

# Analysis Systems for Environmental Applications



*ICP-OES and XRF spectrometers  
for the analysis of heavy metals  
and other elements in  
environmental samples*

Besides the heavy metals like

- arsenic,
- cadmium,
- chromium,
- mercury,
- lead and
- thallium,

SPECTRO's environmental analyzers determine other important elements in full compliance with legal regulations.



**With the SPECTRO xSORT and SPECTRO XEPOS X-ray fluorescence spectrometer and the SPECTRO GENESIS, SPECTROBLUE and SPECTRO ARCOS ICP-OES spectrometers, SPECTRO provides unrivaled solutions for the analysis of heavy metals in environmental samples such as water, soil, sludge and waste. These instruments are robust, reliable and sensitive analytical systems, that are able to deal with diverse material types as well as wide varying elemental concentrations in full compliance with the regulations.**

Heavy metals include the elements arsenic, cadmium, chromium, mercury, lead and thallium. They typically enter the body via the food chain, ambient air or drinking water. Unfortunately, since the beginning of the industrial revolution, waterways and coastal waters have been polluted with these elements and others. Contaminants have also been introduced into the soil with negative consequences not only for the food chain, but also for drinking water.

To safeguard the environment, strict regulations have now been drawn up both in Europe and the United States as well as in many other countries around the world. These new regulations specify the maximum amounts of toxic elements, notably heavy metals, that can be released into the environment. As a consequence, contamination levels in – for example - urban and industrial waste water and soils need to be monitored as do levels in sludge from sewage treatment plants.

# SPECTRO xSORT

The SPECTRO xSORT is a compact, ergonomic handheld ED-XRF spectrometer utilizing innovative technology. It delivers extremely fast analytical results with no constraints on accuracy. The short measuring time of 30 seconds makes it the ideal instrument for rapid screening analyses in environmental analysis, e.g., the determination of the contents of soil, sludge, rock samples or waste. In the mining industry, concentrates and tailings can be characterized in addition to ores. With the optional GPS package, the measurement data can be stored together with a protocol of the testing site, so that the conditions for an entire plot can be quickly and easily mapped.

The SPECTRO xSORT's extraordinary performance is based on the optimized sample excitation using a miniature X-ray tube. The excitation is so well matched to the specially developed detector technology that the SDD-based detector is used to its best advantage. This combination enables the achievement of high pulse rates together with high sensitivity. Faster measurements and increased accuracy are the result.

The SPECTRO xSORT possesses several safety mechanisms for safe, interference-free operation. A shutter that securely closes the measuring aperture and that protects the technology behind it from soiling is also used as the sample for control measurements that the instrument automatically conducts as needed. All of the calibrations available on the instrument are ready for use at all times. Incidentally, these calibrations are based on the models used in SPECTRO's successful laboratory instruments.



## SPECTRO xSORT

- All relevant elements from Mg to U
- Universal calibrations: Simply start an analysis no additional input is required
- Laboratory-like analytical results in just a few seconds
- Extremely fast element screening



The SPECTRO XEPOS simultaneous XRF spectrometer provides a fast, precise, accurate and economic solution for the monitoring of soil, sludge and waste. Measurements require little or no sample preparation and are non-destructive. In addition to heavy metals, all of the relevant elements from Na to U can be determined simultaneously in solids, powders and liquids. Operation can be easily automated using an integrated autosampler. Analyses are largely matrix independent, as the software corrects for this type of influence. This and many additional instrument and software characteristics make operation simple and safe.



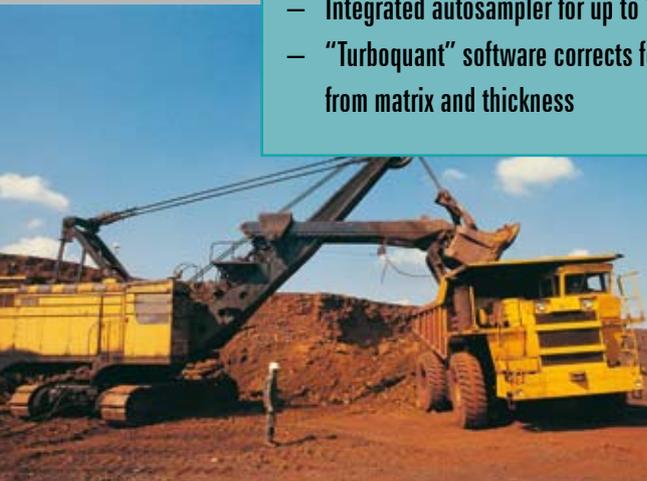
SPECTRO XEPOS is a particularly powerful XRF analyzer with exceptional multifaceted capabilities. Compared to conventional benchtop instruments, it achieves decidedly better detection limits. A very low powered X-ray tube with a power of only 50 W serves as the radiation source. The extreme sensitivity is obtained with an extended polarization system by which the primary tube radiation is bundled in luminously intense polarization and secondary target optics. With this technique, it is not necessary to utilize radiation filters that lead to heavy losses in sensitivity. A high-resolution, Peltier-cooled, SDD detector is used as a detection system, eliminating the need for liquid nitrogen cooling.



## SPECTRO XEPOS

- Element range Na - U
- Low detection limits due to polarized excitation and secondary target optics
- Analysis of solids, powders and liquids
- Integrated autosampler for up to 12 samples
- “Turboquant” software corrects for influences from matrix and thickness

For the analysis of unknown samples the SPECTRO XEPOS provides a rapid, reliable and economic solution by using a special expert system-based software package called “Turboquant”: The matrix in unknown samples is detected and the resulting inter-element effects are automatically taken into consideration, significantly reducing analytical errors.



# SPECTRO GENESIS

The SPECTRO GENESIS inductively coupled plasma (ICP-OES) optical emission spectrometer with axial plasma observation has been specially designed for environmental applications. It offers all of the required analytical capabilities in terms of sensitivity, precision and accuracy and thus is ideally suited to perform analysis of water, waste water, soil, sewage sludge and filter dust in compliance with EPA and international norms. The instrument features a Paschen-Runge spectrometer mount. Employing the proprietary Optimized Rowland Circle Alignment (ORCA) technique, the complete spectrum between 175 and 777 nm is captured. Over 70 elements can be determined simultaneously. A complete analysis can be performed in less than 4 minutes regardless of the number of lines and elements.

Utilizing SPECTRO's Intelligent Calibration Logic (ICAL), not only optimum operating conditions are ensured all the time, but also factory methods can be transferred to individual instruments, making method development redundant and the instrument literally "Plug and Analyze".

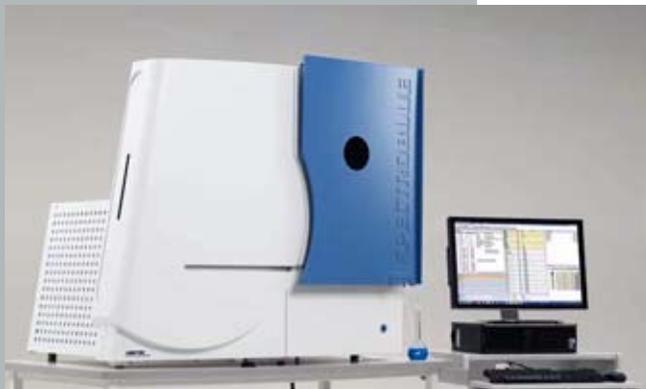
The SPECTRO GENESIS offers a simple, fast, accurate, precise and cost efficient method for the analysis of environmental samples, determining trace, minor, and major elements with excellent recoveries. In conjunction with an autosampler, the SPECTRO GENESIS can be fully automated.



## SPECTRO GENESIS

- Pioneering CCD optical system design
- Proven generator technology
- Minimum installation and training requirements
- ICAL-supported automatic system control
- Factory methods conforming to international standards for water/waste-water, soil, sewage sludge and filter dust
- Seamless integration into the laboratory environment
- Excellent price/performance ratio





## SPECTROBLUE

- Direct light path Paschen-Runge optic design
- Exceptional UV transparency without the need for consumable purge gases
- Air cooled axial plasma observation
- Highly robust, air cooled generator
- Industry leading price to performance ratio
- Full spectrum readout and storage
- Simultaneous measurement

The SPECTROBLUE ICP-OES is the ideal system for environmental laboratories that require a low-cost, high-throughput spectrometry solution. SPECTROBLUE was designed to establish new levels of performance for common laboratory analysis where stability, uninterrupted operation and throughput are as important as sensitivity and resolution. It couples an ultra-reliable design with no-compromise technical innovation to achieve the lowest cost of ownership in its class. A robust generator design packs an ample power reserve that can handle the most extreme plasma loads. The heat from the generator's high-power ceramic tube is eliminated through the use of innovative air-cooled technology that alleviates the need for an expensive external water-based cooling system. Developed specifically to meet the demands of high-throughput laboratories, the SPECTROBLUE's field-proven generator provides the exceptional uptime, stability, and reliability. Its unique OPI Air optical plasma interface makes SPECTROBLUE the first ICP-OES without purchase and energy costs for external cooling.

SPECTROBLUE's optic system and unique full-transparency UV-PLUS approach eliminate consumable purge gases and ensure excellent long-term stability. The instrument's sealed optic system abolishes gas purging for a lifetime savings totaling up to one-third of the instrument's purchase price. Additionally, SPECTRO's innovative Paschen-Runge optic technology permits a direct, high-luminance path for maximized light throughput, allowing the system to more easily process line-rich spectra, improve measurement accuracy and reduce expensive rework.

Along with these features, the SPECTROBLUE ICP-OES system comes equipped with SPECTRO's proprietary SMART ANALYZER VISION software. With its highly adaptable interface, the software makes it easy for users of all experience levels to take full advantage of the instrument's simplified operation and unique analytical capabilities.

# SPECTROBLUE

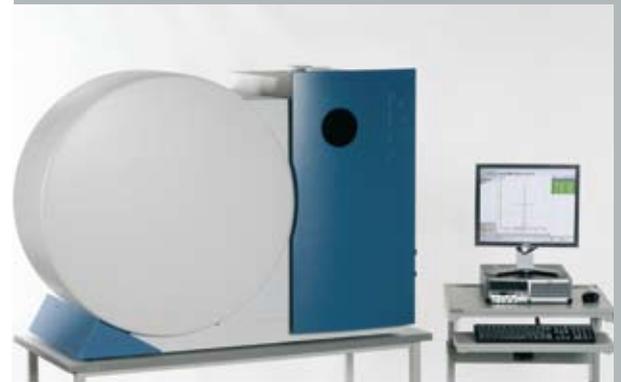
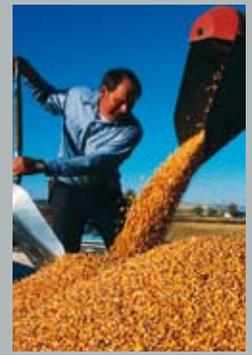
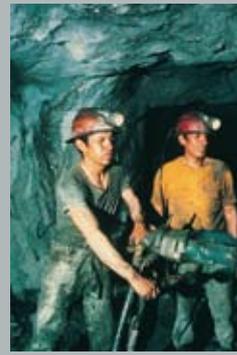
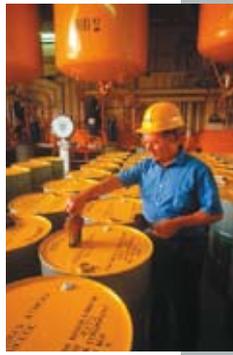
# SPECTRO ARCOS

The SPECTRO ARCOS is a truly versatile high-performance ICP-OES spectrometer with a unique, analytically superior optical system for highest resolution. Both axial and radial plasma observation can be performed: the Optical Plasma Interface (OPI) for axial plasma observation enables extremely low detection limits and practically eliminates matrix effects; the Side-on Plasma Interface (SPI) for radial plasma observation provides high precision and stability for less extreme sensitivity requirements.

With its robust construction, minimal maintenance requirements and intelligent software, the SPECTRO ARCOS is perfectly suited to automatic operation. Water cooling of the free-running generator is not necessary; the argon-filled UV-PLUS system prevents contamination of the optics due to a vacuum or flushing gas. All instrument parameters are monitored and logged by the software. An optional combination of autosampler and autodiluter provides automatic dilution of samples that have exceeded measurement ranges so that they can be analyzed correctly. This all increases measurement accuracy while reducing operational expenses.

The innovative high performance readout system allows measurement of the complete spectrum in less than 2 seconds. The raw data for the entire spectrum is stored and is available for post-processing. A sample can be re-analyzed for new elements and even with different parameters without having to be measured again.

The SPECTRO ARCOS is a powerful ICP-OES instrument with many accessories and innovative technology for the analysis of a very wide range of elements and concentrations. It is suited to routine and difficult tasks in nearly any laboratory and is especially capable of automated analysis.



## SPECTRO ARCOS

- Pioneering CCD optical system design
- Proven generator technology
- OPI and SPI capable
- Post-processing of samples
- Fully automatic analysis
- Self-monitoring
- Numerous accessories



### Table of Accuracy - SPECTRO xSORT and SPECTRO XEPOS

Comparison of the sediment standard GSS6, prepared as loose powder.

El.		given	XEPOS	xSORT
Al <sub>2</sub> O <sub>3</sub>	%	21.23 ± 0.09	23.81 ± 0.02	
SiO <sub>2</sub>	%	56.93 ± 0.11	49.43 ± 0.03	54 ± 2
K <sub>2</sub> O	%	1.7 ± 0.03	1.71 ± 0.01	1.71 ± 0.03
CaO	%	0.22 ± 0.01	0.2 ± 0.01	0.21 ± 0.01
Ti	mg/kg	4390 ± 50	4787 ± 9	4881 ± 52
Cr	mg/kg	75 ± 2	77 ± 1	82 ± 8
Mn	mg/kg	1450 ± 32	1635 ± 3	1780 ± 18
Fe <sub>2</sub> O <sub>3</sub>	%	8.09 ± 0.06	8.11 ± 0.01	8.46 ± 0.01
Co	mg/kg	7.6 ± 0.4	< 8	< 53
Ni	mg/kg	53 ± 1	57 ± 1	59 ± 5
Cu	mg/kg	390 ± 6	380 ± 2	398 ± 11
Zn	mg/kg	96.6 ± 2.4	99 ± 1	57 ± 6
As	mg/kg	220 ± 7	216 ± 1	239 ± 4
Se	mg/kg	1.34 ± 0.12	2.5 ± 0.2	< 3
Br	mg/kg	7.2	10.9 ± 0.3	10 ± 2
Rb	mg/kg	237 ± 4	229 ± 1	249 ± 3
SrO	mg/kg	39 ± 2	38.1 ± 0.2	35 ± 2
Y	mg/kg	18.8 ± 0.8	15.5 ± 0.5	11 ± 3
Zr	mg/kg	220 ± 7	230 ± 2	229 ± 5
Ag	mg/kg	0.2 ± 0.01	< 2	< 11
Cd	mg/kg	0.13 ± 0.016	< 2	< 11
Sn	mg/kg	72 ± 4	80.7 ± 3.6	66 ± 11
Sb	mg/kg	60 ± 3	67.2 ± 5	58 ± 5
Ba	mg/kg	118 ± 6	125 ± 8	< 120
Hg	mg/kg	0.07 ± 0.01	< 2	< 6
Tl	mg/kg	2.4 ± 0.3	3.8 ± 0.8	< 4
Pb	mg/kg	314 ± 6	321.7 ± 2.7	352 ± 7
Bi	mg/kg	49 ± 3	57.6 ± 1.5	51 ± 5
Th	mg/kg	23 ± 1	16 ± 1	< 13
U	mg/kg	6.7 ± 0.5	4 ± 1	< 15

### Table of Accuracy - SPECTRO GENESIS

Comparison of certified and measured concentrations for NIST SRM 1640 (Trace Elements in Natural Water)

El.	Certified Conc. [µg/L]	Meas. Conc. [µg/L]	Recovery [%]
Al	52 ± 1.5	50.7	97.5
Ag	7.62 ± 0.25	7.34	96.3
As	26.67 ± 0.41	26.14	98.0
B	301.1 ± 6.1	298.1	99.0
Ba	148.0 ± 2.2	137.6	92.9
Be	34.94 ± 0.41	34.8	99.5
Cd	22.792 ± 0.96	21.9	96.1
Co	20.28 ± 0.31	19.3	95.2
Cr	38.6 ± 1.6	40.2	104.1
Cu	85.2 ± 1.2	85.6	100.4
Fe	34.3 ± 1.6	30.6	89.2
K	994 ± 27	1013	101.9
Li	50.7 ± 1.4	51.7	101.9
Mn	121.5 ± 1.1	116.5	95.9
Mo	46.75 ± 0.26	47.3	101.2
Ni	27.4 ± 0.8	29.8	108.7
Pb	27.89 ± 0.14	30.8	110.4
Sb	13.79	13.7	99.3
Se	21.96 ± 0.51	22.4	101.9
Sr	124.2 ± 0.7	116.7	93.9
V	12.99 ± 0.97	12.4	95.6
Zn	53.2 ± 1.1	54.4	102.2

Comparison of the certified with the measured concentrations for BCR 141R (Soil)

El.	Certified Conc. [mg/kg]	Meas. Conc. [mg/kg]	Recovery [%]
Cd	14.0 ± 0.5	13.68	97.7
Co	9.2 ± 0.5	9.6	104.3
Cr	138 ± 5	139.6	101.1
Cu	46.9 ± 1.8	47.08	100.4
Hg	0.24 ± 0.03	0.25	104
Mn	653 ± 16	640	98
Ni	94 ± 5	89	94.7
Pb	51.3 ± 2	47.8	93.1
Zn	270 ± 8	278.8	103.3

### Table of Applications

Common environmental analysis applications and suitable instrumentation.

Application	SPECTRO XRF	SPECTRO ICP-OES
Water		X
Waste Water		X
Soil		
- monitoring	X	
- analysis		X
Sewage Sludge		
- monitoring	X	
- analysis		X
Filters	X	X
Solid Waste	X	
Slurries		X
Liquid streams		X



[www.spectro.com](http://www.spectro.com)

**AMETEK**<sup>®</sup>  
MATERIALS ANALYSIS DIVISION



#### GERMANY

SPECTRO Analytical Instruments GmbH  
Boschstrasse 10  
D-47533 Kleve  
Tel: +49.2821.8922102  
Fax: +49.2821.8922202  
[spectro.sales@ametek.com](mailto:spectro.sales@ametek.com)

#### U.S.A.

SPECTRO Analytical Instruments Inc.  
91 McKee Drive  
Mahwah, NJ 07430  
Tel: +1.800.548.5809  
+1.201.642.3000  
Fax: +1.201.642.3091  
[spectro-usa.sales@ametek.com](mailto:spectro-usa.sales@ametek.com)

#### HONG KONG (Asia-Pacific)

AMETEK, Inc. SPECTRO Analytical  
Instruments (Asia-Pacific) Ltd.  
Unit 1603, 16/F., Tower III, Enterprise  
Square No. 9 Sheung Yuet Road  
Kowloon Bay, Kowloon  
Tel.: +852.2976.9162  
Fax: +852.2976.9542  
[spectro-ap.sales@ametek.com](mailto:spectro-ap.sales@ametek.com)

**Subsidiaries:** **CHINA:** Tel +86.10.8526.2111, Fax +86.10.8526.2141, [spectro-china.sales@ametek.com](mailto:spectro-china.sales@ametek.com), **FRANCE:** Tel +33.1.3068.8970, Fax +33.1.3068.8999, [spectro-france.sales@ametek.com](mailto:spectro-france.sales@ametek.com), **UNITED KINGDOM:** Tel +44.1162.462.950, Fax +44.1162.740.160, [spectro-uk.sales@ametek.com](mailto:spectro-uk.sales@ametek.com), **INDIA:** Tel. +91.22.6196.8200, Fax +91.22.2836.3613, [sales.spectroindia@ametek.com](mailto:sales.spectroindia@ametek.com), **ITALY:** Tel +39.02.94693.1, Fax +39.02.94693.650, [spectro-italy.sales@ametek.com](mailto:spectro-italy.sales@ametek.com), **JAPAN:** Tel: +81.3.6809.2405, Fax: +81.3.6809.2410, [spectro-japan.sales@ametek.com](mailto:spectro-japan.sales@ametek.com), **SOUTH AFRICA:** Tel +27.11.979.4241, Fax +27.11.979.3564, [spectro-za.sales@ametek.com](mailto:spectro-za.sales@ametek.com), **SWEDEN:** Tel: +46.8.5190.6031, Fax: +46.8.5190.6034, [spectro-nordic.sales@ametek.com](mailto:spectro-nordic.sales@ametek.com). SPECTRO operates worldwide and is present in more than 50 countries. For SPECTRO near you please visit [www.spectro.com/worldwide](http://www.spectro.com/worldwide). © SPECTRO 2012, Subject to technical modifications • H-12, Rev.0. Photos: SPECTRO, GettyImages, Corbis.

Registered trademarks of SPECTRO Analytical Instruments GmbH **SPECTRO** EU(005673694), USA(3,645,267); „SPECTRO“ (009693769); xSORT EU(7058456), IR USA(3,767,555), IR Japan(978 588); SPECTRO Genesis EU(004206165), USA(3,170,644); iCAL D(303 15 391), EU(003131919), USA(3,189,726); Arcos EU(005326566), USA(3,451,924), Japan(5085474); XEPOS D(398 51 192), USA(2,415,185); SPECTROBLUE D(30 2011 027 798), Japan(1099910), China(1099910)