



PANalytical
get insight



EPSILON 1

Accurate and safe
quantification
of rocks and ores



For the mining industry



1 H 1.008	Z Possible to analyze with Epsilon 1																2 He 4.003																	
3 Li 6.941	4 Be 9.012	Z Not possible to analyze with Epsilon 1																10 Ne 20.180																
11 Na 22.990	12 Mg 24.31	13 Al 26.98	14 Si 28.09	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948	19 K 39.098	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 51.996	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.904	36 Kr 83.80									
37 Rb 85.47	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 101.07	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29	55 Cs 132.905	56 Ba 137.33	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
87 Fr [223]	88 Ra [226]	89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu 244	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [260]	104 Rn [222]	105 At [210]	106 Po [209]	107 Bi 208.98	108 Pb 207.21	109 Tl 204.38	110 Hg 200.59	111 Au 196.97	112 Pt 195.08	113 Ir 192.22	114 Os 190.2	115 Re 186.21	116 W 183.85	117 Ta 180.95	118 Hf 178.49	119 L [173]	120 A [169]	
89 La 138.91	90 Ce 140.12	91 Pr 140.91	92 Nd 144.24	93 Pm [145]	94 Sm 150.36	95 Eu 151.97	96 Gd 157.25	97 Tb 158.93	98 Dy 162.50	99 Ho 164.93	100 Er 167.26	101 Tm 168.93	102 Yb 173.04	103 Lu 174.97																				
90 Ac [227]	91 Th 232.04	92 Pa 231.04	93 U 238.03	94 Np 237.05	95 Pu 244	96 Am [243]	97 Cm [247]	98 Bk [247]	99 Cf [251]	100 Es [252]	101 Fm [257]	102 Md [258]	103 No [259]	104 Lr [260]																				

Rocks and ores

Accurate and X-ray safe quantification

Epsilon 1 is the ideal analytical solution for bringing more accurate results closer to the mines. With its small footprint and very simple installation requirements, the benchtop instrument can be placed very close to where the analysis is needed: in the quarry or mine-site office.

With little or no sample preparation required, Epsilon 1 allows screening and accurate quantification of ores, rocks, stream-sediment samples and even blast-hole chips. Epsilon 1 is an easy-to-operate instrument with guaranteed peace-of-mind X-ray safety.

Without the need for additional chemicals or operating gasses, the system delivers superior precision compared to basic wet-chemical techniques.

The instrument is calibrated with Omnian, PANalytical's market-leading standardless analysis package, also used on the more advanced instruments. As an out-of-the-box solution, Omnian can be used to analyze a wide variety of sample compositions from sodium to americium across the periodic table.

PANalytical has a strong reputation for safe and high-end X-ray instrumentation. Epsilon 1 is built using PANalytical's market-leading technology with superior quality, worldwide service and application support.

The total solution consists of:

- An Epsilon 1 XRF spectrometer
- Factory pre-calibrated with Omnian standardless analysis software
- A validation sample
- A starting kit for preparing the first 100 loose powder samples



Epsilon 1 spectrometer



Sample preparation foils

Preparation tool

Liquid cups

Validation sample

Ready for any sample from the mines

Epsilon 1 can handle a large variety of sample types, weighing a few grams, to larger bulk samples: solids, pressed powders, loose powders, liquids, fused beads, slurries, granules, films and coatings. Also large and irregularly shaped objects with maximum dimensions of 15 x 12 x 10 cm (W x D x H) can be analyzed.

Easy sample preparation



Loose powder in disposable cup or plastic bag



Solids and irregularly shaped samples

Simple to operate



Place your sample for measurement.



Enter sample name and touch the 'measure' icon.

Convenient results viewing



Compound	Conc	Unit
Al	9.376	%
Si	38.966	%
P	4.638	%
S	0.518	%
Cl	0.103	%
K	10.179	%
Ca	11.794	%
Ti	2.613	%
V	29.6	ppm
Mn	10.622	%
Fe	302.4	ppm
Zn	2.4	ppm
As	343.7	ppm
Sr	119.0	ppm
Zr	0.323	%
Ba	7.5	ppm
Pb	194.8	ppm



Measure in your
own language
Ten most common
languages are available
for the operator:

測量
Measure
測定
Mesurer
Messung
Mesure
Zmierzyć
Medida
Измерить
Médier

Built for mining and expl

The Epsilon 1 is a fully integrated energy dispersive XRF analyzer consisting of a spectrometer, built-in computer and analysis software. Powered by the latest advances in excitation and detection technology, the Epsilon 1 is a star performer in the low-cost benchtop instrument class. A well-designed optical path, a wide range of excitation capabilities ranging from 10 to 50 kV for light and heavier elements and a highly sensitive SDD detector system contribute to the Epsilon 1's uniqueness.

- 1 Self-contained system**
Built-in computer running Microsoft Windows 7 with a powerful CPU and 120 GB hard drive ensures flexibility to store and handle thousands of results.
- 2 Repeatability for years**
A low-drift X-ray tube and a handy drift correction routine give compliant results for years without the need for time-consuming re-calibration.
- 3 Maximum sensitivity**
The thin-window Ag anode X-ray tube, designed and manufactured by PANalytical, ensures high quality and sensitivity. The selection of Ag anode material is ideal for the accurate quantification of P and S that are very common in ores, without interference of possible line overlaps in the XRF spectrum, leading to more reliable results. The 50 kV X-ray tube and generator are ideal for exciting heavier elements, resulting in faster analysis times.
- 4 Spillage protection**
In order to shield the delicate heart of the system from spillage, a protection foil is in place. In case of spillage, the foil can be replaced easily by the operator.
- 5 Economical footprint**
Compact design with a built-in computer and touch screen reduces the requirement of valuable lab space to less than 0.15 m².
- 6 Easy operation**
High-resolution (1024 x 768), 10.4" LCD touch screen for easy walk-up and operation



Advantages of XRF in mining

- Unmatched analytical precision and accuracy compared to other analytical techniques
- Quick quantification method
- Simple, fast and safe sample preparation
- Non-destructive analysis
- Wide analytical concentration range (ppm – %) reducing the necessity for dilution and associated errors



oring



7

Easy communication

USB and network connections for use of standard computer peripherals enable extended use, application development and seated operator.

8

Best accuracy

Highly concentrated samples can cause detector saturation resulting in lower accuracy or longer measuring times. Epsilon 1 uses the latest in silicon drift technology to handle these highly concentrated samples without any loss of accuracy or increased measuring times.

9

Atmospheric variations

Low-energy X-ray photons characteristic of sodium, magnesium, aluminium, silicon, phosphorus and sulfur are sensitive to air-pressure and temperature variations. Built-in temperature and air-pressure sensors compensate for these atmospheric variations, ensuring excellent results whatever the weather.

10

Sample positioning

Highly repeatable sample positioning reduces sample-to-sample variations.

Safety guaranteed

Epsilon 1 complies with the latest Machinery Directive, CSA, IEC, EMC, Vollschutz norms and standards for protection and radiation safety to guarantee a safe instrument for the operator.





Robust and flexible quantification

For characterization and analysis of unidentified sample types, or in situations where certified standards that match specific sample characteristics are not available, PANalytical's Omnic package is the solution of choice.

Important applications include quantification of ores, screening of samples from exploration sites, as well as the comparison of different materials. The following data show some representative results obtained using Epsilon 1 and Omnic standardless analysis. Adding in-house standards to the Omnic database with similar composition as the unknown samples, will result in even more accurate data.

Ready for unprepared samples

The Epsilon 1 provides a large area for placing irregularly shaped samples like rocks, which can be as tall as 10 cm.



Copper ores

- GBM309-16 standard
- Prepared as loose powder
- Oxygen as balance

GBM309-16		
Compound	Measured conc. (wt%)	Certified conc. (wt%)
MgO	2.41	
Al ₂ O ₃	3.64	
SiO ₂	15.76	
S	21.7	28.1
K ₂ O	0.3	
CaO	2.82	
Ti	0.24	
Cr	0.012	(0.006)
Mn	0.06	
Fe	22.45	(25.2)
Ni	0.01	
Cu	5.29	5.31
Zn	9.954	10.695
Ba	0.008	(<0.005)
Pb	1.590	1.504
O	13.76	



tification of ores

Iron ores

- ECSC 681-1 standard
- Prepared as loose powder
- Oxygen as balance

ECSC 681-1		
Compound	Measured conc. (wt%)	Certified conc. (wt%)
Al	6.57	5.62
Si	8.41	8.32
P	0.81	0.88
S	0.048	0.103
K	0.53	0.49
Ca	2.76	2.80
Ti	0.31	0.29
V	0.090	0.077
Cr	0.054	0.041
Mn	0.22	0.22
Fe	34.92	33.21
Ni	0.036	0.016
O	45.24	(47.04)

Manganese ores

- SARM 17 standard
- Prepared as loose powder
- Oxygen as balance

SARM 17		
Compound	Measured conc. (wt%)	Certified conc. (wt%)
MgO	5.03	3.03
Al ₂ O ₃	0.01	0.24
SiO ₂	4.22	4.69
P	0.03	0.018
S	0.01	0.01
K ₂ O	0.12	0.09
CaO	14.43	14.4
Mn	35.56	38.81
Fe	4.01	4.27
BaO	0.07	0.08
O	36.51	(34.36)



Omnian advantages

The right result every time

- Advanced technology for robust results
- Precise results for almost any sample using the default setup
- Accuracy and detection enhancement with ASC and selected peak measurements

Easy to use

- Scalable from routine to advanced usage
- Easy data retrieval

Problem solving power for your analytical challenges

- Quantitative analysis
- Batch and materials control
- Quick screening
- R&D analysis tool
- Failure analysis
- Comparative analysis

Omnian - precise results

Long-term precision

To test the precision of Epsilon 1 in combination with Omnian standardless analysis, a manganese ore standard SARM 17 was prepared as a pressed powder and measured 11 times over a period of 2 months, without any re-calibration. The long-term precision of this method is illustrated in the table below.

The certified concentration, measured average concentration, RMS and relative RMS* values are presented in the table. The data shows the high long-term precision of Epsilon 1 in combination with Omnian.

Mn ore (SARM 17)	MgO	Al ₂ O ₃	SiO ₂	P	S	K ₂ O	CaO	Mn	Fe	Zn	SrO	BaO
Certified conc. (wt%)	3.03	0.24	4.69	0.018	0.01	0.09	14.4	38.81	4.27	0.004	0.03	0.08
Measured average conc. (wt%)	3.99	0.40	3.88	0.015	0.01	0.12	14.1	38.17	4.21	0.005	0.02	0.07
RMS* (wt%)	0.14	0.02	0.08	0.001	0.0005	0.005	0.21	0.82	0.09	0.0006	0.0004	0.003
Relative RMS* (%)	3.4	5.3	2.1	6.5	5.6	4.2	1.5	2.1	2.2	12	1.9	4.1

* The RMS value is the standard deviation of the repeated measurements and therefore a measure of the precision of the method.

Exploration

Epsilon 1 is ideal for the exploration of metals in rocks. Omnian scans all elements in the sample, from sodium to americium across the periodic table and reports those elements that are present. Adding in-house standards to the Omnian database with similar composition as the unknown samples, will result in more accurate data.

Omnian		Granite (GSR-1)		Syenite (GSR-7)	
Compound	Unit	Certified	Measured	Certified	Measured
Al ₂ O ₃	(%)	13.4	14.15	17.72	16.83
SiO ₂ *	(%)	72.83	64.66	54.48	44.67
P ₂ O ₅	(%)	0.093	0.1	0.018	0.017
SO ₃	(%)	0.095	0.055	0.025	0.034
K ₂ O	(%)	5.01	5.57	7.48	7.98
CaO	(%)	1.55	1.58	1.39	1.4
TiO ₂	(%)	0.29	0.26	0.48	0.46
V	(ppm)	24	4.9	179	183
MnO	(%)	0.06	0.05	0.12	0.12
Fe ₂ O ₃	(%)	2.14	1.69	7.40	7.56
Zn	(ppm)	28	23	112	118
Rb	(ppm)	466	478	130	143
Sr	(ppm)	106	100	1163	1290
Y	(ppm)	62	57	24.7	27
Zr	(ppm)	167	160	1540	1730
Nb	(ppm)	40	35	66.9	71
Ba	(ppm)	343	201	251	170
Ce	(ppm)	108	77	242	252
Pb	(ppm)	31	33	196	231
Th	(ppm)	54	55	79.3	70
U	(ppm)	18.8	24		

*SiO₂ data affected by method of sample preparation

About PANalytical

PANalytical's mission is to enable people to get valuable insight into their materials and processes. Our customers can be found in virtually every industry segment, from building materials to pharmaceuticals and from metals and mining to nanomaterials. The combination of our software and instrumentation, based on X-ray diffraction (XRD), X-ray fluorescence (XRF) and near-infrared (NIR) spectroscopy as well as pulsed fast thermal neutron activation (PFTNA), provides our customers with highly reliable and robust elemental and structural information on their materials and is applied in scientific research and industrial process and quality control.

PANalytical employs over 1,000 people worldwide. The company's headquarters are in Almelo, the Netherlands. Fully equipped application laboratories are established in Japan, China, the US, Brazil, and the Netherlands. PANalytical's research activities are based in Almelo (NL) and on the campus of the University of Sussex in Brighton (UK). Supply and competence centers are located on two sites in the Netherlands: Almelo (X-ray instruments) and Eindhoven (X-ray tubes), in Nottingham, UK (XRF applications and standards), in Quebec, Canada (fusion sample preparation) and in Boulder CO, US (near-infrared instruments).

PANalytical is active in all but a few countries of the world. This worldwide sales and service network ensures unrivalled levels of customer support.

The company is certified in accordance with ISO 9001 and ISO 14001.

Visit www.panalytical.com for more information about our activities.

PANalytical is part of Spectris plc, the productivity-enhancing instrumentation and controls company.

Access to expertise

With the largest service network we are able to offer the most comprehensive support package possible.

Expertise:

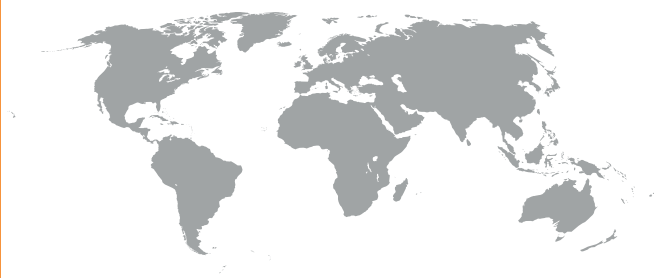
- On-site training available
- XRF training courses
- Performance optimization
- Customizable expertise programs
- Assistance with multi-laboratory standardization

Care Agreements

Our customer support solutions have been developed with your business in mind. They are formulated as a family of four Care Agreements which can be tailored to your specific needs and provide fast, secure and reliable support.

- **ECONOMY:** indispensable coverage for self-sufficient operations
- **ADVANCED:** cost-effective support for routine usage
- **PREMIUM:** flexible package for high equipment usage
- **ELITE:** most comprehensive package for demanding environments

Global and near



PANalytical B.V.
Lelyweg 1, 7602 EA Almelo
P.O. Box 13, 7600 AA Almelo
The Netherlands

T +31 546 534 444
F +31 546 534 598

info@panalytical.com
www.panalytical.com

Regional sales offices

Americas
T +1 508 647 1100
F +1 508 647 1115

Europe, Middle East, Africa
T +31 546 834 444
F +31 546 834 969

Asia Pacific
T +65 6741 2868
F +65 6741 2166