

HITACHI

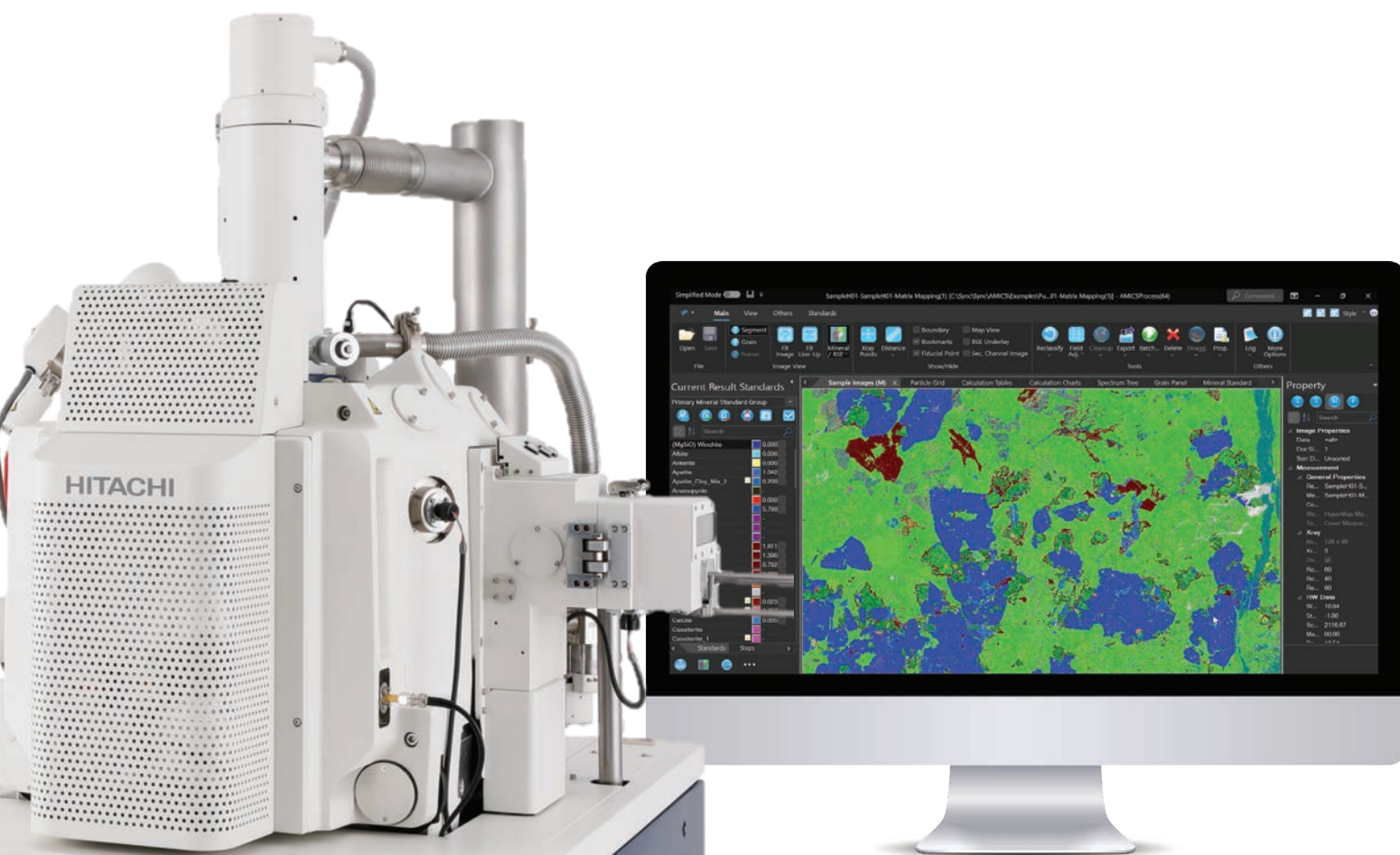
AMICS

Advanced Material Identification and Classification Systems

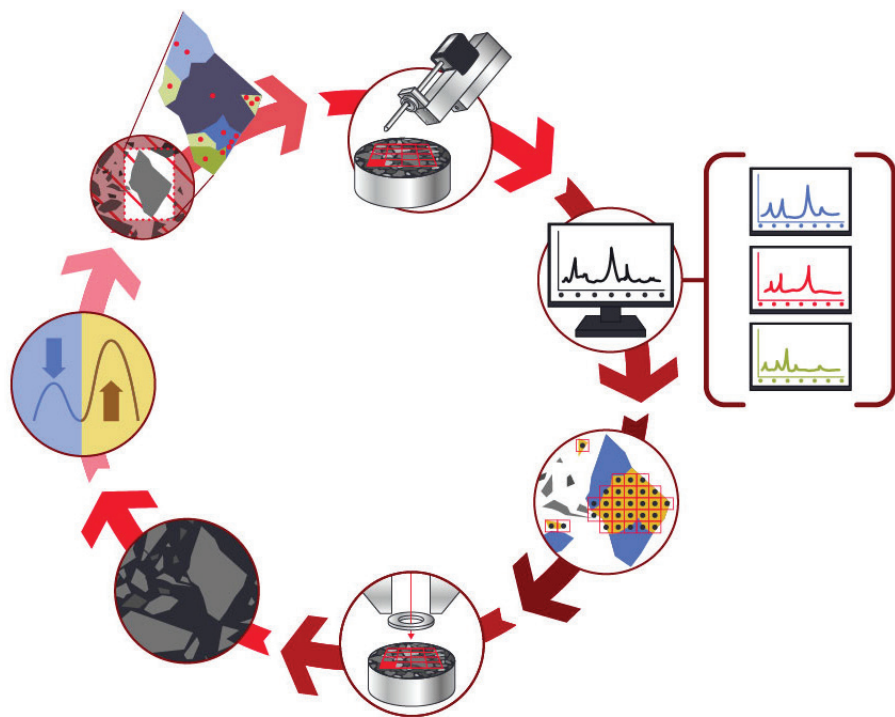


AMICS Key Features

- Extremely flexible automated mineralogy or automated materials characterization system.
- A tool, not a method. AMICS won't lock you into a specific workflow, data collection setting, or classification approach.
- Innovative classification system enables the discrimination of close phases.
- Designed for high throughput to maximize high-resolution sample characterization.
- Cloud-ready, flexible, and open-source data formats with python scripting.
- Advanced reporting and visualization tools.



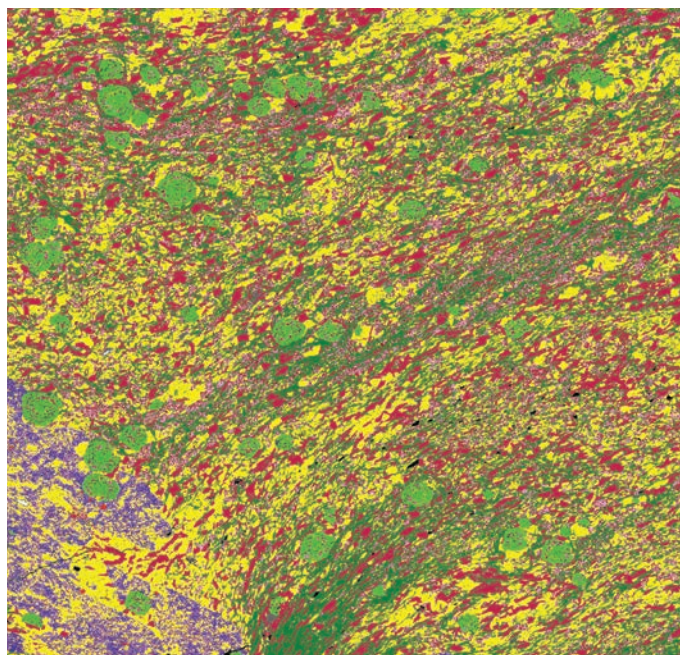
Automation Platform for Large Area Materials



Hitachi High-Tech and Bruker Nano Analytics have partnered to develop AMICS automated mineralogy and materials characterization system. AMICS is an end-to-end hardware, software, and service system focused on maximizing sample throughput for every analytical challenge by increasing specimens per-run, optimizing analytical placement and valid counts. The close integration between the Bruker Xflash® 7 EDS and Hitachi SEM bring unparalleled advantage to automated characterization workflows.



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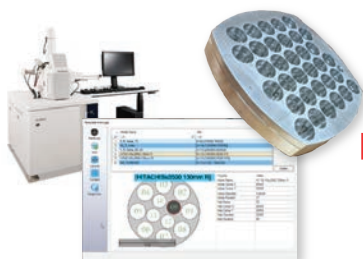
Quartz	Staurolite	Apatite
Plagioclase	Other Clays	Heavy Minerals
Illite/Muscovite	Amphiboles	Chlorite
Mica	Fe-oxides	



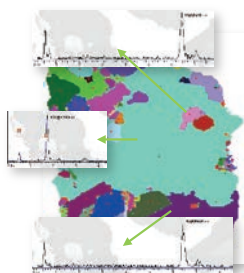
AMICS includes a special multi-specimen holder designed for the selected SEM.

The Unified AMICS System

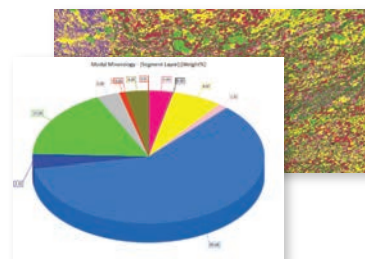
Automated Data Collection



Spectrum Classification



Visualize and Quantify



Bruker 760 EDS

The AMICS hardware package gain up to 1,000 kcps output counts per-channel. AMICS + XFLASH® 7 is the fastest data collection in any mode. Bruker's Slimline™ technology allows for the best angle for unpredictable samples, enabling optimum beam conditions and minimizing background and sample damage.



Tungsten Systems



FlexSEM 1000 II

A powerful SEM in a small package, the FlexSEM 1000 II has excellent imaging (4 nm resolution at 20 kV) and can accommodate 4x30mm rounds in the custom AMICS holder.



SU3900

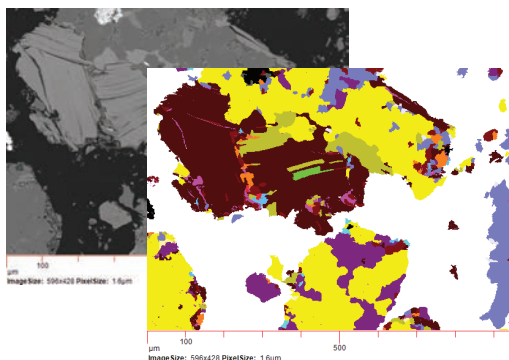
Large chamber and high throughput are the mantra of the SU3900. With 150 mm x 150 mm stage travel the system can accommodate 33 x 25 mm rounds. When packaged with dual 60 mm² EDS this is a system designed for high throughput.

AMICS Investigator

- Full measurement automation with 10+ measurement modes.
- Custom holders and custom holder designer.
- Measurement templates with all measurement setting.



AMICS Process



- Differentiate close phases with whole spectrum best match algorithm, spectrum tree classification, or any combination.
- Easily expandable database with over 25,000 entries included.
- Matrix-matched full spectrum quantification by x-ray, grain, or material for real elemental values.

Field Emission Systems



SU3900 SE

The SU3900 SE is an easy-to-use and affordable Schottky FEG SEM with 150 x 150 mm stage travel and excellent resolution (1.2 nm @ 30 kV). It is built on the same chamber as the SU 3900 tungsten with up to 33 x 25 mm rounds or 23 x 30 mm rounds and up to 15 thin sections.

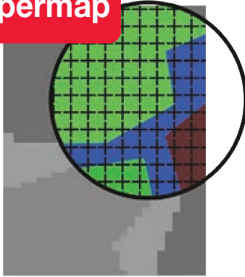


SU7000

The Hitachi SU7000 combines the high-throughput automation of AMICS with the ultimate in imaging and resolution. A 135 x 100 mm stage travel enables 23 x 30mm rounds. It's advanced electron optics provide 0.8 nm resolution at 20 kV and 20 to 2000x magnification.

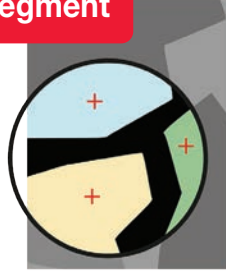
Classic Mapping Modes

Hypermap



Continuous simultaneous BSE and EDS for fast mapping.

Segment



Frame-based image segmentation for EDS placement.

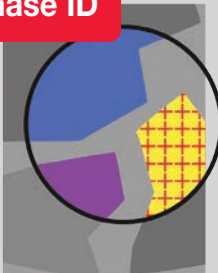
Matrix



Grid-based EDS placement after removal of background.

Trigger Mapping Modes

Phase ID



Triggers are a new and exciting way to characterize a sample. Switch between segment mode and matrix mode based on the material identified, elemental concentrations, or the segment size. The segment size trigger can be used to place a matrix grid over large particles to identify rims or inclusions or cover an area of small segments for mapping of fine-grained areas. Rare phase search can also map only the areas that meet a BSE image rage trigger. Each measurement mode can have multiple triggers and each can independently set the matrix spacing and dwell time.

Grain Size



BSE



Element

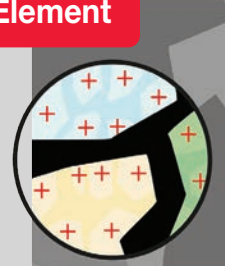
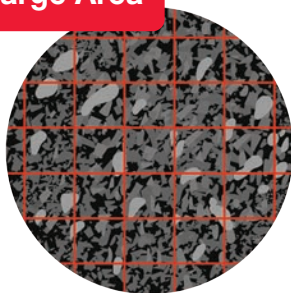


Image Modes

Large Area



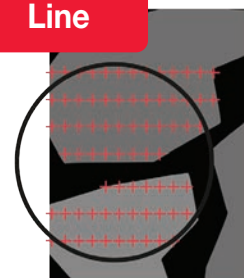
Large area mapping with image stitching.

Multi-channel



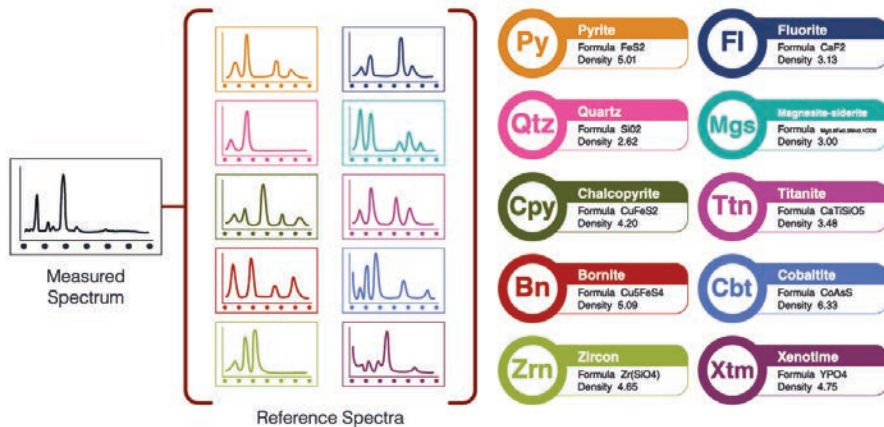
Simultaneous collection of multiple image channels.

Line



High-quality imaging with “quick-look” line mapping.

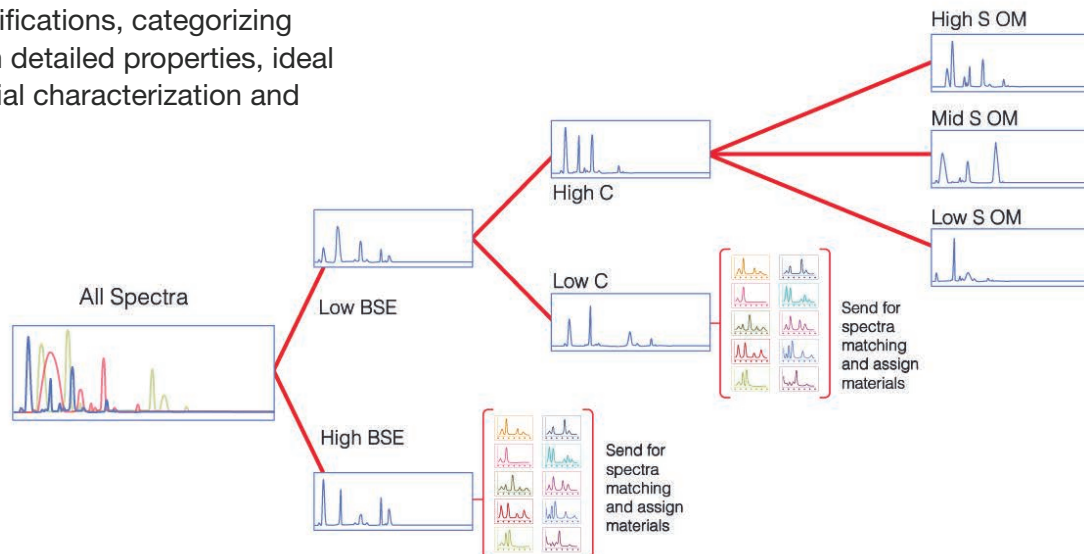
Whole Spectrum Best Match



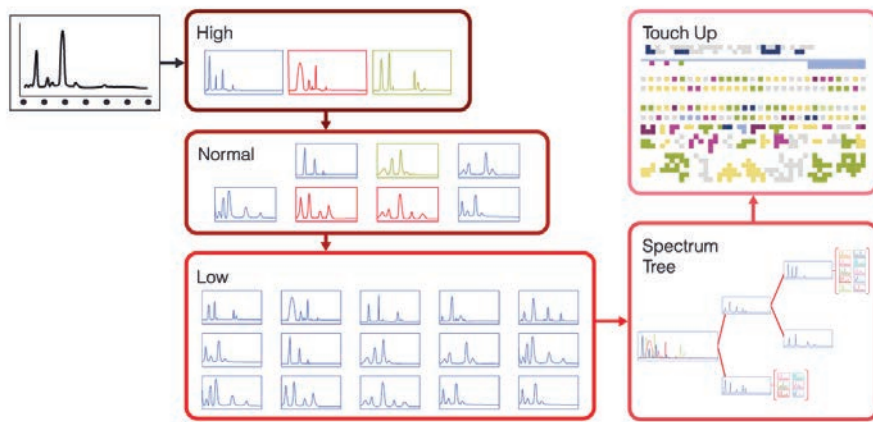
Enhances accuracy by using the complete spectrum compared to all reference spectra to differentiate closely related phases, which is crucial for complex mineral matrices.

Spectrum Tree Rules-based Classification

A sophisticated tool designed for challenging classifications, categorizing spectra based on detailed properties, ideal for precise material characterization and splitting phases.

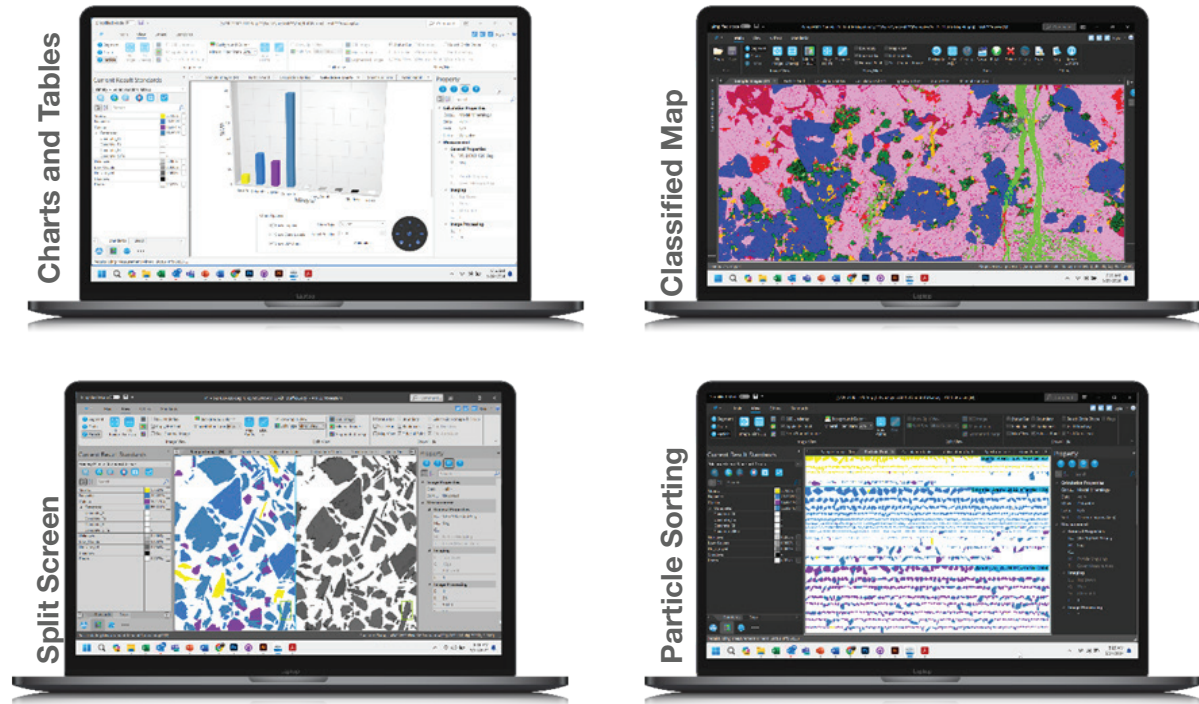


Hierarchical Classification



AMICS offers up to eight methods, including reference spectra matching, elemental composition analysis, and principal component clustering, providing flexibility across various applications.

Visualization and Data Exploration

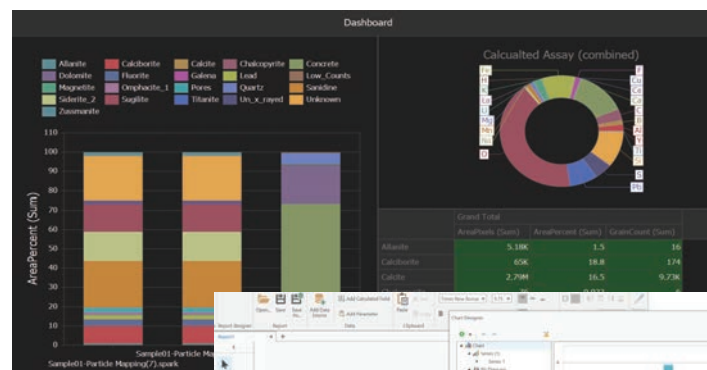


- With one click or keyboard shortcut switch between classified maps, BSE (primary) image and secondary images (SE, UVD), or elemental maps.
- Highly customizable display with background BSE, particle or grain sort, and split mode.
- Visualization and reporting directly access the AMICS file format with no need to push to an external server or database.

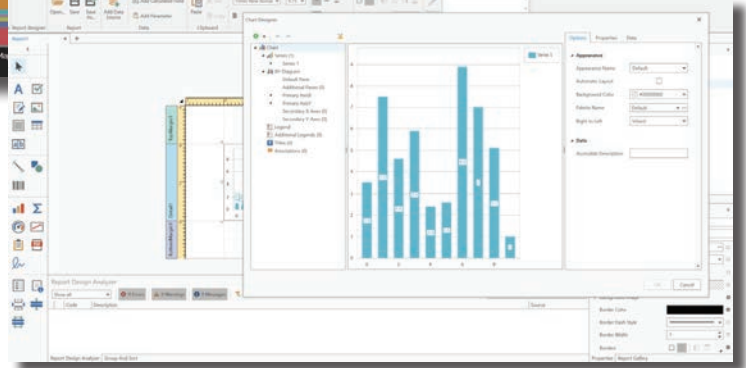
Calculations

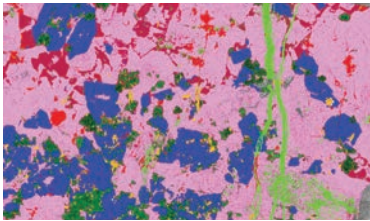
- Modal Material Content
- Calculated Assay
- Elemental Distribution
- Particle Size Distribution
- Grain Size Distribution
- Material Size Distribution
- Destiny Distribution
- Association.
- Material Grade Recovery
- Elemental Grade Recovery
- Locking
- Liberation
- Free Surface Liberation
- Grain & Particle Properties
- Quantified grains and materials

Customized Report Designer



AMICS Reports can be distributed to end users allows for any custom dashboard or report in many export formats.

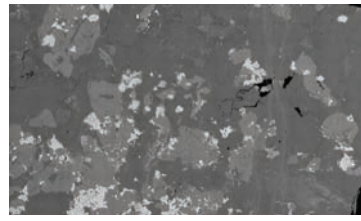




Classified Map



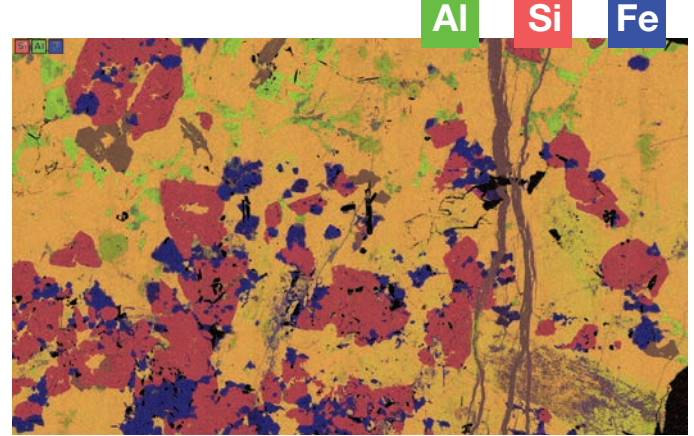
CL Mosaic



BSE Mosaic



Single Element Focus



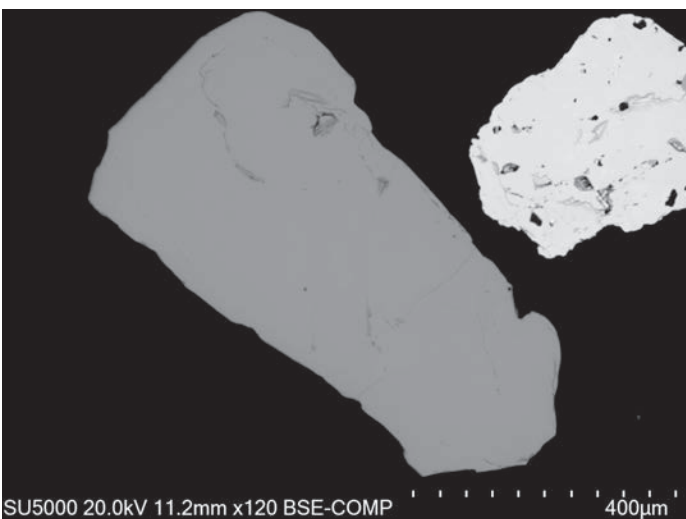
Multi-element Overlay



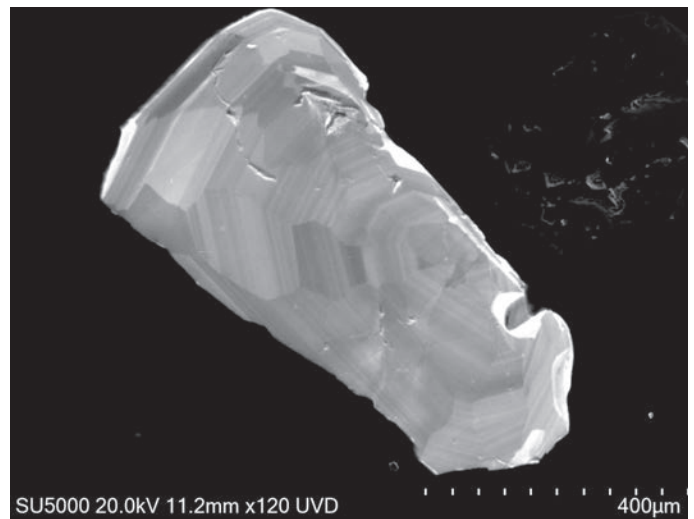
Mirror Mode



Continue Mode



SU5000 20.0kV 11.2mm x120 BSE-COMP 400µm
BSE Image



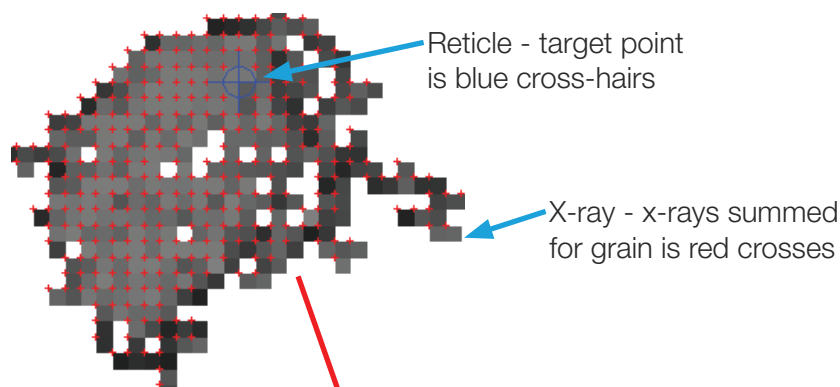
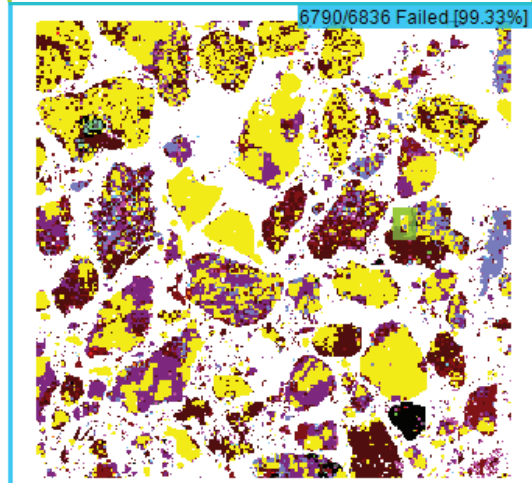
SU5000 20.0kV 11.2mm x120 UVD 400µm
UVD (CL) Image

Applications



1. Indicator mineral mapping and quantification
2. Ground truth for hyperspectral remote sensing
3. Core characterization for discovery and assessment
4. Mine planning and input to digital twin and block models
5. Blast design and optimization
6. Stockpile mixing and blend optimization
7. Optimization of crushing and size reduction
8. Hydro metallurgy process condole and optimization
9. Smelting quality control and steel cleanliness
10. Prediction of Acid Mine Drainage (AMD)
11. Incoming materials quality assurance for Cathode Active Material (CAM)
12. Cathode sheet quality control and contaminant assessment
13. Mission critical and space certified material design
14. Concrete inspection and concrete disease diagnoses
15. Modern mudlogs for oil and gas, hydrothermal, or carbon capture and underground storage (CCUS)
16. Atomic and advanced materials design and quality assurance
17. Rare earth magnets supply chain for electric motors and generators
18. Battery end of life, recycling, and metals recovery

Mineral Exploration and Grain Quantification

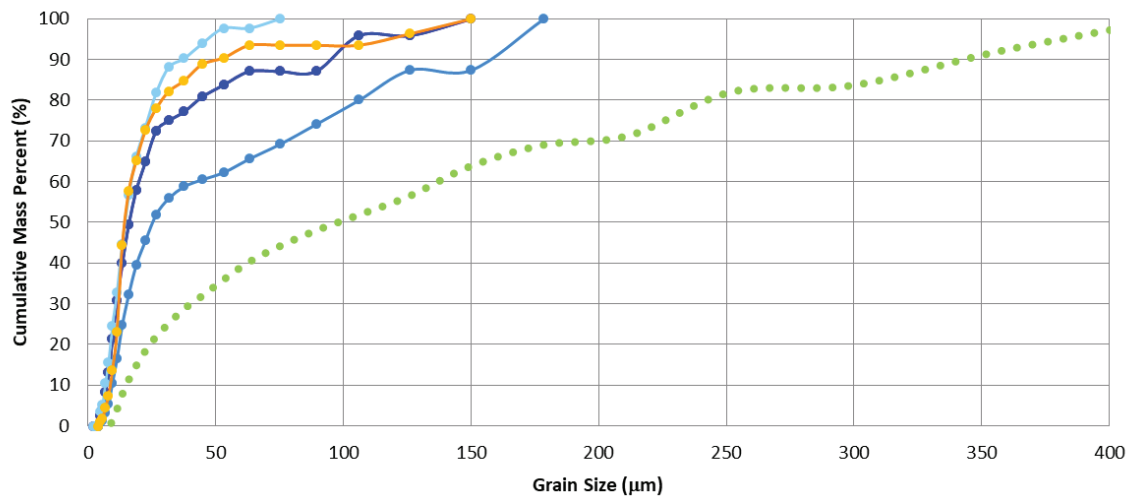


- Specially designed system for indicator mineral workflows or grain quantification and the targeting of points for analysis in LA-ICP-MS or EPMA.
- Capture fiducial points to coordinate across systems.
- Design, save, and apply filters to only target grains of the target mineral(s) that are large enough for downstream analysis.
- Quickly sort, line up, and quality check selected grains, including viewing split/screen to compare mineral map, BSE, SE, or UVD (CL).
- Reposition reticle to ideal positioning and define custom output for export, including column order and grain names.
- Quantify selected grains with either standards-based or standardless quantification. Select how x-rays are combined within the grain.
- Combine all x-rays identified as a selected mineral and quantify with standardless or standards-based quantification method specific to the mineral.

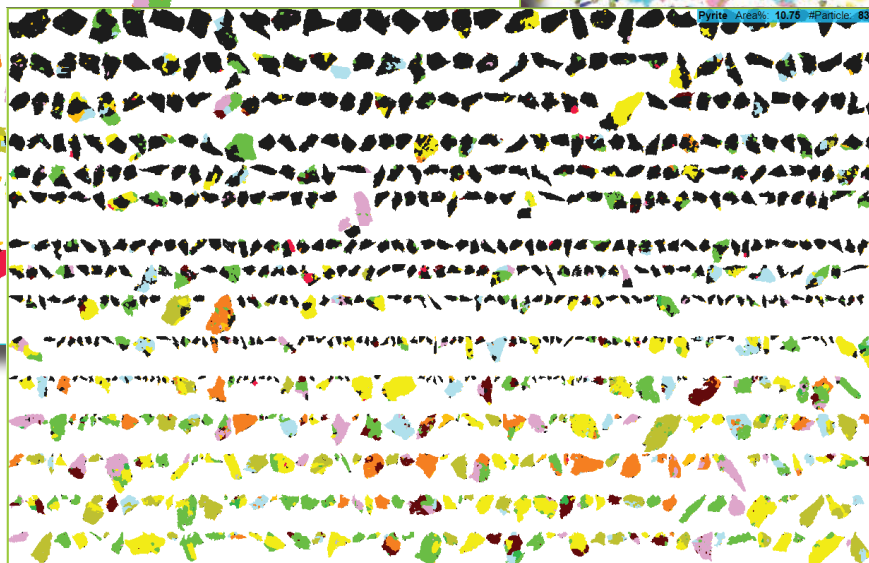
Grain Meta-data Quantified Results

Quantification Result															
	Center Po...	Center Re...	Shap...	Area...	BSE(...	Xrays	Total ...	O	Si	K	Fe	Al	Cu	Sn	
1	895, 110	0.00, 0.00	1.17	169	183	1	9817	48.35	39.55	2.14	9.96	0.00	0.00	0.00	
2	973, 123	0.00, 0.00	1.17	169	137	1	8810	45.13	34.48	3.49	10.56	2.37	3.97	0.00	
3	947, 136	0.00, 0.00	1.17	169	143	1	8330	45.55	35.46	3.48	15.51	0.00	0.00	0.00	
4	1459, 136	0.00, 0.00	1.17	169	127	1	10005	50.40	44.23	0.00	0.00	0.00	0.00	5.37	
5	1259, 175	0.00, 0.00	1.17	168	130	1	10074	53.26	46.74	0.00	0.00	0.00	0.00	0.00	
6	370, 188	0.00, 0.00	1.17	169	124	1	9684	51.15	44.89	0.00	0.00	0.00	0.00	3.95	

Mineral Processing and Particle Analysis



Chalcopyrite Particle Grid

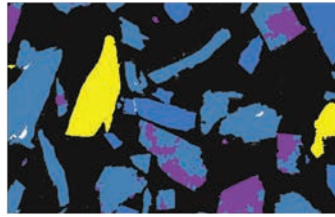


Pyrite Particle Grid

Backscatter Electron (BSE)



Classified False Color



Particle



Grain



- Advanced particle analysis, mineral liberation, and bright phase search included standard with all AMICS versions.
- All mineral processing canalizations include locking and liberation, mineral grade recovery, and elemental grade recovery.
- Calculate mineral liberation using both traditional and free surface methods.
- All standard calculations including particle size distribution, density distribution, modal, and calculated assay.
- Fully customizable report layouts including headers, footers, tables, and charts.
- All data in open-source and fully accessible file formats or exports, including raw data can calculation results.

All Features(702)

Select All Un-sel. All Export Show (M) Mark Drive To Selected

ID	X	Y	W	H	Pi...	Ar...	W...	A...	P...	S...	Image	Minerals	Elements	Al	B	C	C
1	0	-7...	-3...	53...	46...	533	16...	15...	2.85	3	0.99	Calcibori...	O(50.92)...	0.00	17...	0.00	3
2	1	-7...	-3...	47...	19...	224	70...	55...	2.47	3	1.06	Sanidine...	O(46.66)...	9.84	0.00	0.00	0
3	2	-7...	-3...	63...	42...	539	17...	13...	2.50	4	0.93	Sanidine...	O(46.66)...	9.84	0.00	0.00	0
4	3	-7...	-3...	35...	23...	104	32...	20...	2.00	2	1.04	Unknow...	-	0.00	0.00	0.00	0
5	4	-7...	-3...	67...	21...	352	11...	89...	2.54	3	0.99	Sugilite...	O(46.43)...	1.26	0.00	1.81	0
6	5	-7...	-3...	81...	47...	808	25...	26...	3.30	2	1.00	Omphaci...	O(41.11)...	0.00	0.00	0.00	1
7	6	-7...	-3...	63...	42...	672	21...	13...	2.00	3	1.05	Unknow...	-	0.00	0.00	0.00	0
8	7	-7...	-3...	60...	74...	10...	31...	20...	2.00	2	0.94	Unknow...	-	0.00	0.00	0.00	0
9	8	-7...	-3...	11...	53...	11...	36...	33...	2.90	4	0.93	Zussma...	O(41.73)...	1.26	0.00	0.00	0
10	9	-7...	-3...	49...	14...	120	37...	24...	2.00	2	1.03	Unknow...	-	0.00	0.00	0.00	0
11	10	-7...	-3...	67...	72...	997	31...	32...	3.24	4	0.90	Fluorite...	Ca(39.50)...	0.00	0.00	2.39	3
12	11	-7...	-3...	40...	49...	419	13...	15...	3.70	4	0.96	Siderite...	Fe(43.42)...	0.00	0.00	10...	0
13	12	-7...	-3...	63...	97...	11...	35...	28...	2.52	5	0.89	Sanidine...	O(46.72)...	9.16	0.00	0.00	0
14	13	-7...	-3...	76...	23...	393	12...	78...	2.00	2	1.07	Unknow...	-	0.00	0.00	0.00	0
15	14	-7...	-3...	40...	26...	133	41...	33...	2.48	3	0.83	Sanidine...	O(46.66)...	9.84	0.00	0.00	0
16	15	-7...	-3...	19...	21...	70	22...	20...	2.88	1	1.08	Calcibori...	O(50.92)...	0.00	17...	0.00	3
17	16	-7...	-3...	35...	47...	355	11...	77...	2.18	3	1.05	Sugilite...	O(47.48)...	1.53	0.00	0.00	0
18	17	-7...	-3...	23...	10...	60	18...	14...	2.45	3	1.25	Sugilite...	O(47.48)...	1.53	0.00	0.00	0
19	18	-7...	-3...	39...	23...	147	46...	37...	2.52	3	0.91	Sugilite...	O(47.48)...	1.53	0.00	0.00	0

Granular Properties

Granular Tag 10 / 702

Frame ID 1 / 4

Granular Size 38 x 41 (pixels)

SEM Position -76792, -31648

Phase Count 1

Shape Factor 0.90

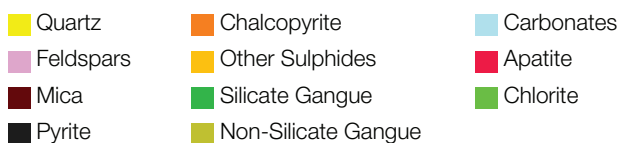
Granular Composition

Area Info 4(M); 997(P) ;314...

Fluorite 00778 pixels (...)

Siderite_2 00187 pixels (...)

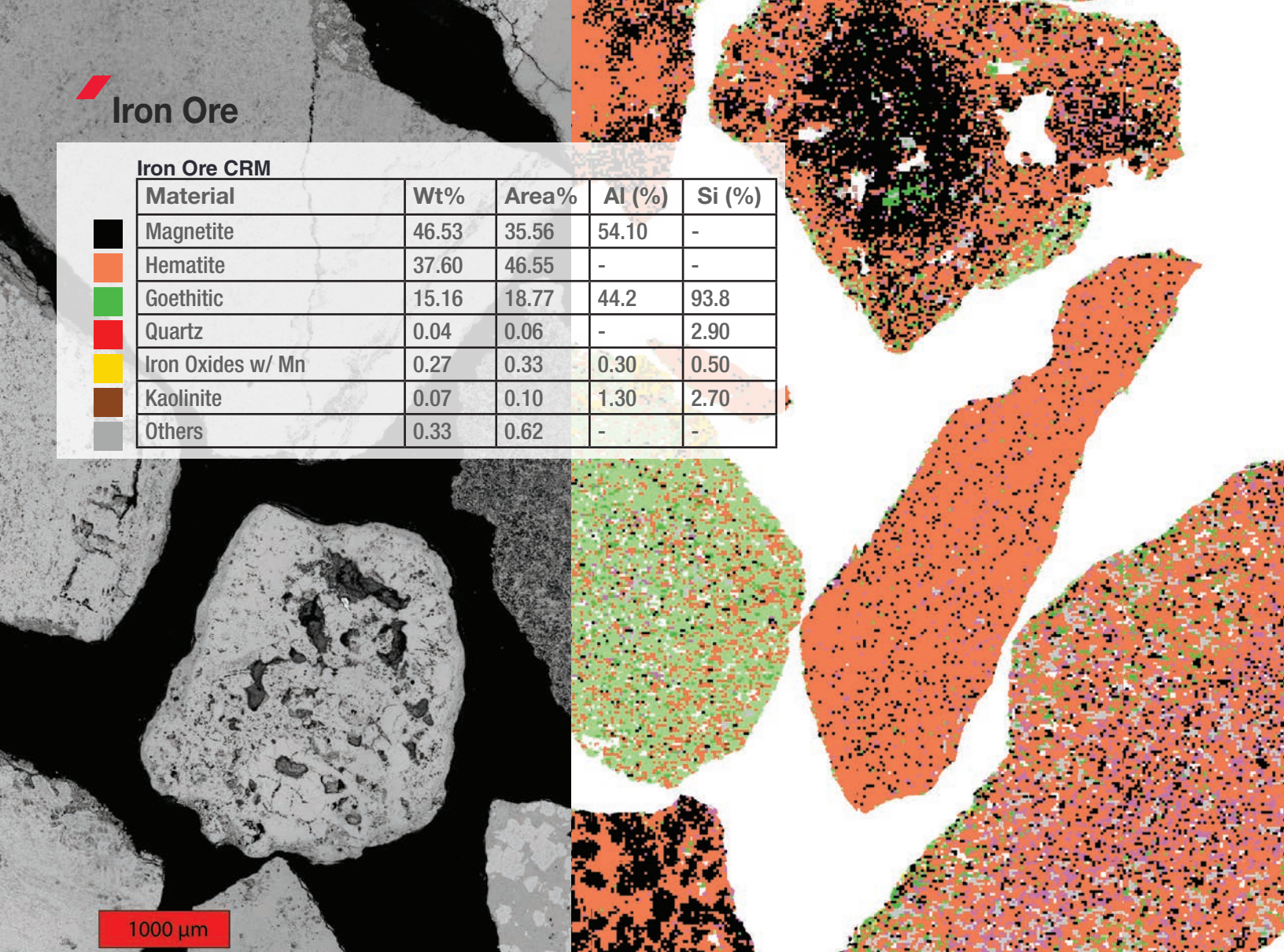
Unknown 00021 pixels (...)



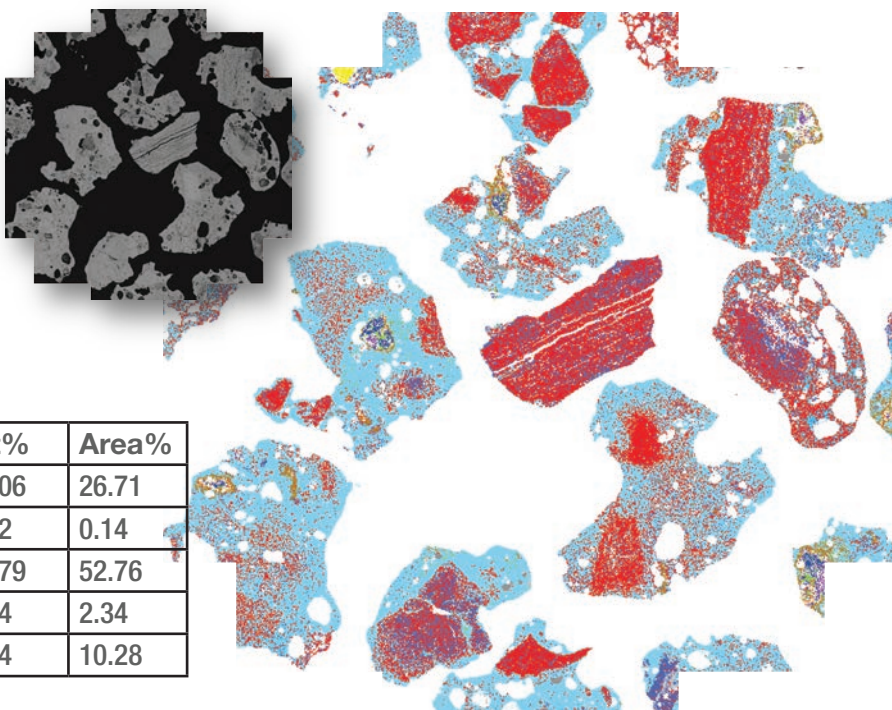
Iron Ore

Iron Ore CRM

Material	Wt%	Area%	Al (%)	Si (%)
Magnetite	46.53	35.56	54.10	-
Hematite	37.60	46.55	-	-
Goethitic	15.16	18.77	44.2	93.8
Quartz	0.04	0.06	-	2.90
Iron Oxides w/ Mn	0.27	0.33	0.30	0.50
Kaolinite	0.07	0.10	1.30	2.70
Others	0.33	0.62	-	-



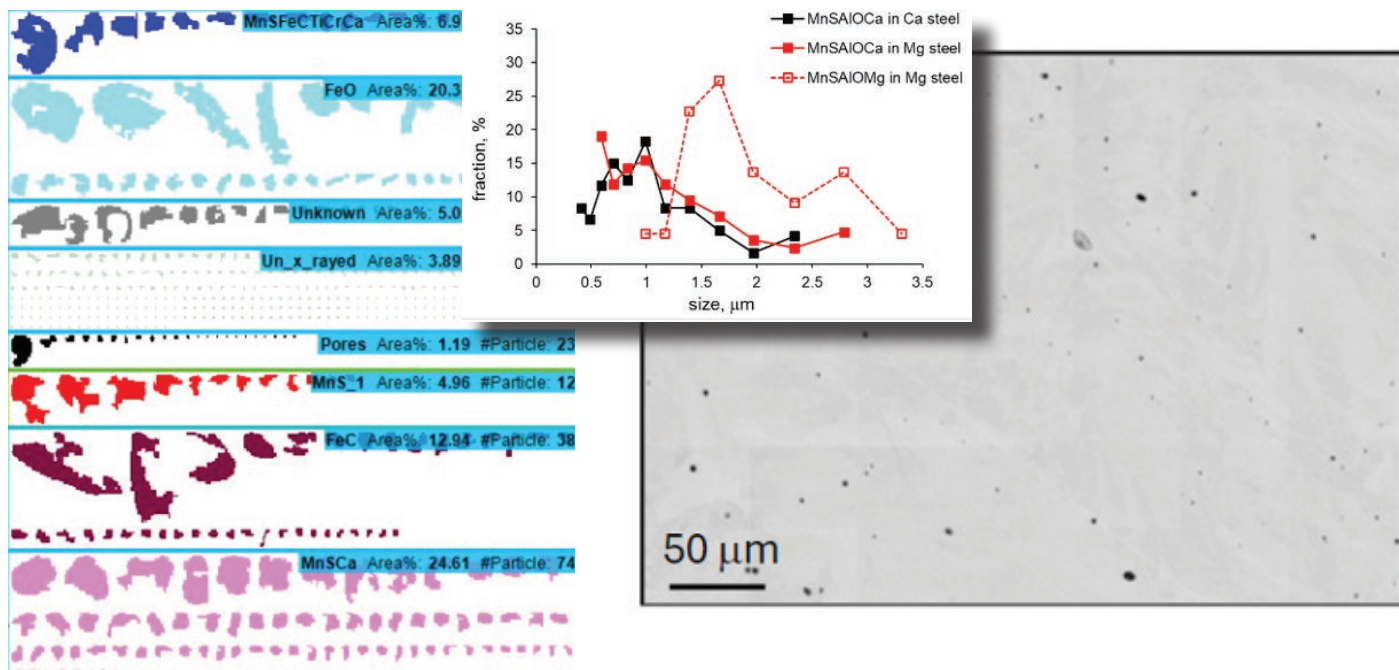
- Separate close iron-oxide phases with precision.
- Automatically classify material types with rules-based particle classification.
- Apply matrix-matched quantification methods for each phase.



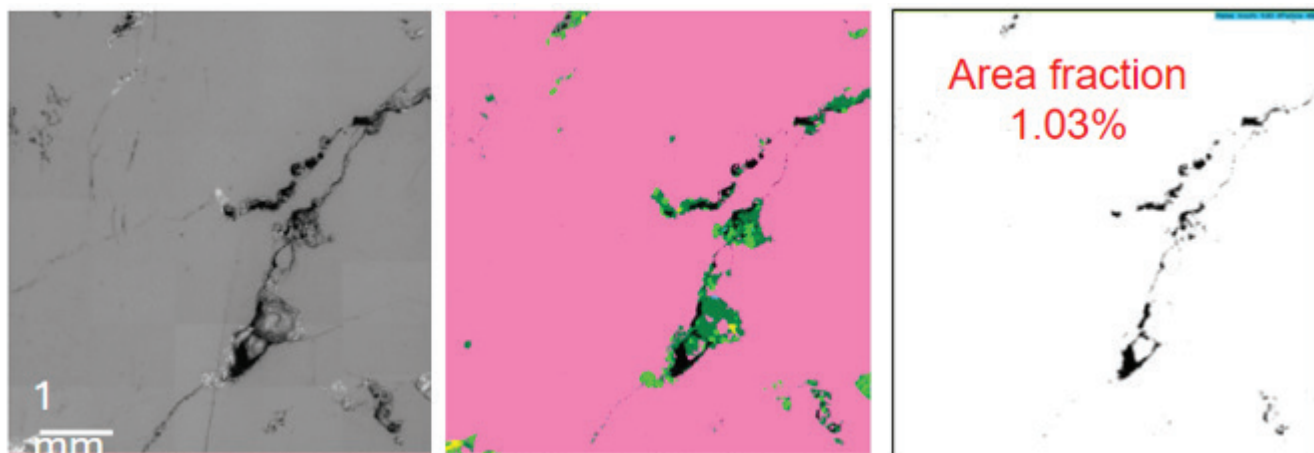
Sinter (iron ore by-product)

Material	Wt%	Area%
Iron Oxides	38.06	26.71
Iron Oxide (Mg-rich)	0.12	0.14
SFCA	43.79	52.76
SFCA (Ca-rich)	1.94	2.34
SFCA (Si-rich)	8.54	10.28

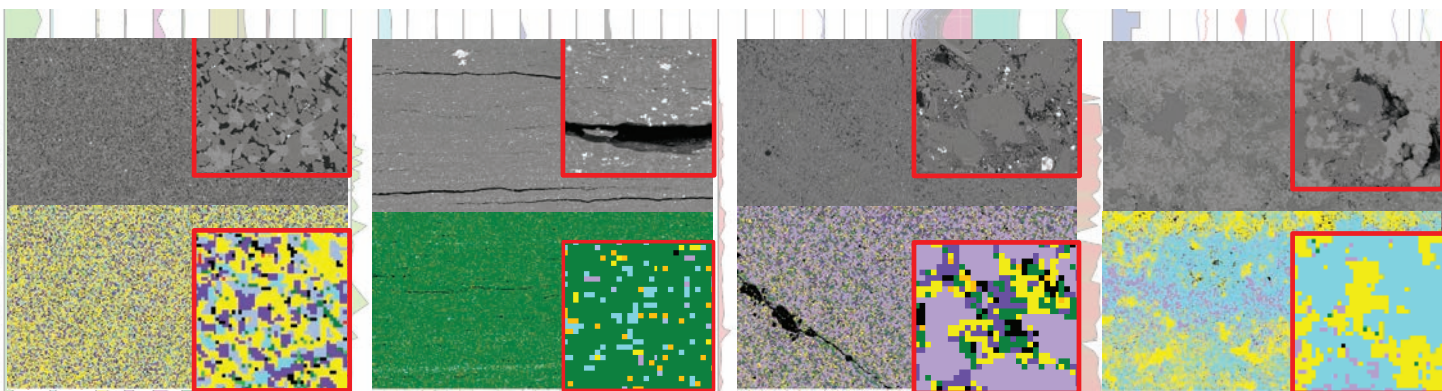
Metals Cleanliness



Pore Analysis



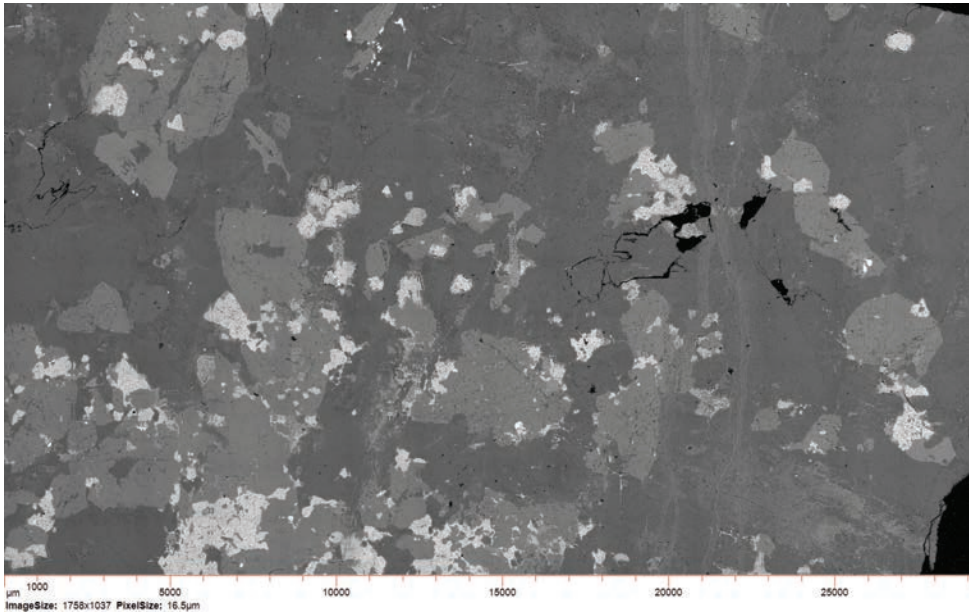
Reservoir Characterization





AMICS Specifications

Item	AMICS Compact	AMICS Standard
Comparable SEM(S)	FlexSEM 1000, FlexSEM 1000 II, and TM Series on request and meeting minimum req.	SU3800, SU3900, SU3900 SE, SU5000, SU7000, and other full-size SEM on request.
EDS System Throughput	250,000 CPS	1,000,000 CPS
Online SEM Licences	One	One
Offline Workstation Licences	Paid Upgrade	Two
Holder Designer	Limited	Yes and custom holder fab options.
Navigation Images	Yes	Yes
Material Database Entries with Simulated Spectra	2,000	30,000
User simulated spectra in matching.	No	Yes, background simulated with Monty Carlo simulation
Elemental Visualization	No	Net counts or peak-height
Standard Mapping Modes	Hypermap, segmentation, matrix, hybrid triggers, rare phase search (bright phase search), large area imaging, multi-modal imaging. Triggers: element present, element concentration, material match, BSE, segment. BSE stability system. Project management system and measurement template system.	
Classification	Whole spectrum best match with matching limits for peak height, BSE values, and ratios. Spectrum tree with peak height range, BSE range, peak height ratios, matching limits, and principal components cluster. Batch classification. Manual assignment. Rules-based particle classification. Advanced mixing (solid solution) with 2 or 3-phase mixtures.	
Calculations and Reports	Modal mineral, calculated assay, elemental distribution, size distribution, object (segment, grain, particle, frame) size distribution, density distribution, association, material and elemental grade recovery, locking, liberation, free surface liberation, grain and particle properties. Custom report layouts. Batch reporting. Advanced grouping.	



Phase Name	Wt%	Area%
Plagioclase	45.40	51.10
Mica	9.41	9.43
Chlorite	4.69	5.01
Kaolinite/Other Clays	0.00	0.00
Ilmenite	8.62	5.36
Epidote	2.54	2.17
Garnet	0.33	0.28
Augite	22.49	19.28
Fe-Oxides	1.29	0.73
Heavy_Minerals	0.07	0.06
Apatite	1.72	1.57
Other_Minor	0.29	0.43
Undefined	3.15	4.59

Image Exports

All images can be exported as PNG, TIFF, or PNG image formats or copied to the clipboard. Export the entire image, screen, graphs, legend, or particle images. Batch export of images in batch processing work-flow.. All image layers are stored as compressed binaries in the AMICS file format and accessible with Python.

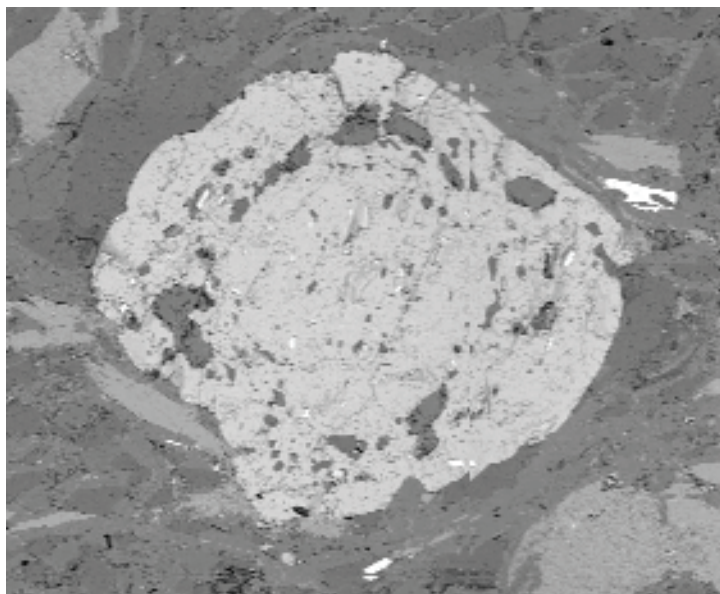
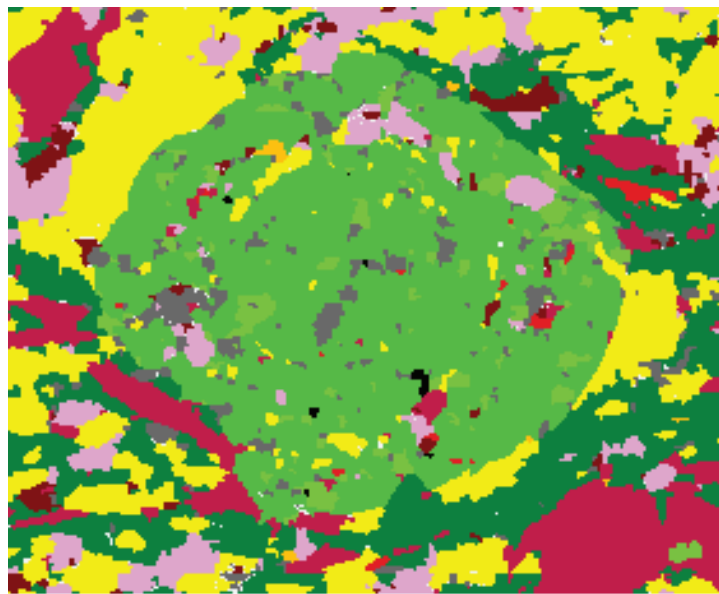
Data Export

All raw data can be exported to a SQLite database or accessed from the AMICS binary file format with Python. Classification results can be accessed and edited with the AMICS Python package. Calculation results are stored and automatically upon classification in an open-source JSON file with a published schema. Results can be exported as CSV, TXT, Microsoft Excel format, or as an Access database.



EDS Specifications

Item	FlexSEM 1000 II	SU3900	SU3900 SE	SU7000
EDS System	Bruker Compact 60mm EDS.	Dual Bruker 760 60mm EDS with Max throughput and VZ.	Dual Bruker 760 60mm EDS with Max throughput and VZ.	Dual Bruker 760 60mm EDS with Max throughput.
EDS Options	Downgrade to 30 mm	Up to 4 EDS. EBSD, WDS, Micro-XRF.	Up to 3 EDS. EBSD, WDS, Micro-XRF.	Up to 3 EDS. EBSD, WDS, Micro-XRF.
Max Input Counts Max Output Counts	1,000,000 cps 275,000 CPS	Up to 3,000,000 cps / channel User-selectable throughput up to 1,000,000 cps / channel.		
Spectral Resolution	129 eV / Channel	129 eV / channel standard. Option for 123, 126, and 129 eV		
Detector	Peltier cooled SDD	Fully field-serviceable peltier cooled SDD with option for 30mm, 60mm, or 100mm squared area.		
Solid Angle	0.0262 sr	0.0365 sr	0.0365 sr	0.0316 sr
Software	ESPRIT Compact, stage control and API.	ESPRIT Core with API, stage control, and maximum count throughput.		





SEM Specifications

Item	FlexSEM 1000 II	SU3900	SU3900 SE	SU7000
Excitation	Pre-centred cartridge type tungsten hairpin filament	Pre-centred cartridge type tungsten hairpin filament	ZrO/W Schottky Emitter	ZrO/W Schottky Emitter
Image Resolution	4 nm @ 20 kV	3 nm @ 30 kV	1.2 nm @ 30 kV	0.8 nm @ 20 kV
Magnification	6 to 300,000 X	5 to 300,000 X	5 - 600,000 X	20 - 2,000,000 X
Standard Detectors	BSE, SE	BSE, SD	TD, BSE, SE	SE & 3 BSE (U,M,L)
Optional Detectors	UVD	UVD	UVD	UVD, PD-BSED
Voltage	0.3 to 20 kV	0.3 to 30 kV	0.5 to 30 kV	0.1 to 30 kV
Max Current		150 nA	150 nA	200 nA
Chamber Size (Ø)	80 mm	300 mm	300 mm	200 mm
Stage Travel	40 x 50 mm	150 x 150 mm	150 x 150 mm	135 x 100 mm
Ports	2	20	20	18
Custom Holders	N/A	Yes	Yes	YES
30 / 25 mm rounds no rotation	N/A	23 / 33	23 / 33	8 / 12
30 / 25 mm rounds With rotation	4 / 6	28 / On Request	28 / On Request	On Request
Thin Sections	3	15	15	5
Large Format Thin Section Holder	No	On Request	On Request	On Request
EDS Elevation	25°	35°	35°	30°
Working Distance	10 mm	10 mm	10 mm	6 mm



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