Application Note

Environmental

Automated Analysis of Low-to-High Matrix Environmental Samples Using a Single ICP-MS Method

Efficient multi-element analysis of waters, sediments, and soils by Agilent 7850 ICP-MS with Advanced Dilution System

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Introduction

The Agilent Advanced Dilution System 2 (ADS 2) is a new two-syringe autodilution system for Agilent ICP-MS instruments that can automatically dilute stock standards and samples up to 400 times. Agilent has developed the ADS 2 to improve the efficiency and cost-per-sample of elemental analyses by automating calibration, sample dilution, and the reanalysis of out-of-range samples.[1]

With its low detection limits, wide dynamic range, high throughput, and multi-element capabilities, ICP-MS is used extensively in environmental laboratories to quantify multiple elements in samples with diverse matrices. Inorganic environmental testing facilities play a crucial role in environmental monitoring, compliance-testing in accordance with regulations, and studying the impact of elemental pollutants on ecosystems. Medium to large contract labs may analyze many hundreds of samples a day including drinking and surface waters, soils, sediments, effluents, agricultural products, and chemical spills. To manage such large and varied sample loads, laboratory managers are constantly looking for new ways to increase the efficiency and productivity of their workflows and to reduce the demands on staff.

Many labs typically screen unknown samples before method development or quantitative analysis. However, with the integrated ADS 2, Agilent ICP-MS can handle a wider variety of sample types without prescreening by combining prescriptive and reactive dilution—greatly improving sample throughput.

The Agilent 7850 ICP-MS is ideal for the accurate measurement of environmental samples, including samples with high total dissolved solids (TDS) content.[2, 3] The 7850 ICP-MS includes the following features that benefit routine testing laboratories:

– **Robust plasma ion source:** the optimized plasma (low CeO^+/Ce^+ ratio) can handle varied sample types easily, ensuring accurate data, good long-term stability, and lower maintenance requirements.

– **Ten orders linear dynamic range:** the wide analytical range simplifies the method setup, as major and trace analytes can be measured in a single run, meaning fewer reruns due to over-range results.

– **Octopole Reaction System (ORS[4]) helium (He) collision mode:** He collision mode is used to control common spectral interferences by Kinetic Energy Discrimination (KED), ensuring data accuracy.

– **Ultra High Matrix Introduction (UHMI) aerosol dilution technology:** UHMI further improves the already exceptional plasma robustness of the 7850 ICP-MS, enabling the instrument to handle samples with percent levels of TDS.

– **Agilent ICP-MS MassHunter:** the powerful software includes helpful software presets, built-in method and report templates, and ease-of-use features that simplify all aspects of the analytical workflow.

To further improve lab productivity through automation, a fully integrated system comprising the 7850 ICP-MS and ADS 2 enables the following three important time-saving functions to be performed automatically:

– **Autocalibration:** all calibration curves can be prepared automatically from a single stock solution, significantly reducing the time needed to prepare standard solutions.

– **Prescriptive dilution:** automatically diluting samples before measurement reduces the time needed to prepare samples with high matrix concentrations. Online autodilution not only reduces manual labor, but also avoids the risk of introducing human error and contamination during sample preparation.

– **Reactive dilution:** automatically dilute and remeasure samples immediately when the concentration exceeds the calibration range or when the internal standard (ISTD) elements exhibit suppression or enhancement. This functionality of the ADS 2 avoids post-analysis rework and manual dilution of out-of-range samples, further improving productivity and freeing analysts to concentrate on more productive tasks.

This application note uses the Agilent 7850 ICP-MS fitted with the ADS 2 and Agilent SPS 4 autosampler to measure 26 major, minor, and trace elements in various environmental samples using a single method. The dilution accuracy and long-term stability of the 7850 ICP-MS with the ADS 2 was evaluated throughout the analysis of drinking water, wastewater, river sediment, soil, and synthetic seawater.

Experimental

Instrumentation

The 7850 ICP-MS with an integrated ADS 2 and SPS 4 autosampler (Figure 1) was fully controlled using ICP-MS MassHunter software version 5.3. The ADS 2 is a preconfigured, two-syringe modular dilution system that includes an Advanced Valve System for ICP-MS (AVS MS)*. The system is easy to install, operate, maintain, and troubleshoot—all factors that will lower running costs and improve sample throughput by reducing manual operations and demands on analyst time.

*AVS MS formerly called ISIS 3.

Figure 1. Agilent 7850 ICP-MS fitted with the Agilent ADS 2 autodilutor and Agilent SPS 4 autosampler.

The 7850 ICP-MS was fitted with the standard sample introduction system, consisting of a MicroMist glass concentric nebulizer, temperature-controlled quartz spray chamber, and quartz torch with 2.5 mm id injector. A nickel-plated copper sampling cone was used with a nickel skimmer cone.

As shown in Table 1, the ORS[4] was operated in three gas modes: no gas (for Be), He (for 24 elements), and enhanced, high energy He (HEHe mode for Se). UHMI-4 was selected as the plasma setting since the TDS content of some of the samples was unknown. Table 1 displays the plasma and instrument parameters; the shaded rows show the automatically defined UHMI settings. The ion lens voltages were automatically optimized to maximize sensitivity.

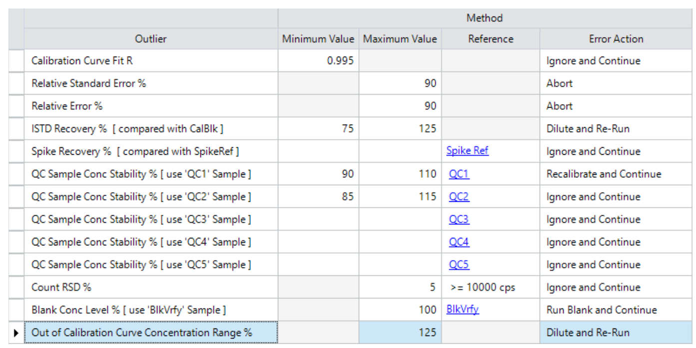
Table 1. Agilent 7850 ICP-MS operating parameters.

Parameter	No Gas	He	HEHe
Plasma Mode		UHMI-4	
RF Power (W)		1600	
Sample Depth (mm)		10	
Nebulizer Gas (L/min)		0.83	
Dilution Gas (L/min)		0.15	
Lens Tune		Autotune	
Cell Gas Flow Rate (mL/min)	0	5	10
Energy Discrimination (V)	5	5	7

The shaded parameters are defined automatically using UHMI. Enhanced HEHe mode settings used for selenium (Se).

The ADS 2 can autodilute solutions by up to a factor of 400, making it highly suitable for the preparation of multilevel calibrations and autodilution of high matrix samples (prescriptive dilution). In addition to prescriptive dilution, the ADS 2 can be used to automatically dilute and remeasure samples (reactive dilution) if the concentration of some elements exceeds a user-defined concentration, such as the maximum calibration concentration.

As shown in Figure 2, the reactive dilution function can be set in the QC software tab for "Out of Calibration Curve Concentration Range" by choosing "Dilute and Re-Run". Dilute and Re-Run can also be applied to the internal standard "ISTD Recovery" signal.



	Method			
Outlier	Minimum Value	Maximum Value	Reference	Error Action
Calibration Curve Fit R	0.995			Ignore and Continue
Relative Standard Error %		90		Abort
Relative Error %		90		Abort
ISTD Recovery % [compared with CalBlk]	75	125		Dilute and Re-Run
Spike Recovery % [compared with SpikeRef]			Spike Ref	Ignore and Continue
QC Sample Conc Stability % [use 'QC1' Sample]	90	110	QC1	Recalibrate and Continue
QC Sample Conc Stability % [use 'QC2' Sample]	85	115	QC2	Ignore and Continue
QC Sample Conc Stability % [use 'QC3' Sample]			QC3	Ignore and Continue
QC Sample Conc Stability % [use 'QC4' Sample]			QC4	Ignore and Continue
QC Sample Conc Stability % [use 'QC5' Sample]			QC5	Ignore and Continue
Count RSD %		5	>= 10000 cps	Ignore and Continue
Blank Conc Level % [use 'BlkVrfy' Sample]		100	BlkVrfy	Run Blank and Continue
Out of Calibration Curve Concentration Range %		125		Dilute and Re-Run

Figure 2. QC tab in Agilent ICP-MS MassHunter software version 5.3 showing action in case of outlier results for ISTD Recovery and/or Out of Calibration Curve Concentration Range %.

Details of the hardware setup for the ADS 2 and SPS 4 are listed in Table 2 and the ADS 2 sample introduction parameters are shown in Table 3.

Table 2. Configuration of Agilent ADS 2 and Agilent SPS 4 autosampler.

Parameter	Details
Sample Loop	1.5 mL
Carrier Syringe	5 mL, glass
Diluent Syringe	10 mL, quartz
Time per Analysis	150 s (no-dilution), 175 to 190 s (with dilution)
Probe	1.0 mm id, 100 cm long (tubing)
Peri Pump Tubing	Supply side: gray/gray. Drain side: purple/white.

Table 3. Agilent ADS 2 sample introduction parameters.

Phase	Time (s)	Pump Speed (%)	Vial	Valve
Sample Load	10	50	Sample	Load
Stabilize	8	5	Rinse Port	Inject
Probe Rinse (Sample/Std)	15	5	Rinse Port	Inject
Probe Rinse 1	5	50	Rinse Port	Inject
Probe Rinse 2	20	0	Rinse Port	Inject
Rinse 3	1	0	Home	Inject
Optional Loop Probe Wash	10	50	Rinse Port	Load
Optional Loop Wash	1	5	Rinse Port	Inject
Optional Loop Probe Wash (Dilution)	10	50	Rinse Port	Load

Probe Rinse 1: any contamination of the rinse solution during "Probe Rinse (Sample/Std)" is removed by increasing the pump speed for a short time. Probe Rinse 2: the fresh rinse solution is allowed time to accumulate in the rinse port, ready for the optional loop washing process. Probe Rinse 3 saves on consumption of the rinse solution by setting the probe to the "home" position.

Samples and solutions

All solutions (carrier, diluent, rinse, internal standard, and calibration standards) were prepared using 1% nitric acid (HNO_3) and 0.5% hydrochloric acid (HCl). HCl was included to ensure the stability of elements such as Ag, Sb, and Hg in solution.

Calibration standards, spikes, and quality control (QC) standards were prepared from Agilent Environmental Calibration Standard (part number 5183-4688). Single-element standards were also used for Al, Mn, Zn, Hg, and Pb (Kanto Chemicals, Japan)*. The calibration curves were made from a single mixed stock standard, which was automatically diluted at 400x, 200x, 100x, 50x, 20x, 10x, 5x, 2x, and 1x (undiluted) using the ADS 2. The calibration range of each element is listed in Table 4.

Table 4. Concentration range of calibration curves.

Elements	Calibration Range (µg/L)
Na, Mg, Al, K, Ca, and Fe	25 to 10,000
Mn, Zn, and Pb	2.5 to 1,000
Hg	0.005 to 2
Be, V, Cr, Co, Ni, Cu, As, Se, Mo, Ag, Cd, Sb, Ba, Tl, Th, and U	0.25 to 100

Details of the drinking water, wastewater, river sediment, soil certified reference materials (CRMs), and the synthetic seawater are given in Table 5.

Table 5. List of environmental samples analyzed in this study.

Name	Type	Supplier
NIST 1643f Trace Elements in Water (1643f)	Drinking water	NIST, Gaithersburg MD
Certified Waste Water - Trace Metals Solution H (CWW-TM-H)	Wastewater	High-Purity Standards, Charleston SC, USA
River Sediment Solution B (RS-B)	River sediment	High-Purity Standards, Charleston SC, USA
Soil Solution B (Soil-B)	Soil	High-Purity Standards, Charleston SC, USA
Marine Art SF-1	Synthetic seawater	Osakayakken, Japan

The initial calibration verification (ICV) and continuing calibration verification (CCV) standards, and the initial calibration blank (ICB) and continuing calibration blank (CCB) solutions were used for in-run QC checks. The ICV and CCV standards were prepared using the ADS 2 by diluting the calibration stock standard by a factor of two.

The ISTD solution was prepared from the Agilent Internal Standard Mix (part number 5183-4681). Single element standards* were used for Ge (SPEX CertiPrep, Metuchen, NJ, USA) and Ir (Thermo Fisher Scientific, Waltham, MA, USA). The ISTD solution comprising ^{6}Li, Sc, Ge, Y, In, Tb, and Ir at 1 ppm was automatically added online. Narrow-bore tubing was used to minimize sample dilution, resulting in an approximate 15x dilution of the ISTD stock.

Analytical workflow

Dilution accuracy and long-term stability tests were performed separately, as outlined in the analytical workflow shown in Figure 3.

*Agilent single-element standards are also available.

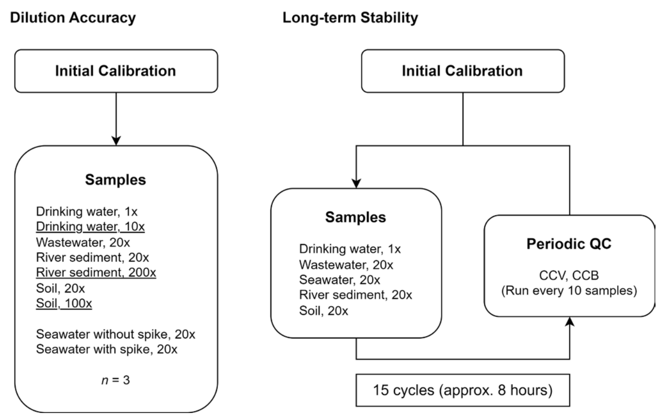


Figure 3. Analytical sequence showing the sample dilution factors. For the dilution accuracy test, the underlined samples were also measured by the Agilent 7850 ICP-MS following automatic reactive dilution by the Agilent ADS 2.

To evaluate dilution accuracy, the drinking water CRM sample was measured without dilution and the higher matrix CRM samples were measured following a 20x prescriptive autodilution. The measured results were compared with the certified values. If the concentration of a single element exceeded the calibration range, the ADS 2 would automatically rerun the sample following reactive autodilution. For further evaluation of dilution accuracy, a synthetic seawater sample was spiked and the standard addition recoveries were assessed.

In the long-term stability test, the same dilution factors and samples were used, although no reactive dilution or spiking of the synthetic seawater sample were performed. CCV and CCB solutions were measured after every 10 samples over an eight-hour run.

Results and discussion

Instrument detection limits and autocalibration

Instrument detection limits (IDLs) for 26 elements were calculated from three times the standard deviation of measurements of seven replicate aliquots of the calibration blank (Table 6).

All autocalibration curves showed excellent linearity over the wide dynamic range from undiluted (1x) to 400x dilution. The calibration coefficients of all the curves were greater than 0.9995. Representative calibration curves for elements across the mass range (Be, V, Cd, and Tl) are shown in Figure 4, left and right, respectively. The excellent linearity of the lower-level calibration standards shows that the ADS 2 is capable of accurate dilution of standards up to 400x.

Table 6. Analyte, cell gas mode, internal standard, and IDLs.

Analyte	Mode	ISTD	IDL (µg/L)
9 Be	No gas	6 Li	0.001
23 Na	He	45 Sc	1.8
24 Mg	He	45 Sc	0.041
27 Al	He	45 Sc	0.055
39 K	He	45 Sc	3.0
44 Ca	He	45 Sc	4.9
51 V	He	72 Ge	0.001
52 Cr	He	72 Ge	0.008
55 Mn	He	72 Ge	0.019
56 Fe	He	72 Ge	0.050
59 Co	He	72 Ge	0.002
60 Ni	He	72 Ge	0.009
63 Cu	He	72 Ge	0.012
66 Zn	He	72 Ge	0.016
75 As	He	72 Ge	0.020
78 Se	HEHe	72 Ge	0.040
95 Mo	He	115 In	0.001
107 Ag	He	115 In	0.001
111 Cd	He	115 In	0.001
121 Sb	He	115 In	0.002
137 Ba	He	115 In	0.019
201 Hg	He	193 Ir	0.003
205 Tl	He	193 Ir	0.0003
Pb*	He	193 Ir	0.0010
232 Th	He	193 Ir	0.0001
238 U	He	193 Ir	0.0001

**Pb data is based on the sum of the 206, 207 and 208 isotopes.*

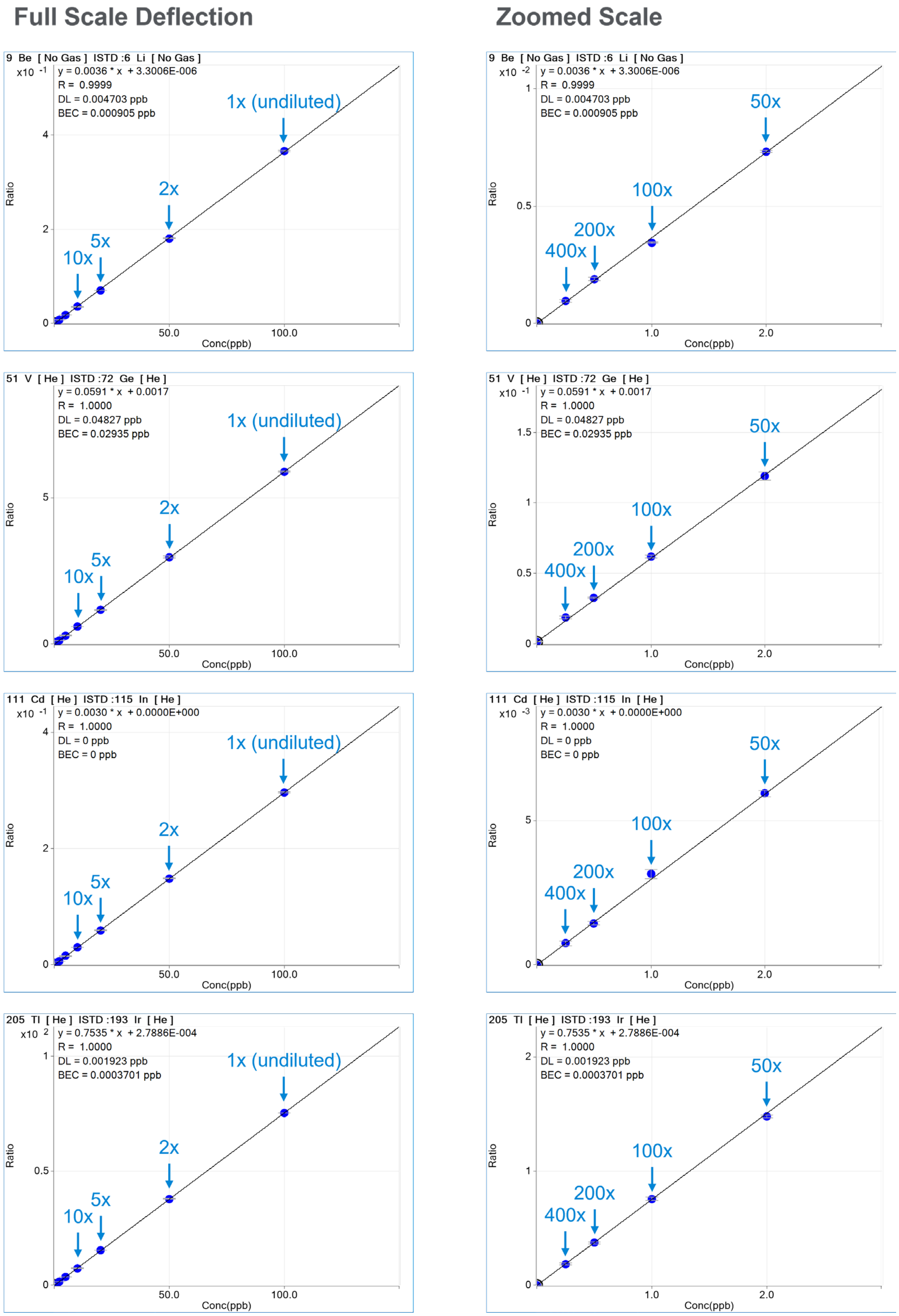


Figure 4. Calibration curves for Be, V, Cd, and Tl. Left: showing the whole calibration range prepared using the Agilent ADS 2 at 400x dilution to undiluted. Right: showing the low concentration standards only, which were autodiluted using the ADS 2 from 50x to 400x.

Accurate analysis of CRMs with reactive dilution

The drinking water, wastewater, river sediment, and soil CRMs were each analyzed three times during the sequence, and the mean concentration and recoveries were calculated for each analyte (Table 7). Noncertified elements are labeled "NA" and recoveries are not given. The concentration of some elements (Na, Ca, Mo, and Ba in drinking water; Al, Ca, Cr, Fe, and Ba in river sediment; and Al, K, Mn, Fe, Cu, Zn, As, Ba, and Pb in soil) were initially measured above the calibration range. Therefore, for these elements in these matrices, the data shown in the shaded cells was acquired following reactive dilution by the ADS 2.

As shown in Table 7, all the certified elements gave recoveries within 100 ± 10%, with most elements showing better than 100 ± 5% recoveries. The results demonstrate that the 7850 ICP-MS and ADS 2 can quantify various types of environmental samples using a single method, which included reactive autodilution when required.

Table 7. Measured concentrations and recoveries of certified elements in CRMs, (n = 3). Concentration units are µg/L. The data shown in the shaded cells was acquired by the Agilent 7850 ICP-MS following automatic reactive dilution by the Agilent ADS 2.

Element	Drinking Water (1643f)				Wastewater (CWW-TM-H)			
	Dilution Factor	Certified Value	Mean Conc.	Recovery (%)	Dilution Factor	Certified Value	Mean Conc.	Recovery (%)
9 Be	1	13.53	13.9	102	20	20	19.2	96
23 Na	10	18640	19500	105	20	NA	608	-
24 Mg	1	7380	7410	100	20	NA	< DL	
27 Al	1	132.5	137	104	20	100	104	104
39 K	1	1913.3	1980	103	20	NA	268	-
44 Ca	10	29140	30600	105	20	NA	253	-
51 V	1	35.71	35.9	100	20	500	508	102
52 Cr	1	18.32	18.4	100	20	500	522	104
55 Mn	1	36.77	37.3	102	20	100	98.8	99
56 Fe	1	92.51	96.7	105	20	250	266	107
59 Co	1	25.05	25.0	100	20	500	529	107
60 Ni	1	59.2	58.4	99	20	500	534	107
63 Cu	1	21.44	20.7	96	20	500	536	107
66 Zn	1	73.7	75.0	102	20	500	522	104
75 As	1	56.85	57.1	100	20	100	105	105
78 Se	1	11.583	11.7	101	20	50	49.6	99
95 Mo	10	114.2	116	102	20	100	104	104
107 Ag	1	0.9606	0.929	97	20	20	20.9	104
111 Cd	1	5.83	5.80	100	20	100	102	102
121 Sb	1	54.9	54.8	100	20	200	201	100
137 Ba	10	513.1	512	100	20	100	100	100
201 Hg	1	NA	0.021	-	20	NA	0.175	-
205 Tl	1	6.823	6.95	102	20	250	238	95
Pb*	1	18.303	18.7	102	20	500	485	97
232 Th	1	NA	0.007	-	20	NA	0.048	-
238 U	1	NA	0.006	-	20	NA	< DL	-

**Pb data is based on the sum of the 206, 207 and 208 isotopes.*

Table 7 continued. Measured concentrations and recoveries of certified elements in CRMs, (n = 3). Concentration units are µg/L. The data shown in the shaded cells was acquired by the Agilent 7850 ICP-MS following automatic reactive dilution by the Agilent ADS 2.

Element	River Sediment (RS-B)				Soil (Soil-B)			
	Dilution Factor	Certified Value	Mean Conc.	Recovery (%)	Dilution Factor	Certified Value	Mean Conc.	Recovery (%)
9 Be	20	NA	0.025	-	20	NA	< DL	-
23 Na	20	50000	50300	101	20	100000	100000	100
24 Mg	20	120000	119000	99	20	80000	79400	99
27 Al	200	600000	589000	98	100	700000	680000	97
39 K	20	200000	197000	98	100	210000	204000	97
44 Ca	200	300000	303000	101	20	125000	121000	97
51 V	20	1000	959	96	20	800	772	97
52 Cr	200	15000	14800	98	20	400	389	97
55 Mn	20	6000	5800	97	100	100000	97600	98
56 Fe	200	400000	409000	102	100	350000	351000	100
59 Co	20	150	151	100	20	100	104	104
60 Ni	20	500	478	96	20	200	205	102
63 Cu	20	1000	944	94	100	3000	3000	100
66 Zn	20	5000	4720	94	100	70000	69500	99
75 As	20	200	191	96	100	6000	5810	97
78 Se	20	10	10.7	107	20	NA	1.61	-
95 Mo	20	NA	0.83	-	20	NA	1.03	-
107 Ag	20	NA	0.19	-	20	NA	0	-
111 Cd	20	30	28.7	96	20	200	196	98
121 Sb	20	40	40.1	100	20	400	387	97
137 Ba	200	4000	3790	95	100	7000	6710	96
201 Hg	20	NA	0	-	20	NA	< DL	-
205 Tl	20	10	9.34	93	20	NA	0	-
Pb*	20	2000	1890	94	100	60000	57500	96
232 Th	20	100	95.1	95	20	100	95.6	96
238 U	20	30	28.9	96	20	250	239	95

**Pb data is based on the sum of the 206, 207 and 208 isotopes.*

Spike recoveries in seawater sample

Matrix spike results for trace elements in the synthetic seawater sample are shown in Table 8. The spike concentration was 1/10 of the calibration standard solution (Table 4) for most elements apart from Ba (20 µg/L) and Hg (1 µg/L). The concentration of major elements (Na, Mg, K, and Ca) in the original seawater sample was too high compared to the spike level, so recoveries are not reported for those elements.

Recoveries for all the trace elements in the seawater sample were within 100 ± 10% of the spike level, demonstrating the accuracy of the quantitative 7850 ICP-MS method.

Table 8. Spike recoveries of trace elements in synthetic seawater, (n = 3).

Element	Dilution Factor	Spike Conc (µg/L)	Recovery (%)
9 Be	20	10	94
27 Al	20	1000	95
51 V	20	10	97
52 Cr	20	10	102
55 Mn	20	100	97
56 Fe	20	1000	97
59 Co	20	10	96
60 Ni	20	10	94
63 Cu	20	10	95
66 Zn	20	100	93
75 As	20	10	93
78 Se	20	10	101
95 Mo	20	10	95
107 Ag	20	10	93
111 Cd	20	10	98
121 Sb	20	10	91
137 Ba	20	20	93
201 Hg	20	1	99
205 Tl	20	10	92
Pb*	20	100	96
232 Th	20	10	96
238 U	20	10	97

**Pb data is based on the sum of the 206, 207 and 208 isotopes.*

Long-term stability (CCV and ISTD recoveries)

Recoveries of all analytes in the ICV and CCV solutions were automatically measured after every 10 samples during the analytical sequence. The CCV was measured 15 times over almost eight hours. As shown in Figure 5, all CCV recoveries were within 100 ± 10% of the expected concentration.

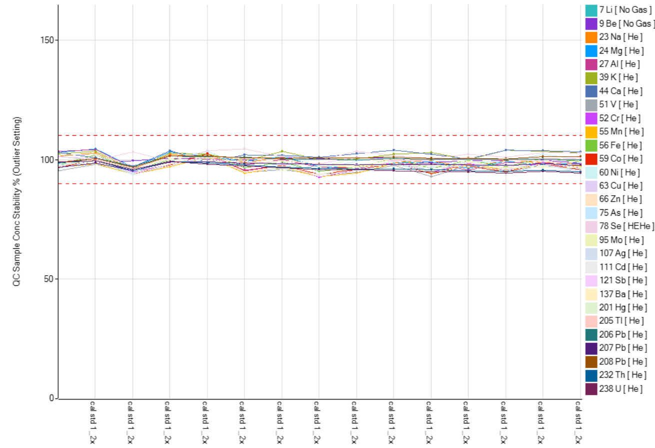


Figure 5. CCV recoveries over the 8-hour sequence. The 2x diluted calibration standard solution was used as the CCV. The red dotted lines show the ±10% control limits.

The ISTD recoveries were also measured in all samples and standards over nine hours with no retuning or recalibration needed. As shown in Figure 6, all ISTD recoveries were within ±25% throughout the whole run, demonstrating the robustness and stability of the method.

The excellent stability results show the suitability of the 7850 ICP-MS with the ADS 2 for routine analysis of multiple elements in environmental samples, including high matrix samples, without any loss of sensitivity.

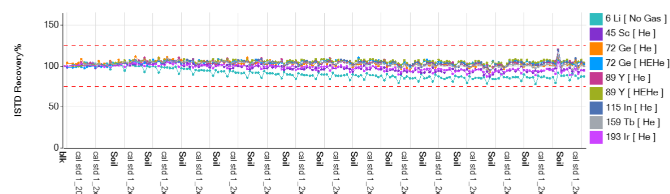


Figure 6. ISTD stability of 140 samples. ISTD recoveries were normalized to the calibration blank for all samples. The red dotted lines show the ±25% control limits.

Conclusion

The Agilent 7850 ICP-MS fitted with the Agilent Advanced Dilution System (ADS 2) simplified the analysis of waters, sediments, and soils by automating time-consuming manual tasks. The fully integrated automated dilution system was used to analyze a long sequence of samples, including high matrix samples, using a single method.

The UHMI aerosol dilution technology of the 7850 ICP-MS provided the robust plasma conditions necessary to minimize matrix effects and drift during the analysis of these high matrix samples. Helium collision cell mode proved effective for removing all common matrix-derived polyatomic interferences, providing accurate results across the range of complex sample matrices. The ADS 2 improved the efficiency of the ICP-MS workflow by providing:

- Automated dilution of calibration stock standards and samples.
- Autocalibration of the instrument using a single stock standard, although two or more stock standards can be used if an even wider calibration range is needed.
- Automatic, prescriptive dilution of samples. In general, samples with high matrix concentrations are often diluted before measurement. With this function, manual dilution operations can be skipped.
- Reactive dilution of samples when elements exceed the calibration range, alleviating the need for post-analysis rework and repeat sample batch measurement.

The 7850 ICP-MS with ADS 2 shortens sample turnaround time and lowers cost-per-sample while improving the quality of the quantitative results by eliminating time-consuming manual tasks.

References

1. Agilent Advanced Dilution System (ADS 2) – Technical overview, Agilent publication, 5994-7211EN
2. Yamanaka, K., Wilbur, S., Maximizing Productivity for High Matrix Sample Analysis using the Agilent 7900 ICP-MS with ISIS 3 Discrete Sampling System, Agilent publication, 5991-5208EN
3. Kubota, T., Routine Analysis of Soils using ICP-MS and Discrete Sampling, Agilent publication, 5994-2933EN

Related information

Zou, A., Yamanaka, M., Intelligent Analysis of Wastewaters using an Agilent ICP-MS with Integrated Autodilutor, Agilent publication, 5994-7113EN

Riles, P., Productive Analysis of High Matrix Samples using ICP-MS with Advanced Dilution System, Agilent publication, 5994-7232EN

Consumables list

Product Type	Agilent Part Number	Description
Sample Loop for AVS MS/ADS 2	5005-0425	1.50 mL 1.00 mm ID 1/pk
Bottle Kits	5005-0435	Diluent/Carrier 6 L Bottle kit, includes a 6 L can, GL45 StaySafe cap, fittings, and venting valve
	5005-0436	Diluent 2 L PFA bottle kit for ICP-MS, includes 2 L PFA bottle, GL45 StaySafe cap, fittings, and venting valve
	5005-0437	Waste container kit, includes a 10 L waste can, S60 StaySafe cap, fittings, and acid vapor filter
AVS MS Tubing Kit	G8411-68202	AVS MS preconfigured kit
ADS 2 Tubing Kits	5005-0106	ADS 2 tubing kit, Valve C set-up, 2/pk
	5005-0107	ADS 2 tubing kit, Valve C - AVS MS Pump, 1/pk
	5005-0182	ADS 2 tubing kit, Valve C - AVS MS Valve, 1/pk
	5005-0102	ADS 2 tubing kit, Valve B set-up, 4/pk
	5005-0103	ADS 2 tubing kit, Valve A – Valve C, 1/pk
	5005-0105	ADS 2 tubing kit, Carrier/Diluent, 2/pk
	G8457-68004	ADS 2 tubing kit, Valve A - AVS MS Valve, 1/pk

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