INTRODUCTION TO ENVIRONMENTAL ANALYSIS

Roger N. Reeve University of Sunderland, UK



Contents

Se	ries I	Preface	xiii		
Pr	eface		xv		
A	crony	ms, Abbreviations and Symbols	xix		
Al	out 1	the Author	xxiii		
1	Introduction				
	1.1	The Environment	1		
	1.2	Reasons for Concern	2		
		1.2.1 Today's World	4		
		1.2.2 Past and Current Crimes	4		
	1.3	Pollution	4		
	1.4	The Necessity of Chemical Analysis	8		
2	Tra	nsport of Pollutants in the Environment and			
	Approaches to their Analysis				
	2.1	Introduction	11		
	2.2	Sources, Dispersal, Reconcentration and Degradation	12		
	2.3	Transport and Reconcentration of Neutral Organic Compounds	15		
		2.3.1 Bioconcentration	16		
		2.3.2 Accumulation in Sediments	17		
		2.3.3 Biomagnification	18		
		2.3.4 Degradation	19		
	2.4	Transport and Reconcentration of Metal Ions	20		
		2.4.1 Solubilization	22		

		2.4.2 Deposition in Sediments	22	
		2.4.3 Uptake by Organisms	22	
	2.5	What is a Safe Level?	23	
	2.6	Sampling and Sample Variability	24	
		2.6.1 Representative Samples	24	
		2.6.2 Sample Storage	25	
		2.6.3 Critical Paths and Critical Groups	26	
	2.7	General Approach to Analysis	26	
	2.8	The Choice of Laboratory or Field Analysis	28	
	2.9	Quality Assurance	30	
		2.9.1 Finding a Suitable Method	32	
		2.9.2 Laboratory Standards	33	
3	Water Analysis – Major Constituents			
	3.1	Introduction	35	
	3.2	Sampling Management of Water Quality	41	
	3.3	Measurement of Water Quality 3.3.1 Suspended Solids	46 46	
		3.3.2 Dissolved Oxygen and Oxygen Demand	40	
		3.3.3 Total Organic Carbon	54	
		3.3.4 pH, Acidity and Alkalinity	55	
		3.3.5 Water Hardness	57	
		3.3.6 Electrical Conductivity	59	
	3.4	Techniques for the Analysis of Common Ions	61	
	٥.,	3.4.1 Ultraviolet and Visible Spectrometry	61	
		3.4.2 Emission Spectrometry (Flame Photometry)	68	
		3.4.3 Ion Chromatography	69	
		3.4.4 Examples of the Use of Other Techniques	73	
4	Water Analysis - Trace Pollutants			
	4.1	1 Introduction		
	4.2	Organic Trace Pollutants	78	
		4.2.1 Guidelines for Storage of Samples and their		
		Subsequent Analysis	80	
		4.2.2 Extraction Techniques for Chromatographic Analysis	81	
		4.2.3 Gas Chromatography	88	
		4.2.4 Liquid Chromatography	101	
		4.2.5 Immunoassay	105	
		4.2.6 Spectrometric Methods	110	
	4.3	Metal Ions	112	
		4.3.1 Storage of Samples for Metal Ion Analysis	112	
		4 3 2 Pretreatment	113	

Contents ix

		4.3.3	Atomic Spectrometry	114		
		4.3.4	1	124		
		4.3.5	Anodic Stripping Voltammetry	125		
		4.3.6	Liquid Chromatography	128		
		4.3.7	Metal Speciation: A Comparison of Techniques	131		
5	Ana	Analysis of Land, Solids and Waste				
	5.1	Introd	uction	135		
	5.2	Comn	non Problem Areas in the Analysis of Solids	138		
		5.2.1	Sampling	138		
		5.2.2	Pretreatment	139		
		5.2.3	Extraction of the Analyte	140		
		5.2.4	Sample Clean-up	140		
		5.2.5	Analytical Determination	141		
		5.2.6		141		
	5.3	Specif	ic Considerations for the Analysis of Biological Samples	142		
		5.3.1	Sampling and Storage of Plant Material	142		
		5.3.2		142		
		5.3.3		144		
		5.3.4				
			for Trace Metals	145		
		5.3.5	Analysis of Animal Tissues	146		
	5.4	Specific Considerations for the Analysis of Soils				
		5.4.1	Sampling and Storage	146		
		5.4.2	1 6	148		
		5.4.3	Extraction of Organic Contaminants	148		
			Extraction of Available Ions	149		
			Dissolution Techniques for the Determination of Total			
			Metal Concentrations in Soil	150		
		5.4.6	Determination of pH	150		
	5.5	Specific Considerations for the Analysis of Contaminated Land				
		5.5.1	Steps in the Investigation of Contaminated Land	152		
		5.5.2	Sampling, Sample Storage and Pretreatment	154		
	5.6	Specif	ic Considerations for the Analyses Involved in Waste			
		and its Disposal by Landfill				
		5.6.1	Types of Waste and their Disposal	156		
		5.6.2		158		
		5.6.3	Pretreatment of Solids and Liquids with a High			
			Solid Content	160		
		5.6.4	Analysis of Leachate	161		
		5.6.5	Introduction to Gaseous Emissions	164		

	5.7	7 Specific Considerations for the Analysis of Sediments		
		and S	ewage Sludge	165
		5.7.1	Sampling and Storage	165
		5.7.2	Pretreatment	165
		5.7.3	Extraction Techniques for Organic Contaminants	167
		5.7.4	Dissolution Techniques for Trace Metals	167
		5.7.5	Analysis of Sewage Sludge	168
	5.8	New 1	Extraction and Dissolution Techniques	168
		5.8.1	Automated Soxhlet	169
		5.8.2	Accelerated Solvent Extraction	169
		5.8.3	Microwave Digestion and Microwave-Assisted	
			Extraction	169
		5.8.4	Sonication	170
		5.8.5	Supercritical Fluid Extraction	170
		5.8.6	Comparison of the Techniques	172
6	Atmospheric Analysis – Gases			
	6.1	Introd	uction	175
			A Note on Units	181
	6.2	6.2 Determination of Time-Weighted Average Concentration		183
			Absorption Trains	183
			Solid Adsorbents	186
			Diffusion (or Palmes) Tubes	189
	6.3			191
		6.3.1	\mathcal{E}	191
		6.3.2		199
		6.3.3		201
		6.3.4	\mathcal{E}	205
		6.3.5	Remote Sensing and other Advanced Techniques	206
7	Atmospheric Analysis – Particulates			
	7.1	Introduction		
	7.2	Samp	ling Methods	216
		7.2.1	High-Volume Samplers	216
			Personal Samplers	217
			Cascade Impactors	218
		7.2.4	Further Considerations for Organic Compounds	219
		7.2.5	Sampling Particulates in Flowing Gas Streams	220
		7.2.6	PM ₁₀ Sampling	222
		7.2.7	Sampling of Acid Deposition	224

Contents xi

7.	.3	Analy	tical Methods Involving Sample Dissolution	225
		7.3.1	Metals	225
		7.3.2	Organic Compounds	226
7.	.4	Direct	Analysis of Solids	227
		7.4.1	X-Ray Fluorescence	227
		7.4.2	X-Ray Emission	229
		7.4.3	Neutron Activation Analysis	230
		7.4.4	Infrared Spectrometry	230
		7.4.5	Methods for Asbestos Analysis	230
8 U	Ultra-Trace Analysis			
8.	.1	Introd	uction	233
		8.1.1	What Groups of Compounds are We Discussing?	234
8.	.2	Analy	tical Methods	236
		8.2.1	General Considerations	236
		8.2.2	Factors Affecting Detection Sensitivity	237
		8.2.3	Mass Spectrometric Detection	239
		8.2.4	Quantification	245
		8.2.5	Quality Control	246
8.	.3	A Typical Analytical Scheme		246
		8.3.1	Pretreatment	248
		8.3.2	Gas Chromatography	250
Resp	ons	ses to S	Self-Assessment Questions	253
Bibliography			273	
Glossary of Terms Units of Measurement and Physical Constants Periodic Table				279
				285
				291
Index				293