

Determination of lanthanides by ion chromatography using non-suppressed conductivity and UV/VIS detection

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Summary

The simultaneous ion chromatographic determination of trace-levels of lanthanides (or lanthanoids) was achieved by using either direct non-suppressed conductivity detection or UV/VIS detection after post-column reaction (PCR) with arsenazo III at 655 nm. Conductivity detection under isocratic conditions resulted in an overall analysis time of approx. 70 minutes. In contrast, the determination of the lanthanides via gradient elution and subsequent spectrophotometric detection of the arsenazo III-lanthanide(III) complexes was performed within 22 minutes. Besides the outstanding analysis time, UV/VIS detection excelled by its enhanced selectivity and sensitivity and did not suffer from interferences by ubiquitous non-lanthanide impurities such as iron(III) or other transition metals.

For both conductivity and spectrophotometric detection, the inclusion of sample preconcentration steps lowered the limit of detection (LOD) to the sub-ppb range.

Introduction

Lanthanides, in the past often misleadingly called rare earths, are of increasing technological importance. They are widely used in lasers, lamps, lenses, magnets and as catalysts in the production of petroleum derivatives and synthetic compounds.

The lanthanide series consists of 15 chemically very similar elements (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) with atomic numbers 57 to 71. The most commonly applied analytical techniques for determining the lanthanide metals are atomic absorption spectroscopy, X-ray fluorescence, inductively coupled plasma-mass spectrometry (ICP-MS) and inductively coupled plasma-atomic emission spectroscopy (ICP-AES). Although these methods provide invaluable information, the high costs of instrumentation and the need for highly skilled operators are major drawbacks.

This poster presents two straightforward ion chromatographic methods for lanthanide analysis using either isocratic or gradient elution combined with conductivity detection or spectrophotometric detection after post-column reaction.

Instrumentation

Conductivity detection

- > 850 Professional IC – Cation
- > 858 Professional Sample Processor
- > Nucleosil 5SA
- > Nucleosil 5SA IC Guard Column Cartridge
- > Metrosep C PCC 1 Preconcentration Column

UV/VIS detection

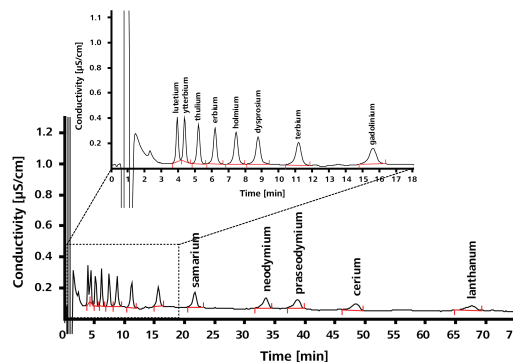
- > 850 Professional IC – Cation
- > 858 Professional Sample Processor
- > Nucleosil 5SA
- > Nucleosil 5SA IC Guard Column Cartridge
- > Metrosep C PCC 1 Preconcentration Column



> Lambda 1010 UV/VIS Detector

Non-suppressed conductivity detection

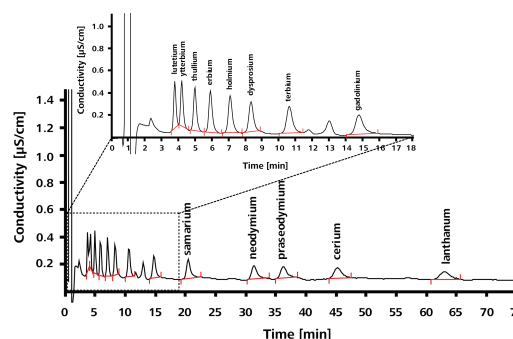
Direct injection of a 1 ppm standard



Eluent: 10 mmol/L α-hydroxy isobutyric acid
2 mmol/L ethylene diamine (pH ~ 3.8)

Flow: 1.5 mL/min
Loop: 100 µL

Preconcentration of 25 mL of a 10 ppb standard



The preconcentration volume was 25 mL. The chromatographic conditions correspond to those indicated above.

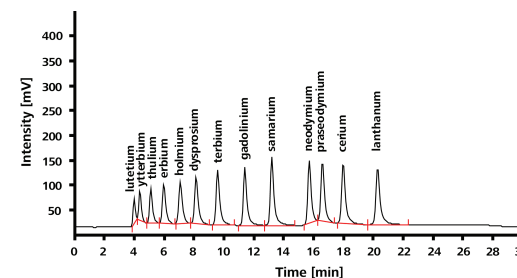
Calibration

	Lanthanide ¹												
	Lu	Yb	Tm	Er	Ho	Dy	Tb	Sm	Gd	Nd	Pr	Ce	La
Correlation coefficient	0.99862	0.99849	0.99885	0.99878	0.99892	0.99974	0.99892	0.99964	0.9992	0.99996	0.99869	0.99948	0.99871
Relative standard deviation [%]	3.188	3.334	2.903	2.995	2.815	1.388	2.950	1.621	2.359	0.532	3.104	1.952	3.081

¹each calibration curve is based on six different standard concentrations

PCR with subsequent UV/VIS detection

Direct injection of a 1 ppm standard



Eluent A: 50 mmol/L α-hydroxy isobutyric acid
10 mmol/L ethylene diamine (pH ~ 3.5)

Flow: 1.5 mL/min
Loop: 250 µL

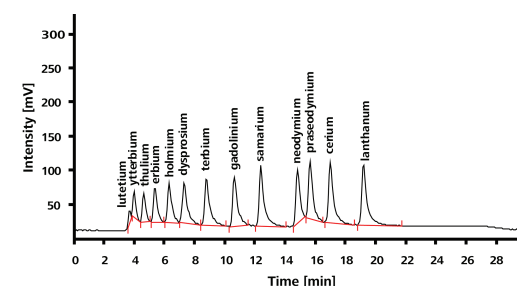
Eluent B: Ultrapure water

Gradient: 0.0 min 25% A 75% B
5.0 min 25% A 75% B
25.0 min 95% A 5% B
27.0 min 25% A 75% B
30.0 min 25% A 75% B

PCR reagent: 0.015% arsenazo III
0.1 mol/L phosphoric acid

PCR flow: 0.5 mL/min
Wavelength: 655 nm

Preconcentration of 25 mL of a 10 ppb standard



The preconcentration volume was 25 mL. The chromatographic conditions correspond to those indicated above.

Calibration

	Lanthanide ¹												
	Lu	Yb	Tm	Er	Ho	Dy	Tb	Sm	Gd	Nd	Pr	Ce	La
Correlation coefficient	0.99991	0.99742	0.99934	0.99947	0.99986	0.99976	0.99949	0.99879	0.99891	0.99897	0.99883	0.99879	0.99897
Relative standard deviation [%]	1.047	5.604	2.836	2.547	1.330	1.703	2.490	3.825	3.638	3.540	3.772	3.842	3.538

¹each calibration curve is based on six different standard concentrations