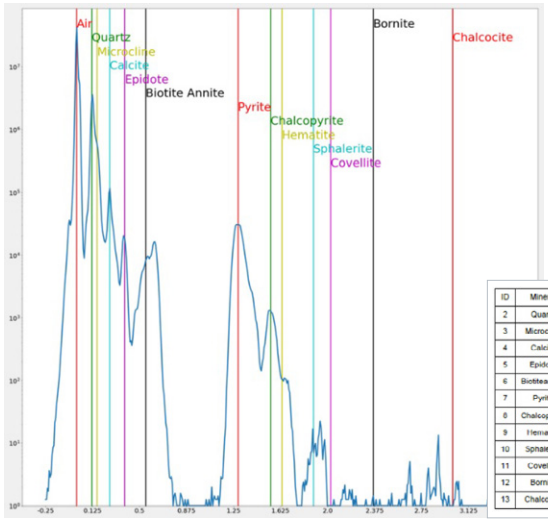
With ZEISS Mineralogic 3D, you benefit from the application of advanced and flexible machine learning protocols that recognize individual particles even when they are in contact with other particles of the same composition. Particles are then analyzed individually to provide a series of pertinent outputs such as modal mineralogy, volume, porosity, feret dimensional measurements, associations, and liberation.

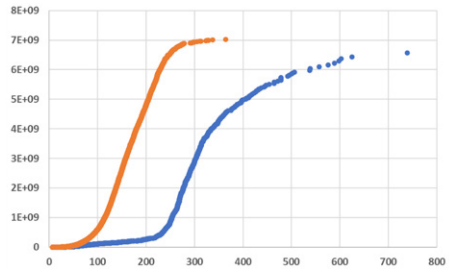
Mineral Classification

Making full use of the imaging capability of the X-ray microscope, enhanced by DeepRecon Pro deep learning algorithms, Mineralogic 3D automatically classifies the mineralogy of the sample based on attenuation measurements. The ability to classify the mineralogy in tomographic scans is unique, and when combined with the morphological measurements of the 3D particle and grain objects, allows the calculation of standard mining-relevant outputs.



Machine learning assisted segmentation identifies each particle, and considers it individually, without the need for additives nor manual separation.





ID	Mineral	Liberated %	Middling %	Locked %	<10 %	<20 %	<30 %	<40 %	<50 %	<60 %	<70 %	<80 %	<90 %	<100 %	100 %
2	Quartz	41.03	54.21	4.76	3.23	1.53	2.0	3.46	6.24	10.07	13.5	18.94	18.96	22.03	0.04
3	Microcline	14.44	67.64	17.92	10.87	7.05	7.74	11.26	12.97	13.59	13.3	8.78	7.91	6.52	0.01
4	Calcite	45.59	32.74	21.67	15.74	5.93	4.28	7.15	7.07	3.59	4.74	5.92	10.54	34.96	0.1
5	Epidote	44.46	38.28	17.26	13.68	3.58	4.56	3.36	6.75	6.51	4.71	12.38	10.52	33.92	0.01
6	Biotteannite	62.6	31.33	6.07	4.97	1.1	1.28	1.79	0.23	8.34	10.65	9.04	19.81	41.74	1.05
7	Pyrite	81.63	12.66	5.71	4.47	1.24	1.11	0.63	1.51	0.5	3.65	5.26	5.04	75.38	1.21
8	Chalcopyrite	7.79	56.04	36.17	21.75	14.42	0.35	14.52	0.0	10.22	9.07	9.89	7.15	0.57	0.08
9	Hematite	0.0	17.92	82.08	24.73	57.34	15.73	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Sphalerite	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Covellite	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Bornite	0.0	5.68	94.32	54.68	39.65	5.68	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Chalcocite	0.0	0.0	100.0	61.55	38.45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Mineral classifications based on attenuation measurements and particle size and liberation outputs based on morphological measurements of the reconstructed 3D entities

ZEISS Mineralogic 3D at Work

› In Brief

› **Mineralogic 3D (XRM)**

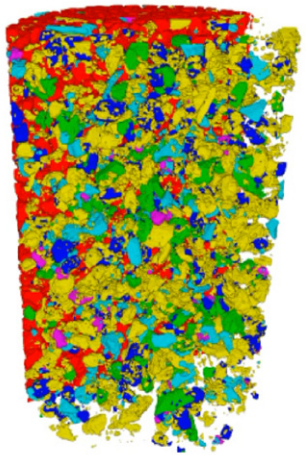
› Mineralogic 2D (SEM)

› Systems

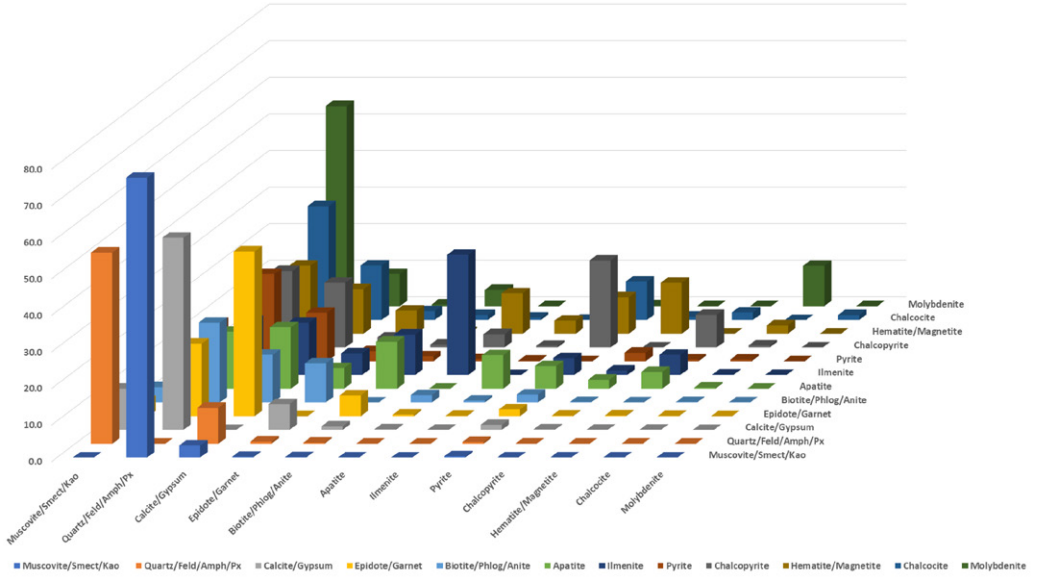
› Service

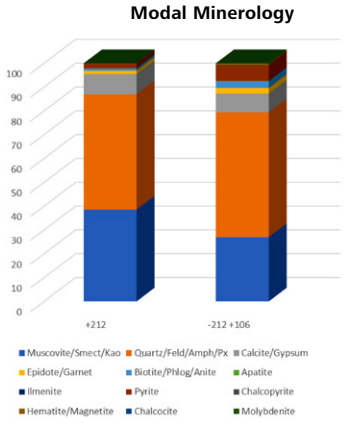
Mineral Processing

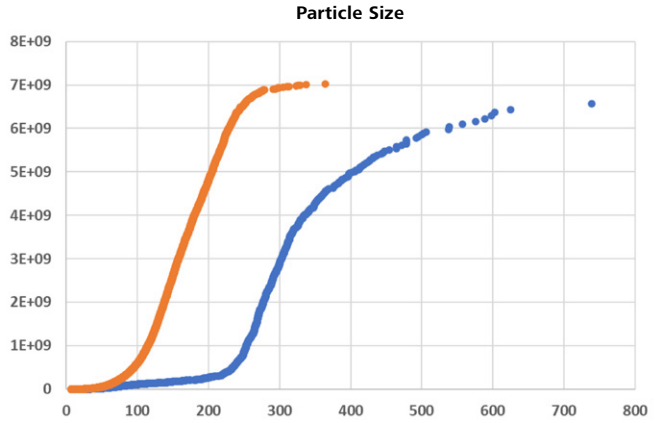
Increasing demand on resources has led to the evaluation of more complex, lower grade, ores. Maximizing recovery requires improvements in efficiency that involve detailed knowledge of the ore body, and of the mineralogy that influences behavior during the beneficiation process. When time is of the essence, Mineralogic 3D produces the actionable data needed for decision making, from comminution improvements, through process enhancements, to assessing the quality of the final concentrate.



Analysis of a comminuted ore reveals mineralogical, morphological, and liberation details of the constituent mineralogy.







Mineralogic 3D standard outputs include bulk mineralogy, morphological measurements, liberation and associations.

Mineralogic 2D: Simpler. More Intelligent. More Integrated.

› In Brief
› Mineralogic 3D (XRM)
› **Mineralogic 2D (SEM)**
› Systems
› Service

Quantitative Chemical Analysis and Classification

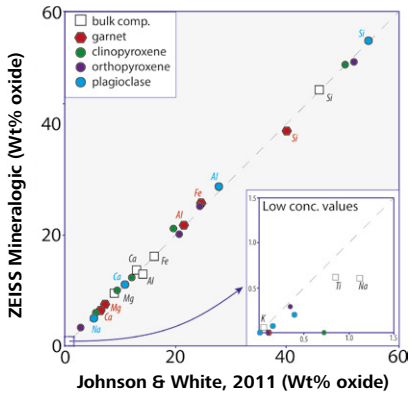
Match mineral classification methods to your sample texture. For maximum accuracy, use the highly sensitive technique of standards-based quantitative EDS. For the fastest analysis speeds, choose BSD greyscale alone. Include element ratio rules to discriminate end members of a solid solution. Combining chemical and morphochemical classifications allows you to classify lithology to automatically categorize your particles, and identify and quantify ore types. High resolution imaging combined with a full suite of image processing functions gives you a powerful edge to solve previously impossible application challenges.

Morphochemical and Lithological Classification

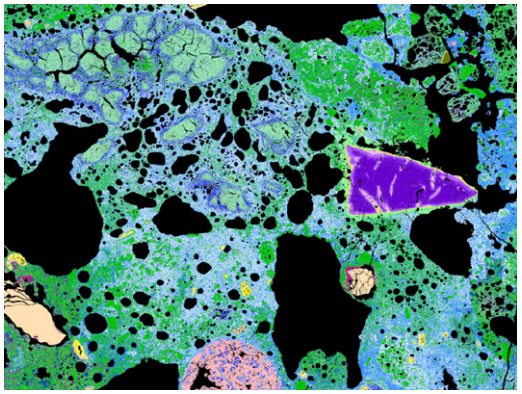
Geological studies often involve complex, heterogeneous systems and therefore simple classification criteria may not be sufficient to fully describe a system. Use morphological parameters with mineral chemistry to further describe your mineralogy and differentiate key evidence. Combine chemistry with grain size, shape parameters, grey level, and porosity to achieve in-line morphochemical quantification with all the results tabulated immediately at the end of the analysis. Distinguish between crystalline and porous instances of your pyrite or goethite to better assess mineral genesis, instances of bio-mineralization and/or make fact-based operational decisions.

High Throughput

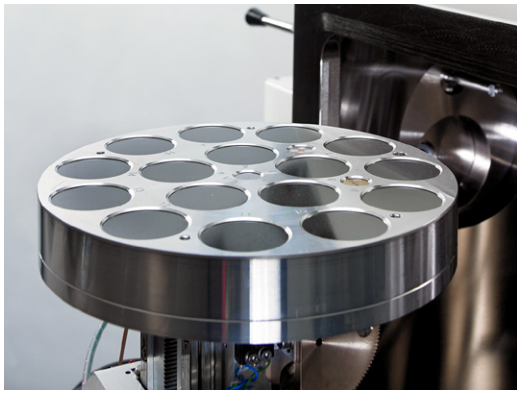
ZEISS Mineralogic 2D measures and classifies minerals in real time. Once the sample run is complete, there is no need for post processing. Quantification of the EDX spectra takes no time at all thanks to today's computing technology. Measurement modes and stop criteria allow you to tailor your analysis speed. You can also reanalyze data sets retrospectively offline using modified mineral classification rules. You'll achieve maximum automation and productivity with a 16-stub sample holder and a range of ZEISS SEMs. Choose the size and number of energy dispersive spectrometers (EDS) with class leading detector solid angles. Producing dedicated reports has never been easier.



High accuracy bulk chemistry and modal mineralogy, measured with ZEISS Mineralogic 2D, plotted against bulk rock chemistry by XRF and mineral chemistry by EMP



Steel production sinter revealing some original Fe-ore mineralogy within the sinter products



Analyze up to 16 metallurgical blocks in a single run with the 16-block holder

Mineralogic 2D: Simpler. More Intelligent. More Integrated.

› In Brief

› Mineralogic 3D (XRM)

› **Mineralogic 2D (SEM)**

› Systems

› Service

Geochemical Investigation

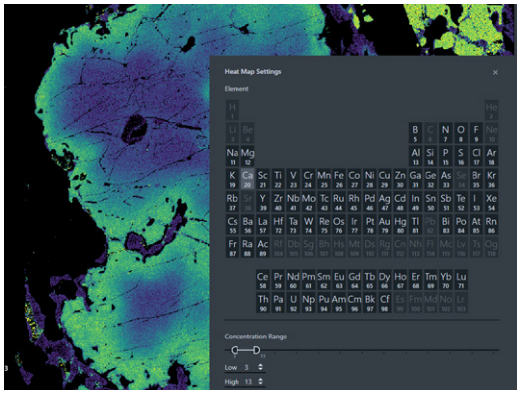
Geochemical modeling of geological events is based on knowledge of the mineralogy and bulk chemistry of the rocks that recorded the alteration. Using standards-based EDS analysis, ZEISS Mineralogic 2D provides precise, actionable bulk chemistry, mineralogy, and phase chemical zonation at micron scale in a single analysis. This reduces the time to results and the volume of corroborating data that must be acquired. Return to grains of interest with the press of a single button to acquire trace element profiles using WDS or export the coordinate map for use with TOF-SIMS and LA-ICP-MS. User-friendly Mineralogic interface allows visualization and export of quantitative geochemical data.

Ore Body Characterization

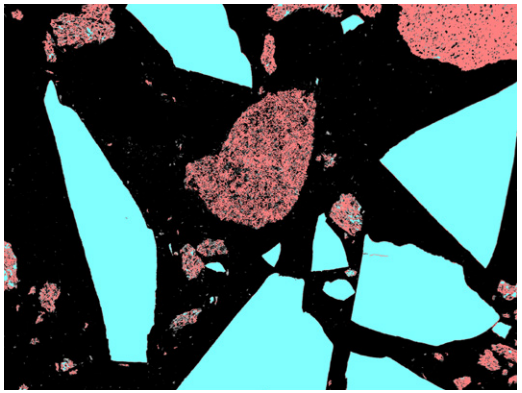
Ore body mineralogy is now simple to characterize thanks to quantitative EDS. The chemical composition of all minerals is measured and can be used to quickly classify mineralogy. Simply return to the grain of interest at the click of a button and investigate further with the system's full standalone EDX capability. Creating a mineral library to classify a new ore body takes hours instead of weeks. Furthermore, mineral libraries can be copied to new instruments to avoid a significant overhead recreating instrument-specific libraries. Trace elements can be quantified using TOF-SIMS, WDS and LA-ICP-MS through a new seamless correlative workflow and assigned to mineral classes to report trace element assay measurements and take account of hydrated or lithium bearing minerals.

EDS Flexibility

Enjoy increased flexibility when deciding on your Mineralogic 2D system with a choice of Ultim Max EDS detectors from Oxford Instruments or Xflash 6 EDS detectors from Bruker. Choose the detector/s that best fit your working requirements based on peak resolution, detection of light elements, or detector size to match your resolution and throughput requirements. Add a WDS detector to expand your possibilities to below 1000 ppm quantification and use the assigned chemistry option to carry through these results into the ZEISS Mineralogic 2D Explorer data analysis engine.



Full thin secrion scan of a metamorphic rock from Glenelg, Scotland. Garnet map shows the periodic table user interface for element and concentration range selection.



Mineralogic 2D analysis of an iron ore sample containing both vitreous (cyan) and ochreous (salmon) goethite

Choose Oxford Ultim Max or Bruker EDS detectors to meet your analytical requrements

Mineralogic 2D: Your Insight into the Technology Behind It

› In Brief

› Mineralogic 3D (XRM)

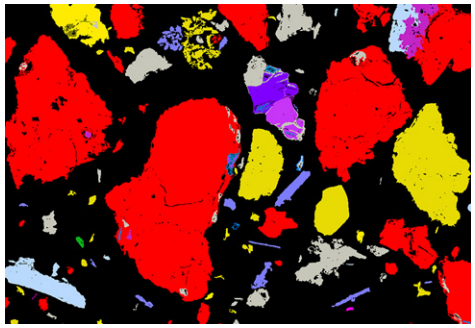
› **Mineralogic 2D (SEM)**

› Systems

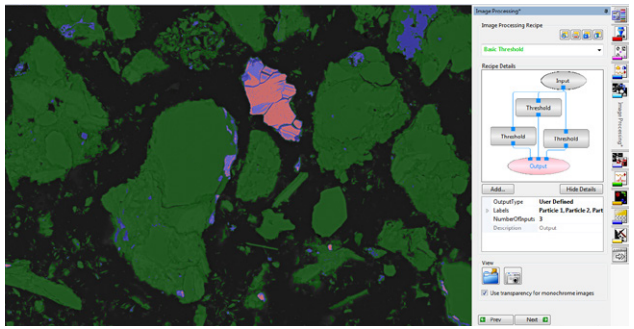
› Service

Image Processing

With ZEISS Mineralogic 2D you benefit from a unique suite of more than 60 algorithms for customized image processing. This gives you a particular advantage when tailoring your analysis to unique textures, materials and application questions. Set multiple BSD greyscale thresholds and windows to exclude potting media and analyze only the phases of interest. Avoiding unwanted regions and edge effects using image processing reduces your time to result while improving your data quality.



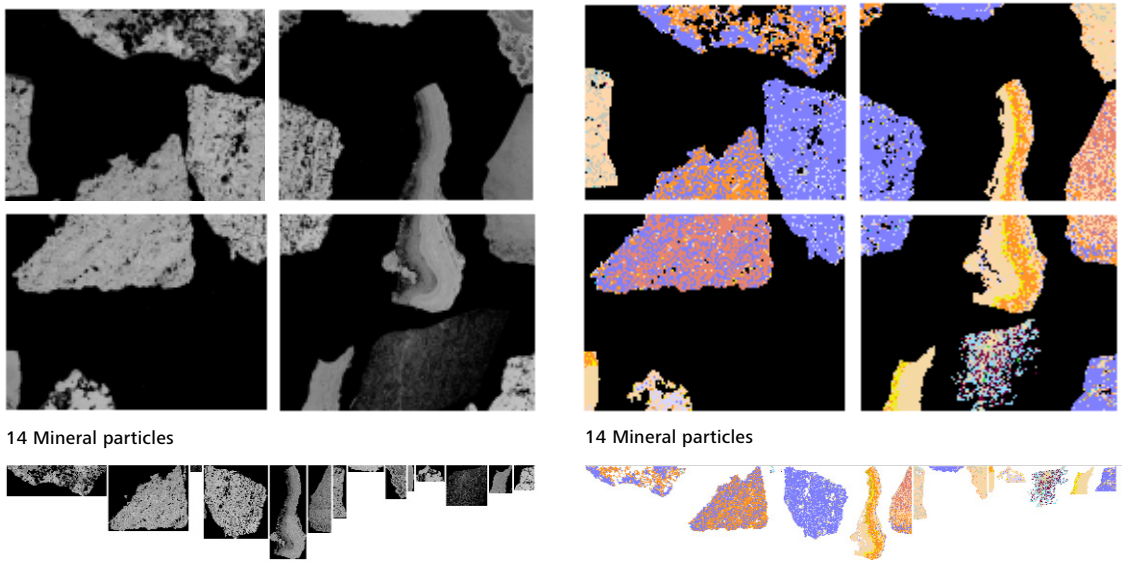
Multiple thresholding example showing resultant segmented image. Color assignments correspond to unique grey levels in each particle.



Automated multiple grey level segmentation using ZEISS Mineralogic 2D image processing suite

Mapped Data Stitching

When a particle is not fully contained within a field of view, stitching of the particles is required across multiple fields of view. The innovative ZEISS approach offers full stitching accuracy beyond that offered by simple particle alignment, which is very dependent on stage repeatability and beam calibration. ZEISS Mineralogic 2D stitching enables recombination of fragments to provide precise and accurate measurement and classification of grains and particles. Simply enable data stitching and ZEISS Mineralogic will automatically stitch the overlapping boundary particles and ensure data integrity across the measurement of chemistry, particle size, grain size, and all dependent parameters.



Stitching of mineral particle data across multiple fields of view ensures accurate textural information and avoids skewing of data when analyzing large particles

Mineralogic 2D: Your Insight into the Technology Behind It

› In Brief
› Mineralogic 3D (XRM)
› **Mineralogic 2D (SEM)**
› Systems
› Service

Mineral Classifications

Standards-based Quantitative EDX
Measure the chemical composition of each pixel and assign mineralogy independently of beam conditions using spectral deconvolution calibrated with certified reference materials.

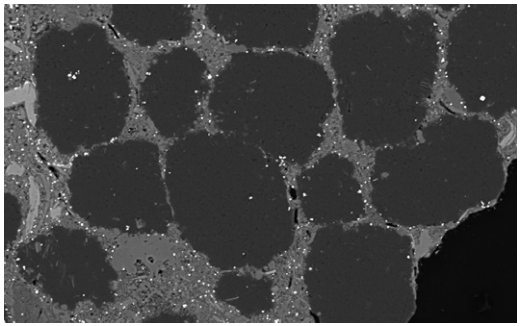
Standardless Quantitative EDX
Measure the chemical composition of each pixel and assign mineralogy independently of beam conditions with spectral deconvolution based on calibration to a known element's energy peak and intensity.

Assigned Compositions
Import high precision, trace element data from an external data source and assign elemental abundances to mineral definitions.

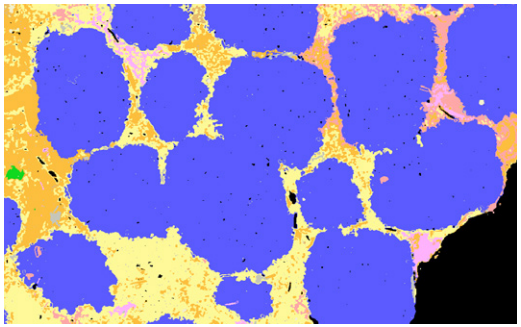
Element Ratios
Use elemental ratios to easily differentiate minerals in a same mineral group, thus efficiently dealing with solid solutions.

BSE Only
For high speed mineral classification, use the calibrated BSE detector to identify minerals at the speed and resolution of imaging.

Morphochemical and Lithological Classification
Use high resolution images in combination with chemical and morphological analyses to create morphochemical classifications that describe mineral textural features. Combine chemical and morphochemical classifications with particle morphology to create lithological classifications that help describe texture and permit rapid particle and ore-type classification.



Example BSE image of a lithium-bearing silicate mineral



Example classified image showing a clear mosaic texture

Lithology	Number	Area %	Weight %	Carbonate Silicate	Carbonates Gangue	Clean Roanikite	Dirty Roanikite	Feldspars	Mica	Sulfides	Roanikite Sulfides	Others	Pore
Mosaic	64	4.33	4.01	3.03	2.53	93.07	0.52	0.00	0.58	0.26	0.00	0.00	2.87
Disseminated	3165	23.88	22.52	40.76	23.46	0.00	2.90	0.00	5.57	1.03	26.15	0.12	33.87
Gangue	11521	67.74	69.17	64.36	34.33	0.00	0.15	0.00	0.57	0.00	0.00	0.58	5.13
Remaining Particles	492	4.05	4.29	48.03	29.67	0.00	0.00	0.00	1.64	19.57	0.00	1.09	6.43
Sample	15242												

Quantification of different lithologies present in the sample.

Mineralogic 2D: Your Insight into the Technology Behind It

› In Brief
› Mineralogic 3D (XRM)
› **Mineralogic 2D (SEM)**
› Systems
› Service

Analytical Measurement Modes

Full Mapping
Perform quantitative EDX mapping of a sample at a user-defined spacing to build up a detailed map of your sample.

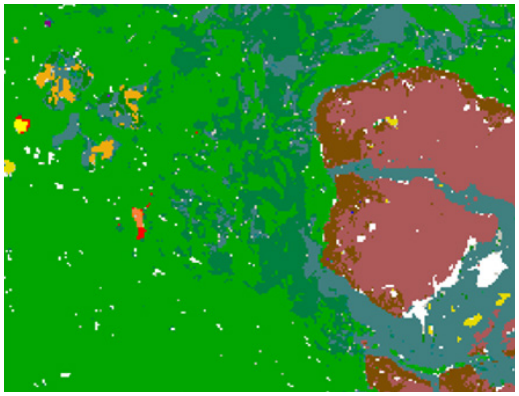
Fast Scan
Individual grains are identified and multiple spots are analyzed across the grain to provide a rapid average composition of the grain.

Spot Centroid
Individual grains are identified and their mineralogy assigned by an EDX analysis at the center of the grain.

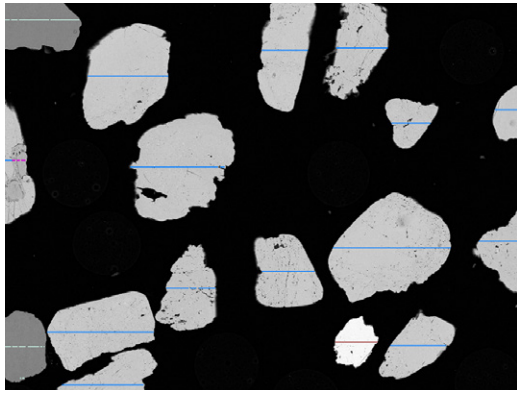
Line Scan
A quantitative EDX analysis is performed at a user-defined spacing along a line through the center of a particle to build-up a fast bulk composition of the sample.

Feature Scan
Individual grains are identified and their mineralogy assigned by quantitative EDX while the electron beam rasters over the grain.

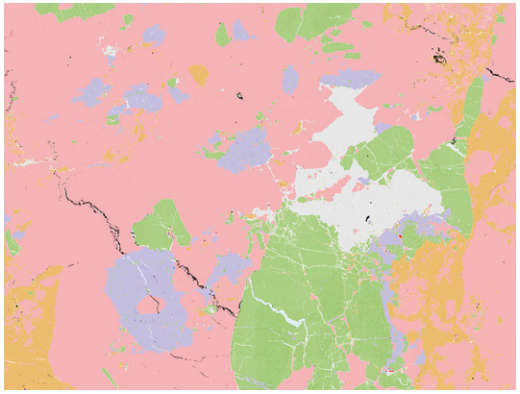
Phase of Interest Search
Identify grains of interest through image processing and map them and any associated grains rapidly.



High resolution map of a PGE-rich podiform chromite prospect
Courtesy of Dr. Chris Brough and University of Cardiff, Wales



Example of mapped line scan mode showing quantitative EDX measurements across the center of each particle



Montage image of ZEISS Mineralogic 2D analysis of a gold-silver hosting base metal sulfide vein
Courtesy of John Spratt, Natural History Museum, UK

Mineralogic 2D: Your Insight into the Technology Behind It

› In Brief
› Mineralogic 3D (XRM)
› **Mineralogic 2D (SEM)**
› Systems
› Service

View and Manage Your Results

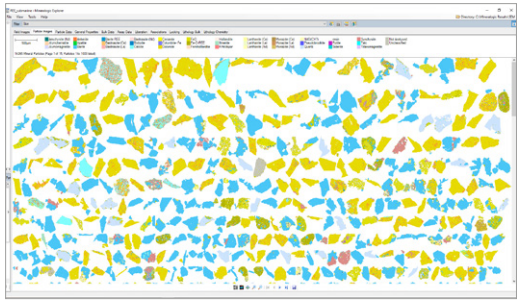
Use the ZEISS Mineralogic 2D Explorer application to browse and combine the results of your analyses. Immediately at the end of the analysis you can expect tabulated data on mineralogy, assay, associations, liberation, lithology bulk data, lithology chemistry, and lithology liberation. Further investigation is possible with advanced filtering that allows you to use any of the measured or calculated parameters to refine your data search. Click on a particle of interest and the SEM will automatically drive to it and provide a live image. Automatically separate touching particles. Create large mineral maps and BSD greyscale montages. With the remote license, enjoy the convenience of modifying mineral classifications and retrospectively re-analyzing data offline for increased productivity.

Create Reports Effortlessly

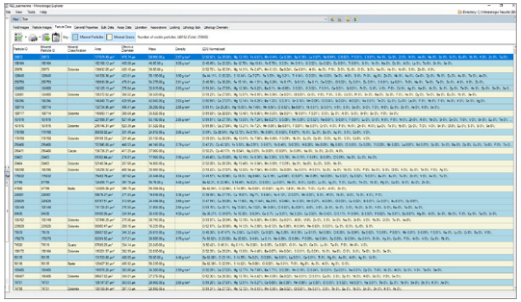
Save time with the ZEISS Mineralogic 2D built-in batch output tool: predefined filtered outputs can be exported automatically, while the SEM is still acquiring data. Alternatively, you can generate reports from previously acquired data at your convenience.

Handle, Filter and Query Data

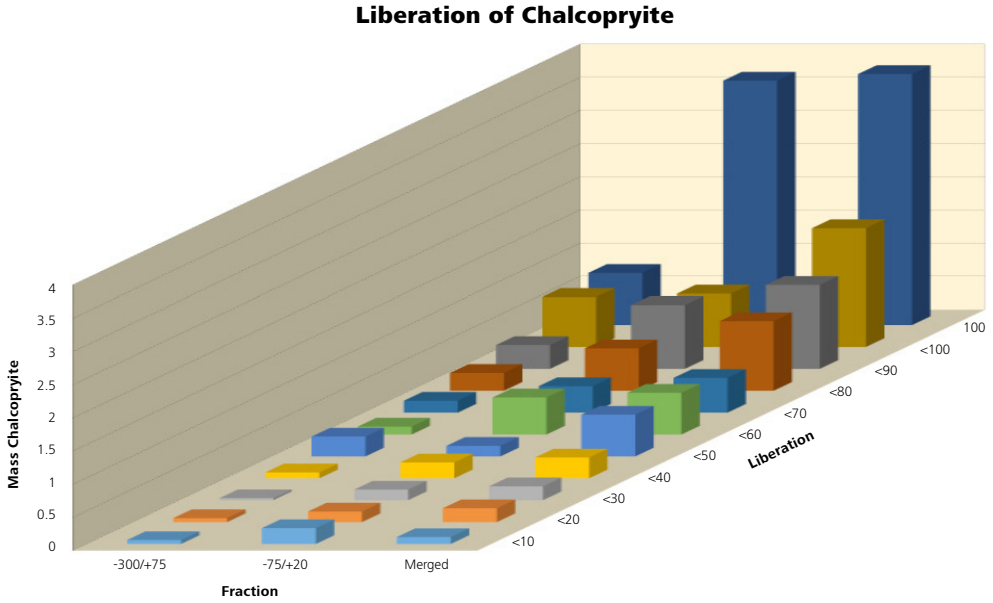
Merge replicate data and report as a single fraction. Merge fractions to reconstitute the unsieved material. The ZEISS Mineralogic 2D comprehensive filtering and data querying engine allows you to probe sample data like never before.



ZEISS Mineralogic 2D Explorer view of classified mineral particles of REE feed material



ZEISS Mineralogic 2D Explorer tabulated selection of particle and grain data



Mass versus liberation of chalcopyrite for 3 different size fractions of a recleaner feed in a copper flotation circuit

ZEISS Mineralogic 2D at Work

› In Brief

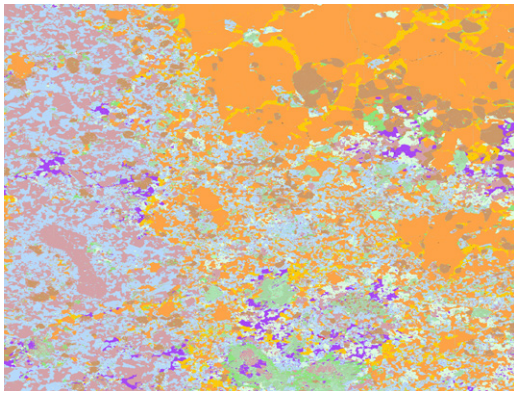
› Mineralogic 3D (XRM)

› **Mineralogic 2D (SEM)**

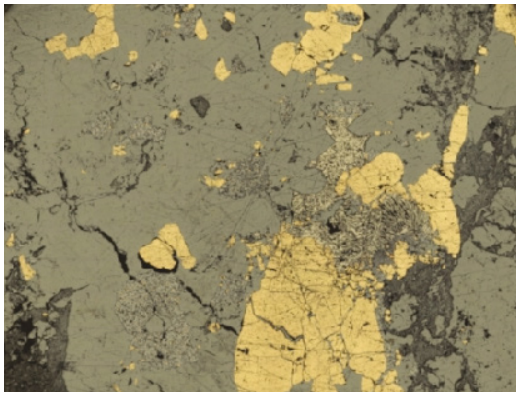
› Systems

› Service

Mining Feasibility

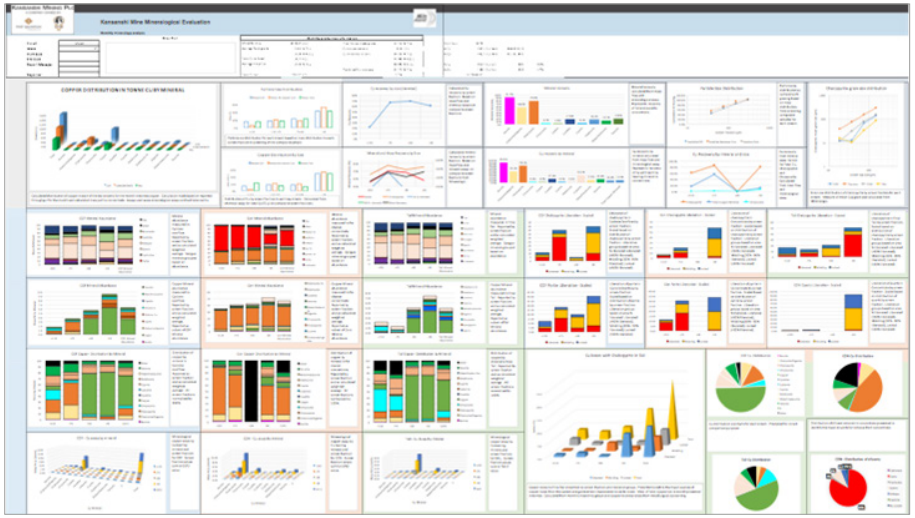


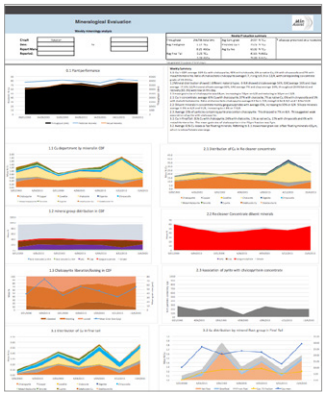
High resolution mineral map. Ni-Cu ore, Fraser Mine, Sudbury. Courtesy: University of Leicester, UK



Analysis of metals with ZEISS Mineralogic 2D. Gold mineralization in association with sulfide veining, in particular with sphalerite.
Courtesy of Prof. Simon Dominy, Curtin University, Australia

Mineral Processing





Mineral processing plant automated daily metallurgical reports. Courtesy of iMIN Solutions.

ZEISS Mineralogic 2D at Work

› In Brief

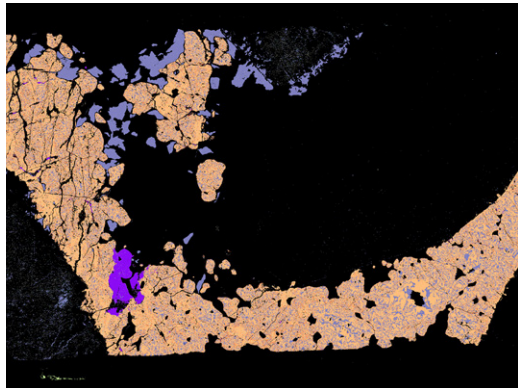
› Mineralogic 3D (XRM)

› **Mineralogic 2D (SEM)**

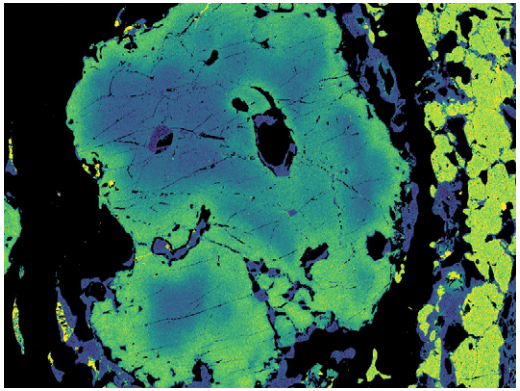
› Systems

› Service

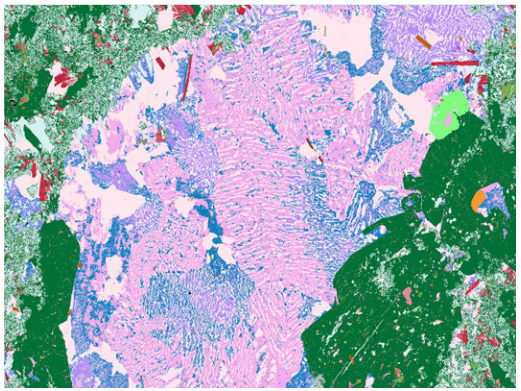
Geoscience



Applied morphochemical classification to assess differences in major element chemistry between two distinct magnetite textures. Courtesy of Prof. David A. Holwell, Applied Environmental Geology, University of Leicester, U.K.

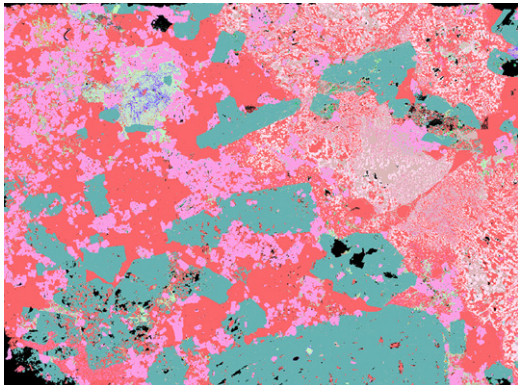


Quantitative calcium heatmap within an area of thin section showing a zoned garnet from Glenelg, Scotland.

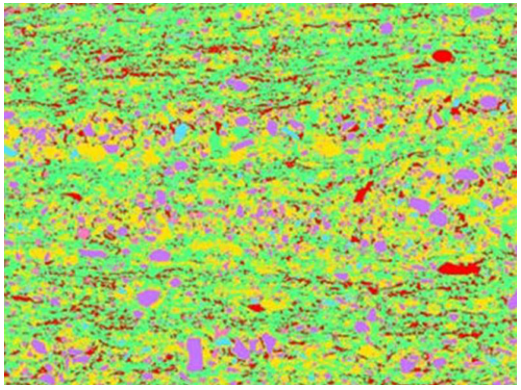


Mineralogic 2D scan of Scottish Lamprophyres showing feldspathic inclusions with myrmekite exsolution of quartz in a mixed feldspathic (plagioclase, albite and orthoclase) matrix.

Atlas-correlation of thin section photomicrographs and Mineralogic 2D data to help classify magnetite textures. Courtesy of Prof. David A. Holwell, Applied Environmental Geology, University of Leicester, U.K.



Peralkaline Granite, Northern Quebec, Canada, containing rare earth elements, including a fluorite vein that crosscuts the sample and zoned zircons.



Fully quantify elements to allow for both mineral identification and major element geochemistry at once. This sample, comprising clinochlore and chamosite, breaks down to Mg (15.3%), Al (9.1%), Fe (11.7%), Si (14.2%), O (48.4%).

ZEISS Mineralogic 2D at Work

› In Brief

› Mineralogic 3D (XRM)

› **Mineralogic 2D (SEM)**

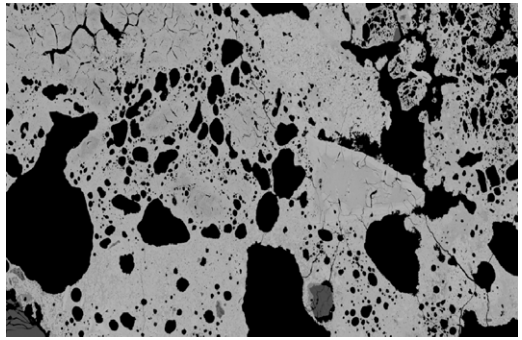
› Systems

› Service

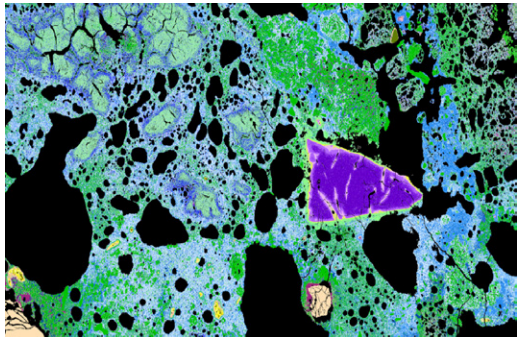
Verifying Raw Materials in Steelmaking
As steelmaking becomes more concentrated at large efficient facilities, economies of scale are exhausted and producers must look for incremental gains in yield and purity in the steelmaking process.

Accurate characterization of minerals and intermediates enables maximal understanding of the iron ore, sinter, coke, and flux fed to primary steelmaking furnaces. This insight allows steelmakers and other metals producers to perform extractive metallurgy, with optimal resource efficiency through better understanding and tuning the chemistry of the reaction in their furnaces.

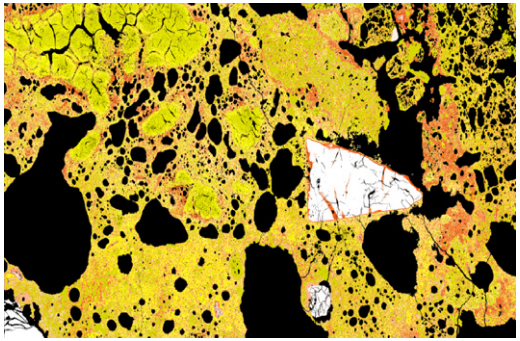
ZEISS Mineralogic 2D gives rapid automated on-site quantification of process inputs, beneficiation agents, refractories and slag. Fast and accurate determination of the composition, grain size, mineral association and liberation in the feedstock, including contaminants and minor elements, optimizes the cleanliness and productivity of steelmaking and other primary metallurgy.



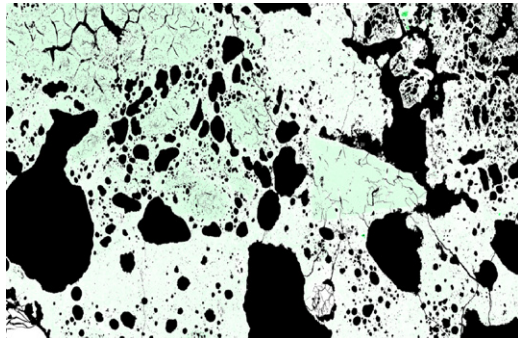
BSE image of sample. Differences in the brightness of the grey levels indicate variations in the concentrations of Fe, Al, Ca, Si and P across the sample



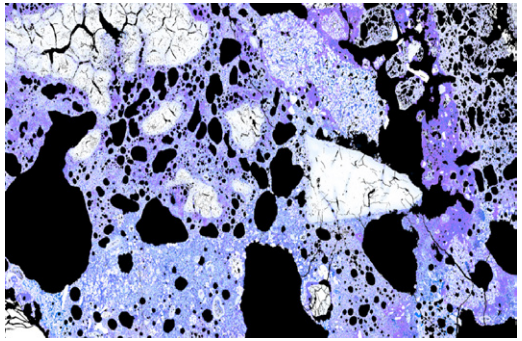
Mineralogic 2D analysis of pre-processed Fe-ore displaying variability in the mineralogy and the chemical composition of the sinter products



Fe concentration map extracted from Mineralogic 2D analysis, grading from 0% (white), 0.1wt% (pink) to 50 wt% (yellow) to >60% (green)



Al concentration map extracted from Mineralogic 2D analysis, grading from 0% (white) to >37wt% (darkest green)



Ca concentration map extracted from Mineralogic 2D analysis, grading from 0% (white) to >45% (darkest blue)

Your Flexible Choice of Systems

› In Brief

› Mineralogic 3D (XRM)

› Mineralogic 2D (SEM)

› **Systems**

› Service

ZEISS Mineralogic is available on the ZEISS SEM (Mineralogic 2D) and on ZEISS X-ray systems (Mineralogic 3D). Mineralogic 2D combines a scanning electron microscope with one or more EDS detectors and a mineral analysis engine – all controlled and operated from a single user interface. You can use all standard sample types, including stubs, geological slides and core cuttings.

ZEISS Mineralogic 3D is available on ZEISS Xradia Versa XRM or ZEISS Xradia Context microCT, with flat panel detectors, and combines deep learning algorithms with cutting edge classification and measurement capability. Choose the ZEISS platform that best suits your applications.

ZEISS EVO for 24/7 Ore Process Control

ZEISS EVO is the industry-standard platform for automated mineralogy and is in operation worldwide in mineral processing laboratories. ZEISS EVO's column isolation valve allows fast sample transfer and chamber pump down, making it the ideal SEM for 24/7 ore processing. Choose between three chamber sizes – 10, 15 or 25 – to get the right system for your application. Use ZEISS EVO in variable pressure mode for easy analysis of uncoated samples, shortening your time to result. Add ZEISS Atlas 5 to correlate data with optical and X-ray microscopy.

ZEISS Sigma and GeminiSEM for Highly Detailed Analysis

ZEISS Sigma is a Schottky thermal emitter that combines a high brightness source with high stability, improving your time to result. By exploiting ZEISS Sigma's exceptional imaging capabilities, you can distinguish minerals of similar average atomic weight by greyscale alone (0.07 atomic mass unit resolution). Thanks to the unique ZEISS Gemini lens design, the ZEISS Sigma family leads the field in terms of solid angle for maximum sample throughput. Add ZEISS Atlas 5 to correlate data with optical and X-ray microscopy.

ZEISS Xradia Context and Versa for High Throughput and Shorter Time to Results

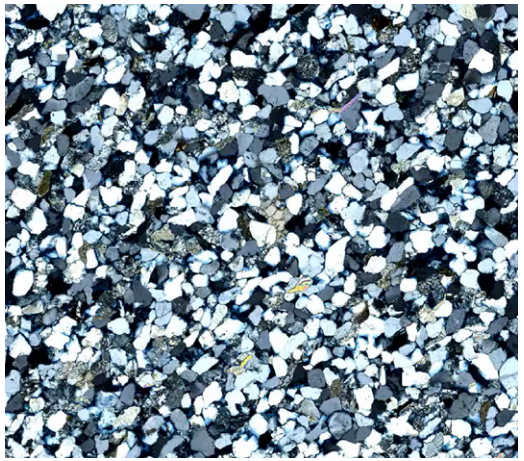
Relying on ZEISS's best-in-class imaging, combined with machine learning, ZEISS Xradia Context and ZEISS Xradia Versa X-ray systems offer a simple workflow, devoid of the intricacies of sample preparation for 2D analyses, resulting in a vastly reduced time to actionable information. Enhanced with ZEISS DeepRecon Pro and making full use of the ZEISS Xradia flat panel technology adds further flexibility and ensures full sample imaging and fast throughput.

Your Goals Realized with Maximum Efficiency

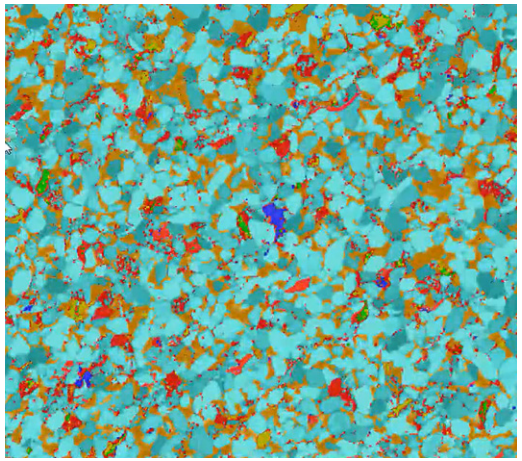
› In Brief
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› **Systems**
› Service

Segmentation and Measurement

ZEISS Intellesis offers powerful machine learning segmentation of multidimensional images. Compatible with the entire range of ZEISS materials microscopes, automated Intellesis segmentation removes user bias and speeds up time to results. When combined with ZEN image analysis, they provide automated petrographical analysis.



Sandstone compound image. Each pixel's carrier information of the brightfield transmitted light image and of the correlated polarized image.



Intellesis-segmented image displaying grain and mineral segmentation

	Region Classification	Count [#]	Area...
	A	B	C
1	Statistics pore	4,013	19.53
2	Statistics qz	6,724	69.93
3	Statistics mica	15,545	7.74
4	Statistics brown high relief	1,465	0.63
5	Statistics calcite	1,623	0.39
6	Statistics opaques	850	1.05

Modal mineralogy directly developed from the Intellesis machine learning segmentation of the sample

Expand Your Possibilities

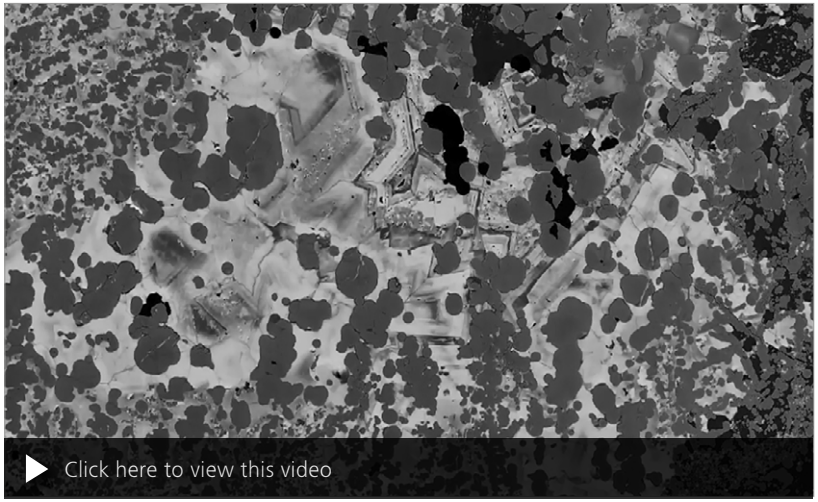
› In Brief
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› **Systems**
› Service

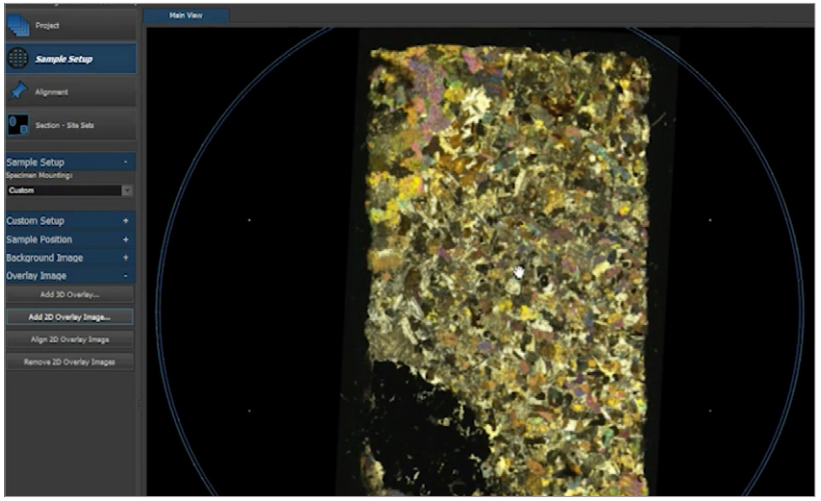
Correlative Image Viewing with ZEISS Atlas 5

With ZEISS Atlas 5 you can compare and correlate data from any ZEISS microscope system. Combine images from the same region of interest acquired with optical, electron, ion and X-ray microscopes. ZEISS Atlas 5 is your disruptive technology for correlative data interaction in mining and geo-science.

Correlate the Following Image Types

- Entire thin sections imaged with the ZEISS Axioscan 7 slide scanner
- Reflected and transmitted polarized images from a light microscope such as ZEISS Axio Imager 2
- Secondary electron, backscatter and catho-doluminescence images from a scanning electron microscope such as ZEISS EVO, ZEISS Sigma, and ZEISS GeminiSEM
- Mineral maps from a petrological analyzer such as ZEISS Mineralogic
- 3D datacubes from an X-ray microscope such as ZEISS Xradia Versa and ZEISS Xradia Ultra
- 3D datacubes from a FIB-SEM such as the ZEISS Crossbeam series





Expand Your Possibilities

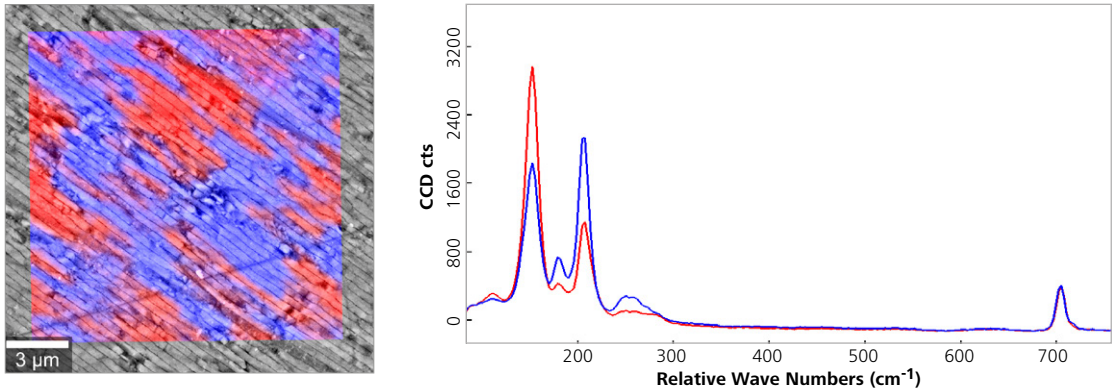
› In Brief
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› **Systems**
› Service

Raman RISE Microscopy

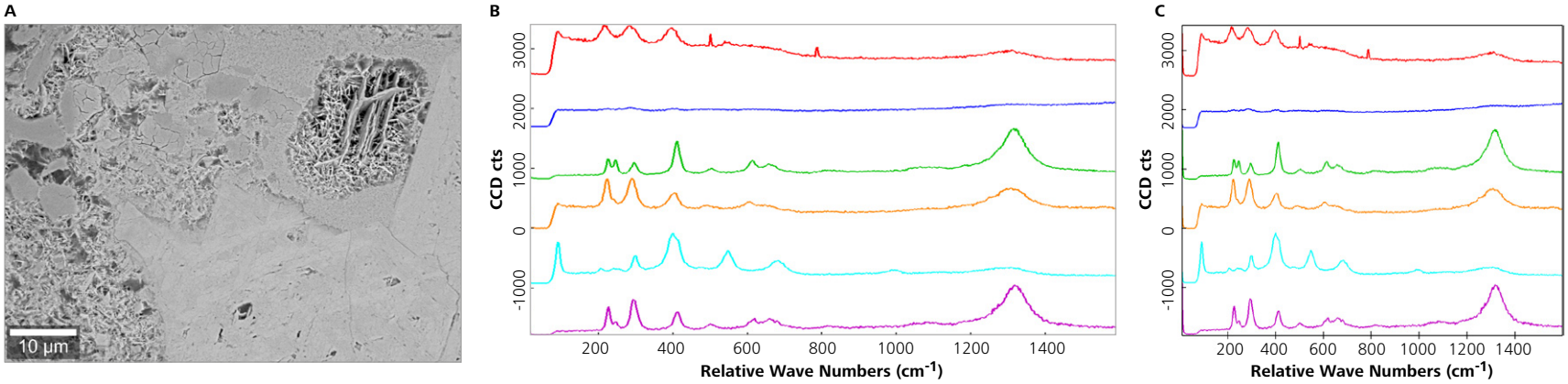
Enhance your automated mineralogy system with Raman vibrational spectroscopy to achieve a correlated Raman-automated mineralogy system.

Raman spectroscopy distinguishes minerals based on their vibrational spectrum. It is able to identify minerals with identical chemical composition, but differing crystal structure such as rutile and anatase (both TiO_2).

ZEISS Mineralogic 2D and WiTec's RISE Raman system are in use in mineral research laboratories around the world answering the most challenging applications questions concerning Earth and the solar system.



Abalone shell – (A) RISE image of a polished cross-section reveals the layered structure of the nacre (mother-of-pearl). It consists of aragonite, a crystal form of calcium carbonate. (B) Raman spectra can enable the differentiation of crystal orientations (blue / red) revealing the anisotropy of the aragonite phase



Iron mineralogy – (A) In the SEM image a piece of hematite (Fe_2O_3) shows some structural characteristics. (B) Hematite and goethite ($FeO[OH]$) in several crystal orientations were identified from their Raman spectra. Crystal forms of hematite are depicted in red, green, orange and pink; those of goethite in light blue and cyan. From the spectra, a Raman image was generated. (C) Correlation of Raman and SEM data resulted in the RISE image.

Expand Your Possibilities

› In Brief
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› **Systems**
› Service

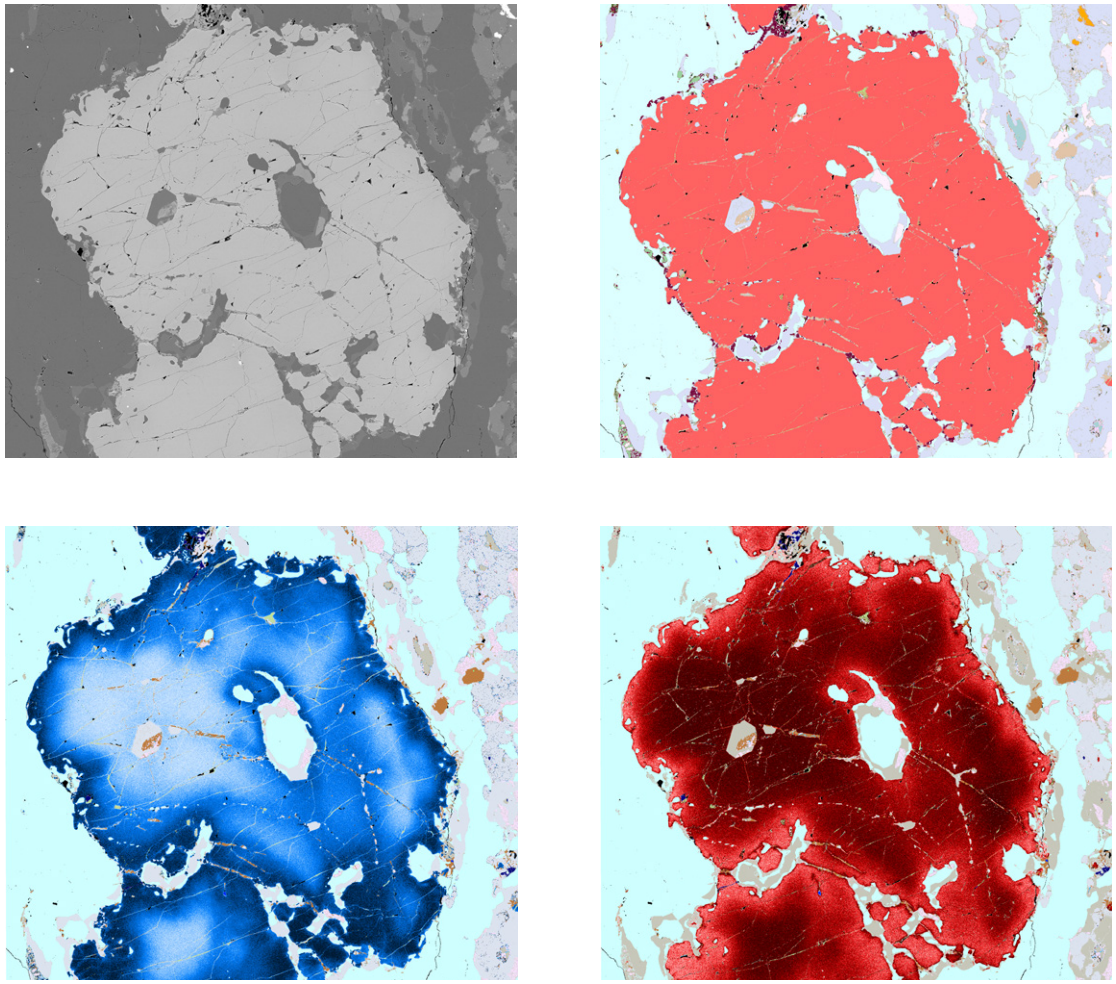
Integrate EDX, WDX and µ-XRF
ZEISS Mineralogic 2D allows you to combine EDX and WDX data in a single application for maximum flexibility. Spatial data correlation is automatically guaranteed.

Mineralogic 2D offers the choice of Bruker or Oxford detectors and fully licensed Esprit or Aztec software. This allows the system to be used for standalone SEM-EDX work, imaging, and quantitative automated mineralogy.

Upgrade your SEM with WDX or µXRF and experience a completely integrated EDX-WDX-µXRF analytical SEM.

WDX extends your analytical detection limit to 10 ppm and allows precise assigned mineral compositions to be inserted into Mineralogic 2D for probe-quality measurements.

µXRF provides rapid bulk elemental quantification and high sensitivity, particularly of heavy elements, down to 10 ppm. SEM – µXRF removes the need for a standalone uXRF system.



Zoned garnet from Glenelg, Scotland. The geochemical variation charts the rapid burial of these rocks to higher pressures. Making multiple observations from a single SEM dataset streamlines geological research.
Clockwise from top left, BSD image, Mineralogic 2D mineral map, Fe concentration map, and Ca concentration map.

Expand Your Possibilities

› In Brief
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› **Systems**
› Service

Correlation to LA-ICP-MS

ZEISS Mineralogic 2D includes a correlative workflow between the automated quantitative mineralogy system and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). ZEISS and ESI have collaborated to provide a seamless automated workflow between ZEISS Mineralogic 2D and the laser ablation system that incorporates a common correlative sample holder. Use the standards-based analyses from Mineralogic 2D for mass balance and simply select your ICP-MS system of choice to experience trace element detection levels with complete confidence in the location of your laser spot.

Take the output of the LA-ICP-MS and insert trace element concentrations of minerals directly into Mineralogic 2D to automatically report trace element assay.

Applications include indicator mineral searching for mineral exploration, zircon dating for geochronology, and quantification of refractory gold in deportment studies.

ESI Lasers NWR213 *ablation laser accepts direct outputs from ZEISS Mineralogic 2D. With a spot size of 4 µm, this Nd:YAG laser has a repetition rate of 20 Hz and is ideally suited to analyze earth science samples from hard rock ores to zircons and beyond.*

For further information, scan this QR code to download our correlative white paper using LA-ICP-MS

Expand Your Possibilities

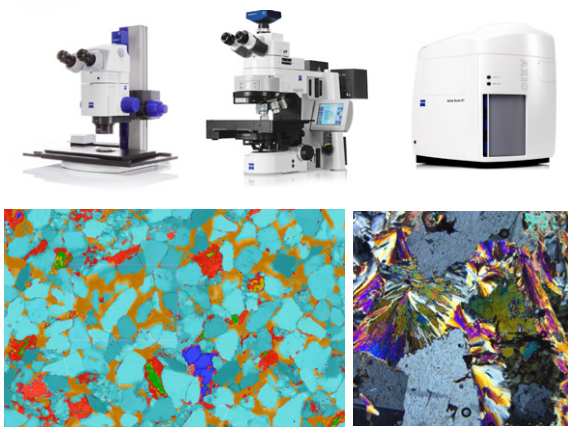
› In Brief
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› **Systems**
› Service

ZEISS Mineralogic Portfolio for Natural Resource

From field-deployable to lab-based high-resolution analysis, and widefield to nanoscale market leading contextual analysis, ZEISS offers you the widest range of imaging solutions for natural resources.

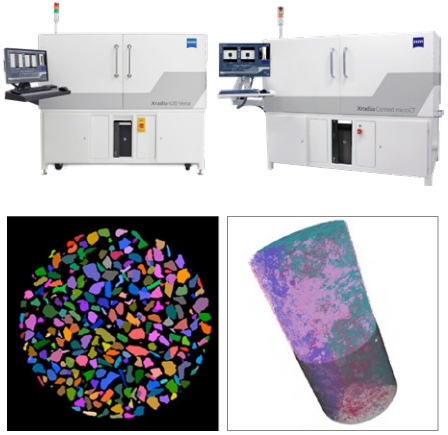
Choose from light, X-ray, electron, and ion microscopes to yield the most information from your mineralogy samples.

Automated Petrography



Leading with Machine Learning

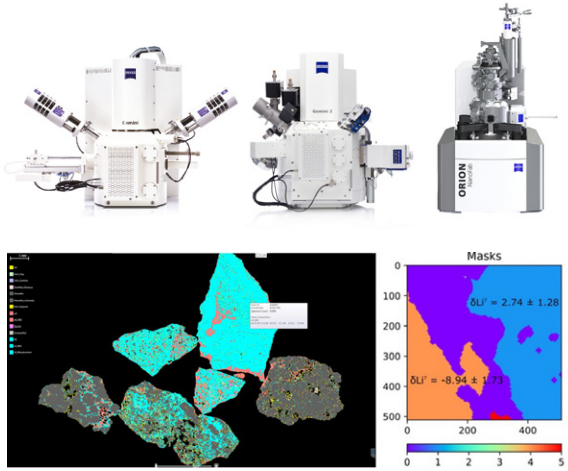
3D Ore Knowledge



Leading with Deep Learning Algorithms

Petrology / Geochemistry

Isotope Chem



Market Leading Analytical Resolution

System Requirements

› In Brief
› Mineralogic 3D (XRM)
› Mineralogic 2D (SEM)
› **Systems**
› Service

Mineralogic 2D

Scanning Electron Microscope choices	ZEISS GeminiSEM	ZEISS Sigma FE-SEM	ZEISS EVO CSEM
Detector Options		Oxford Ultim Max or Bruker EDS detectors	
Software Required		Mineralogic 2D	
Recommended Option		Second EDS detector	

Mineralogic 3D

X-ray microscope selections	ZEISS Xradia Versa 510, 610, 620	ZEISS Xradia Context microCT	ZEISS Xradia CrystalCT
Detectors	Flat panel extension (FPX) 4x (optional)	Flat panel included	Flat panel included
Software Required		Mineralogic 3D; DeepRecon Pro; Scout-and-Scan; ZEN Intellesis	
Software (optional)		ORS Dragonfly Pro	

X-ray system feature compatibility	Max Power	Flat Panel (FPX)	Objective Detectors	Mineralogic 3D	Autoloader	Automated Filter Changer
Xradia Context microCT	10W	Included	N/A	Compatible	Compatible	No
Xradia 510 Versa	10W	Option	Default	Compatible	Compatible	No
Xradia 610 Versa	25W	Option	Default	Compatible	Compatible	No
Xradia 620 Versa	25W	Option	Default	Compatible	Compatible	Yes

ZEISS Service – Your Partner at All Times

Your microscope system from ZEISS is one of your most important tools. For over 170 years, the ZEISS brand and our experience have stood for reliable equipment with a long life in the field of microscopy. You can count on superior service and support - before and after installation. Our skilled ZEISS service team makes sure that your microscope is always ready for use.

Procurement

- Lab Planning & Construction Site Management
- Site Inspection & Environmental Analysis
- GMP-Qualification IQ/OQ
- Installation & Handover
- IT Integration Support
- Startup Training

Operation

- Predictive Service Remote Monitoring
- Inspection & Preventive Maintenance
- Software Maintenance Agreements
- Operation & Application Training
- Expert Phone & Remote Support
- Protect Service Agreements
- Metrological Calibration
- Instrument Relocation
- Consumables
- Repairs

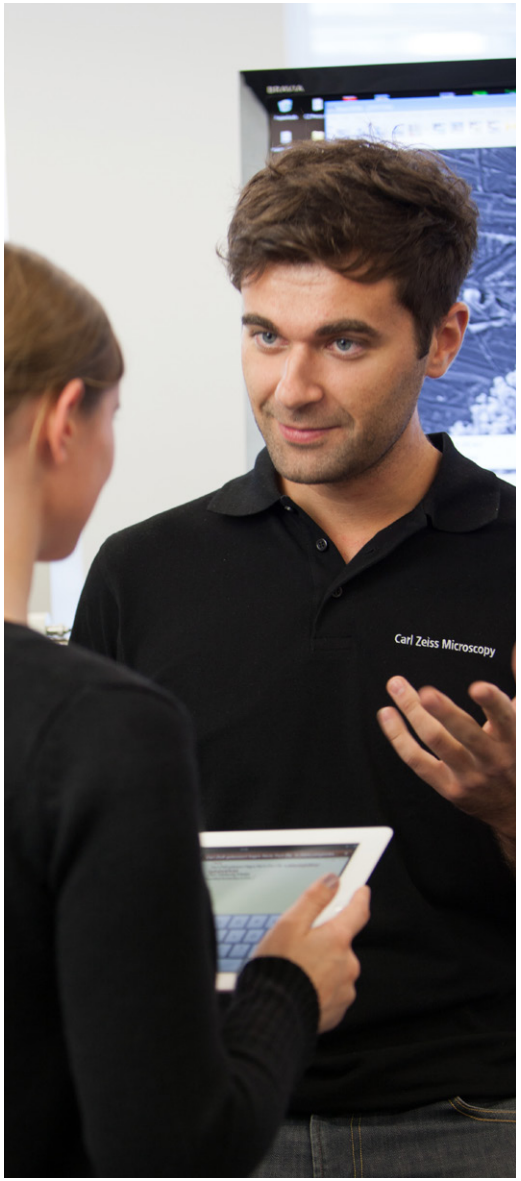
New Investment

- Decommissioning
- Trade In

Retrofit

- Customized Engineering
- Upgrades & Modernization
- Customized Workflows via APEER

Please note: Availability of services depends on product line and location



>> www.zeiss.com/microservice

Carl Zeiss Microscopy GmbH
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/mineralogic

EN_42_011_135 | CZ 02-2022 | Release 4.2 | Design, scope of delivery and technical progress subject to change without notice.