Introduction

Analytical Geochemistry
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What is Analytical Chemistry?

The theory and methods used to determine the chemical compositions of materials.

What is Analytical Geochemistry?

The theory and methods used to determine the chemical compositions of geological materials. In this unit, however, we focus on geological materials relevant to the environment (soil, sediments and water).

Why do we care?

•The environment itself is nothing more than a large chemical system, so understanding its composition is fundamental.

•Chemical tracers are often used as “proxies” to identify processes in the environment.

Practical Applications

•We to measure concentrations of pollutants and nutrients in soil and water to assess environmental hazards and impacts.

•Geochemical analyses are a powerful tool when prospecting for ore deposits.

Example: Guidelines for Heavy Metals in Soils

Metal	Typical Soil Background England (mg/kg)	Soil Guideline Value (SGv) in mg/kg			
		Residential	Allotment	Commercial	Agricultural*
Pb	180	450	450	750	
As	32	10	43	640	50
Hg	0.5	10	26	26	
Ni	42	130	230	1800	
Cd	1.0	10	1.8	230	3
Cr		200	130	5000	400

Example: Allowable Limits/Guidelines for Heavy Metals in Drinking Water

Metal	**WHO limit (mg/L)**	**US EPA MCL (mg/L)**	**Health Effects**
Pb	0.01	0.015	Mental development
As	0.01	0.01	Skin damage, Cancer
Hg	0.006	0.002	Kidney Damage
Ni	0.07		
Cd	0.003	0.005	Kidney Damage
Cr	0.05	0.1	Cancer (Cr^{+6})

How do we measure concentrations in geochemical samples?

Method		Concentration Range	Applications
Classical Methods			
Volumetric		1-1000 mM	Alkalinity, Dissolved O_2
Gravimetric		> 0.1 wt. %	Sulfur, H_2O
Instrumental Methods			
Spectroscopy	Atomic (ICP-OES, XRF)	0.001ppm-100%	Most elements with Z > 3
	Molecular (UV-Vis Colorimetry)	0.001-100 ppm	Fe^{+2}/ Fe^{+3},
Chromatography	Gas Chromatography	0.1	Organic compounds
	Ion Chromatography		Anions: Cl-, SO_4^{-2}, NO_3^-
Electrochemistry	Voltammetry	0.001	Trace metals, speciation
	Ion-Selective Electrodes		pH, eH, dissolved O_2
Mass Spectrometry			Trace elements, Isotopes

Learning Objectives

- Be able to choose an analytical method for a particular problem.
- Be able to perform chemical calculations.
- Understand basic statistics and data handling.

Unit Assessment

• 5 practicals using analytical methods (50%). Each practical is to be written-up in a brief report giving background of method, results of measurements and statistical analysis.

•Final Examination (50%) covering chemical calculations, statistics and understanding of methods.