



Joint Research Program
Environmental Assessment of Coal Ash Leaching Properties and
Beneficial Use Applications using the Leaching Environmental
Assessment Framework (LEAF)

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Research Goals

1. Provide a scientifically sound, risk-informed basis for determining acceptable and unacceptable options for use of coal fly ash (FA) in Israel.

Must be protective of human health and environment

2. Adapt Leaching Environmental Assessment Framework (LEAF) to specific Israeli needs and conditions (hydrology, geology, ash types, etc.).
3. Develop specific technical foundation for Israeli criteria for FA use in cement and concrete, infrastructure, roadways, and agriculture.
4. Carry out targeted data analysis and research to fill key information gaps.
5. Use FA as a pilot for consistent environmental evaluation framework across wide range of materials and applications.

LEAF - Research Outline

- Usage of EPA LEAF test methods
- Use LeachXS for data management and as an evaluation tool
- Geochemical speciation modeling as a tool to guide experiments and interpret results
- Evaluation of the effect of partial carbonation on previous FA containing cement mixtures test
- Investigation of upper boundaries of FA usage in concrete and cementitious materials
- Laboratory testing of agricultural applications using FA (and FA-containing products) for Israeli soils
- Potential use examination of stable isotope analysis as a tracing tool in agricultural use of FA applications
- Development of a framework tailored to Israeli conditions for consistent, risk-informed evaluation of potential FA uses in road construction, infrastructure and agriculture.

Specific Research Objectives

1. (i) increase familiarity and efficiency in use of EPA Leaching Environmental Assessment Framework (LEAF) test methods and interpretation approaches, along with use of LeachXS as a data management and evaluation tool.
(ii) develop a LeachXS database of all results from testing of Israeli coal ash samples and ash derived products, along with comparative information from other sources.
2. evaluate the effect of high FA use rates in concrete and cementitious materials to understand the upper bounds to potential usage rates.
3. evaluate the potential for agricultural use of FA (and FA-containing products) based on testing results from Israeli reference soils and ashes.
4. Develop and recommend a framework, with example calculations, for evaluation of fly ash use in paving, infrastructure and agricultural applications that would be tailored to specific Israeli conditions.

Scientific Advisory Committee Tasks and Responsibilities

- 1. to insure that critical questions regarding coal ash use in Israel are being addressed;**
- 2. to review specific experimental objectives and plans;**
- 3. to review results and reports prior to finalization;**
- 4. to provide the research team with input on Israeli and US perspectives on coal ash use, including related initiatives within their respective organizations;**
- 5. to insure that research will provide needed support to development of practical and relevant Israeli regulations**

Scientific Advisory Committee

Participants - Agriculture

- **The Israel Ministry of Environmental Protection**
- **The Israel Ministry of Health**
- **Israel Water Authority**
- **Israel Ministry of Agriculture**
- **Israel Ministry of Transport / National Roads Authority**
- **National Coal Ash Board (NCAB)**
- **US Environmental Protection Agency (EPA) - scientific & regulation perspectives**



Task 1 – Enhancing Israeli Capability in Use of LEAF and LeachXS

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Conventional FA Leaching methods

TCLP

EPA Test Method 1311 - TCLP,
Toxicity Characteristic Leaching Procedure

The TCLP, or Toxicity Characteristic Leaching (not Leachate) Procedure is designed to determine the mobility of both organic and inorganic analytes present in liquid, solid, and multiphasic wastes. This is usually used to determine if a waste may meet the

**EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM**

EN 12457-2

September 2002

ICS 13.030.10; 13.030.20

English version

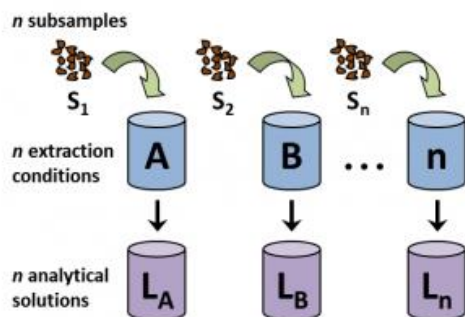
EN

Characterization of waste – Leaching
Compliance test for leaching of granular waste
materials and sludges

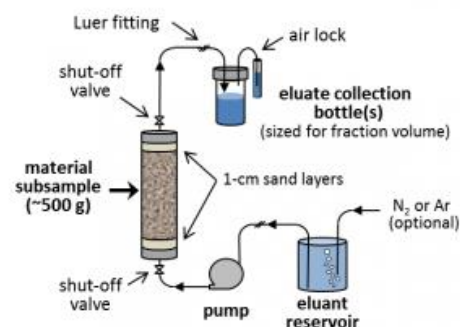
Part 2: One-stage batch test at a liquid to solids ratio of 10 l/kg for materials
with a particle size below 4 mm (with or without size reduction)

Enhancing Israeli Capability in Use of LEAF and LeachXS

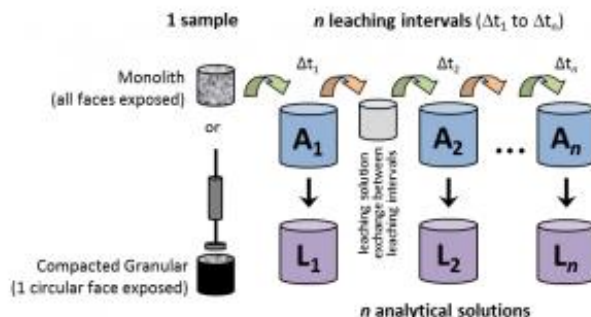
Increase Israeli familiarity in use of EPA Leaching Environmental Assessment Framework (LEAF) test methods and interpretation approaches, along with use of LeachXS as a data management and evaluation tool.



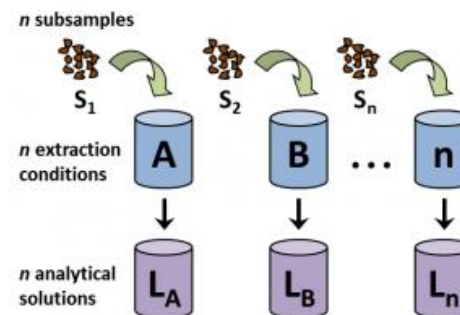
Method 1313 – pH-dependence



Method 1314 – Percolation Column



Method 1315 – Mass Transfer Rates



Method 1316 – Batch L/S

Israeli LeachXS Database



Previous Data:
Total content
pH dependence (1313)
monolith (tank test; 1315)
Leaching: TCLP, EN 12457-2



Implementation of GSI data
(2004-present) into a
dataset containing US-EPA
Coal Combustion Residues
(CCRs) and Cementitious
materials

Granular Material Comparisons

Case Manager | Statistics | Graphs Layout | Values below DTL | Help

Granular Materials Comparison

Follow the steps below to select materials and constituents to analyze and graph leaching data

Step 1: Select pH Dependent Data

Skip this step to exclude pH dependent data

- Coal fly ash IS Blend (P,1,1)
- Coal fly ash Israel FM2 (P,1,1)
- La Loma LS 012012 (B,1,1)
- La Loma LS 012012 (B,2,1)
- LS Blend 012012 (B,1,1)
- LS Blend 012012 (B,2,1)

Buttons: Select..., Delete, Clear

☐ Add overall polynomial fit curve

☐ Include percolated materials in graph

Display Units

☒ Show pH <-> Leaching in mg/kg

☒ Show pH <-> Leaching in mg/L

Composition and Availability

☐ Show total composition, if available

☐ Show availability, if available

Material Line Scheme

<Default>

Buttons: Default, Edit..., Select...

Step 2: Select Percolation L/S Data

Skip this step to exclude percolation and L/S data

Buttons: Select..., Delete, Clear

Graphing Options

☒ Show L/S <-> Release (mg/kg)

☒ Show L/S <-> Concentration (mg/L)

☐ Show L/S <-> pH

Curve Fitting and Weights

☐ Show fitted E values

☐ Show fitted exponential model values

Weights: None

Material Line Scheme

<Default>

Buttons: Default, Edit..., Select...

Step 3: Select Constituent

Pick the constituent that is the subject of your comparison

Buttons: Select..., Clear

☐ Use pH Dependent regulatory thresholds

Regulatory Thresholds

Lower pH limit: 7.00

Upper pH limit: 10.00

High threshold: 0 mg/kg

Buttons: Select...

☐ Include own pH

☐ Show indicator lines

Indicator Lines Definition

<No indicator lines>

Buttons: Select...

Step 4a: Graph

Click View Graph to generate graphs and export data based on your selections.

Buttons: View Graph >

Step 4b: Export

Click Bulk Export to generate an Excel workbook with graphs and data for more than one constituent at a time.

Buttons: Bulk Export >

<unnamed case>

Israeli Data Implementation

Total content 2004-2013; ~10 FAs/year; 10 major and 20 trace elements

(Monolith: CLSM, grout)



pH dependence (two 2011 FAs): full range (pH 2-13):

BB-Prime & Newlands (15 % ash)

Leaching:

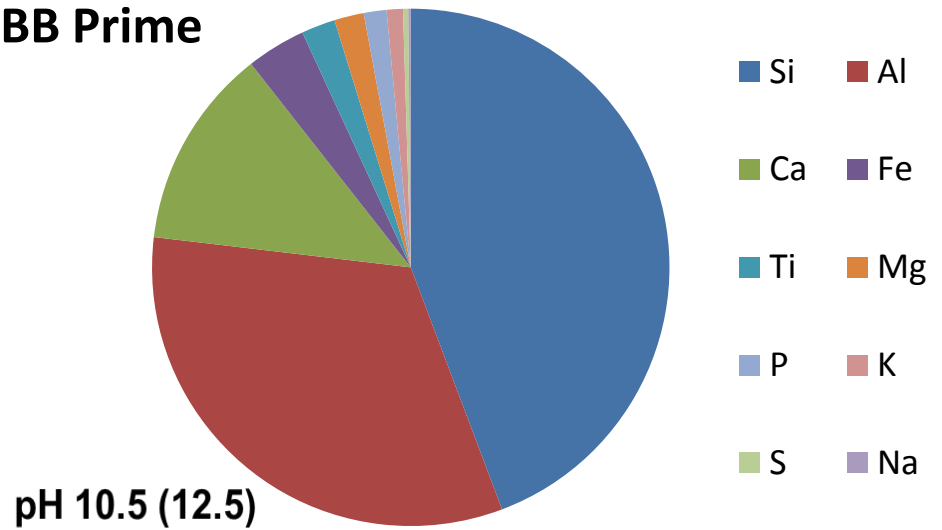
TCLP (2004-2013) - acidic (low pH)

EN 12457-2 (2008-2013) natural (high pH)

Sampled	Mind	Provider	Country
15.2.11	BB Prime	Billiton	
4.5.11	Newlands	MIM	

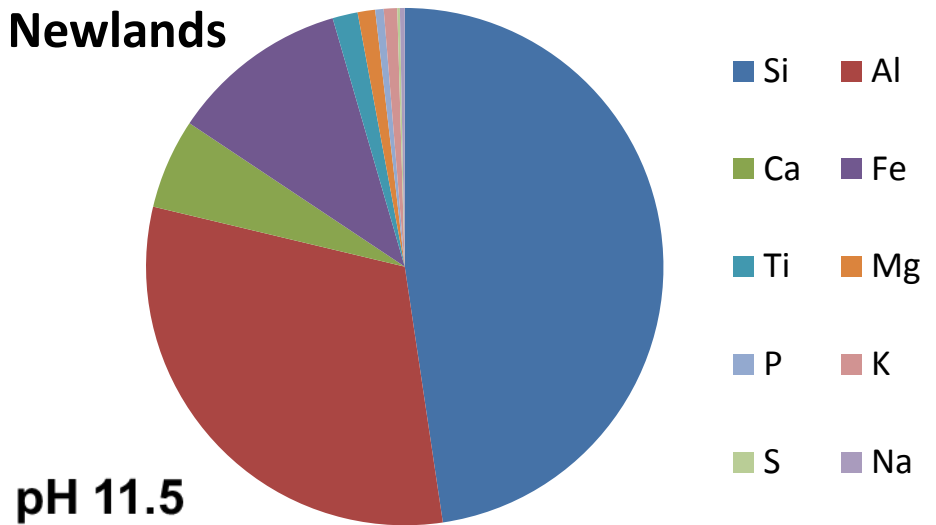
Fly ash composition

BB Prime



pH 10.5 (12.5)

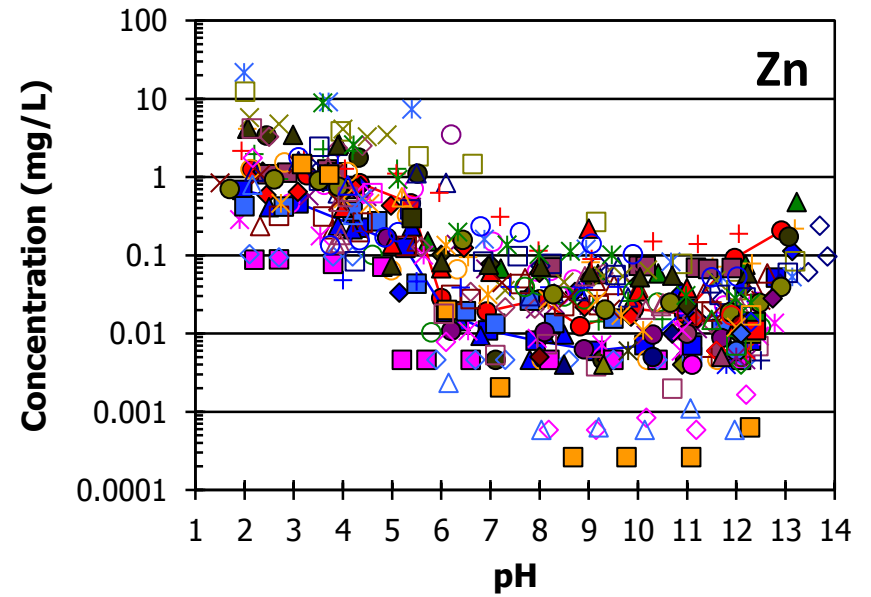
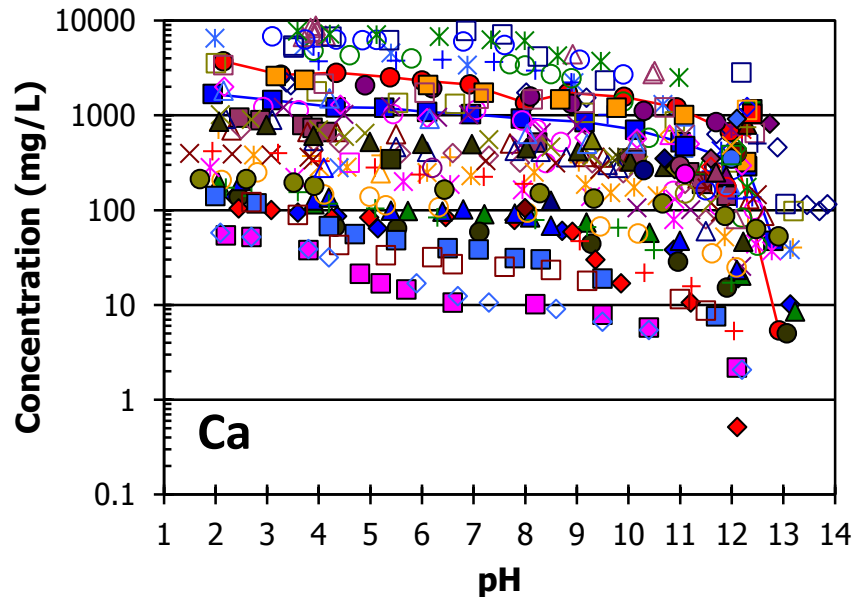
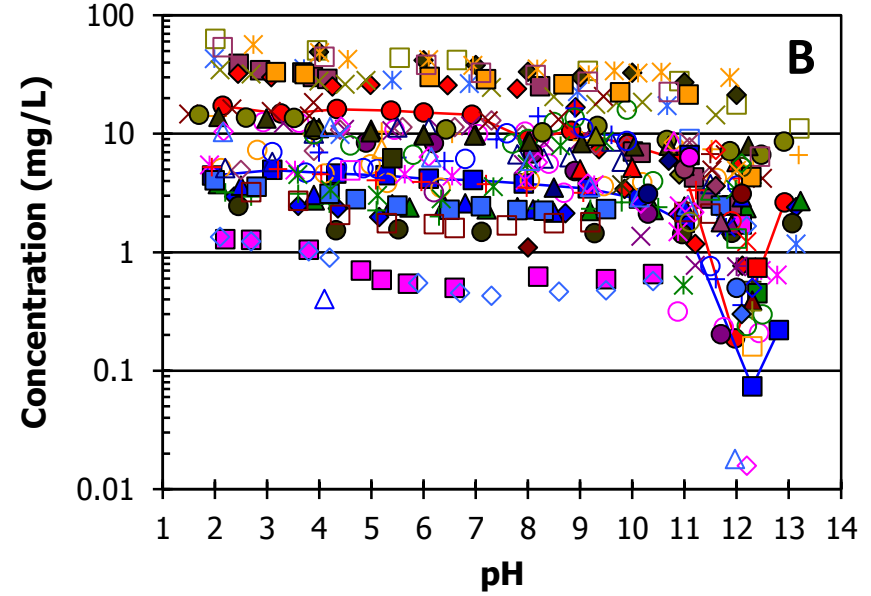
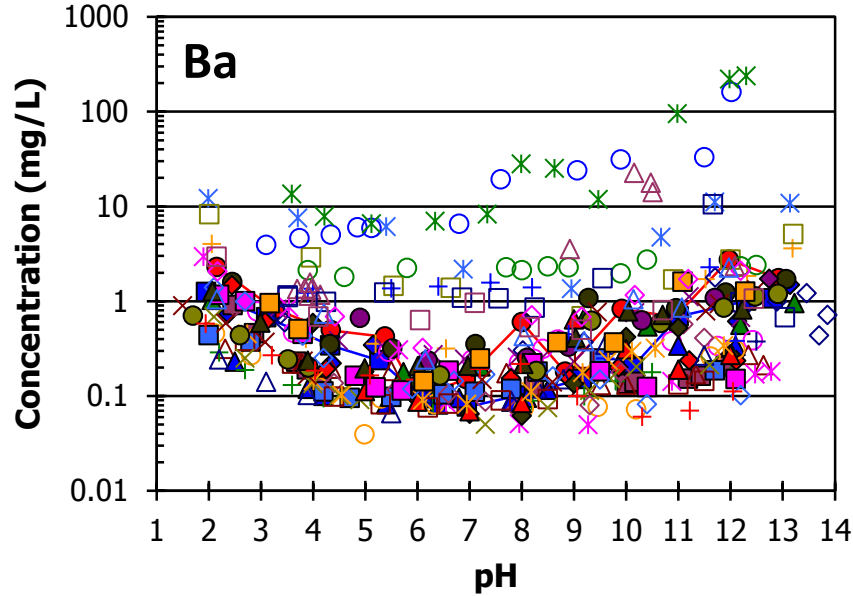
Newlands



pH 11.5

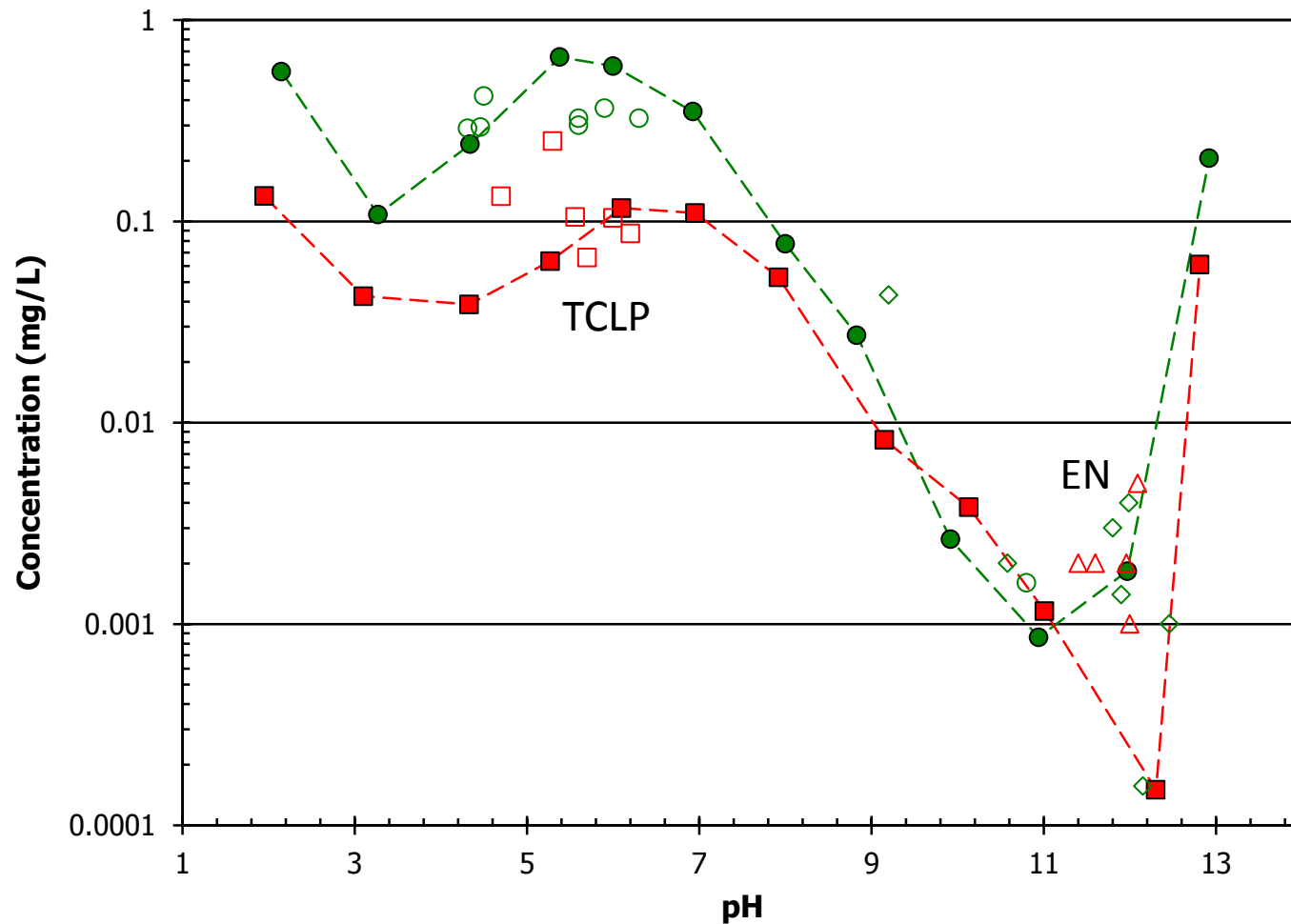
pH dependence **BB-Prime** & **Newlands** with worldwide data

Israeli Data Implementation



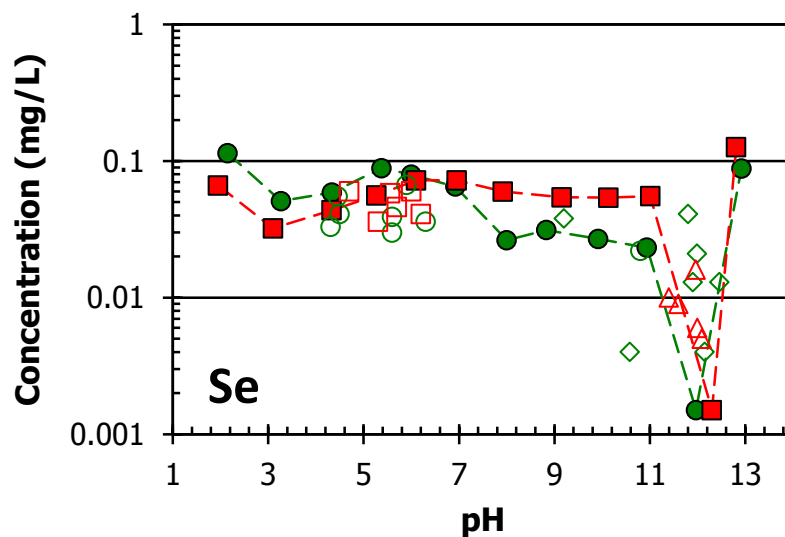
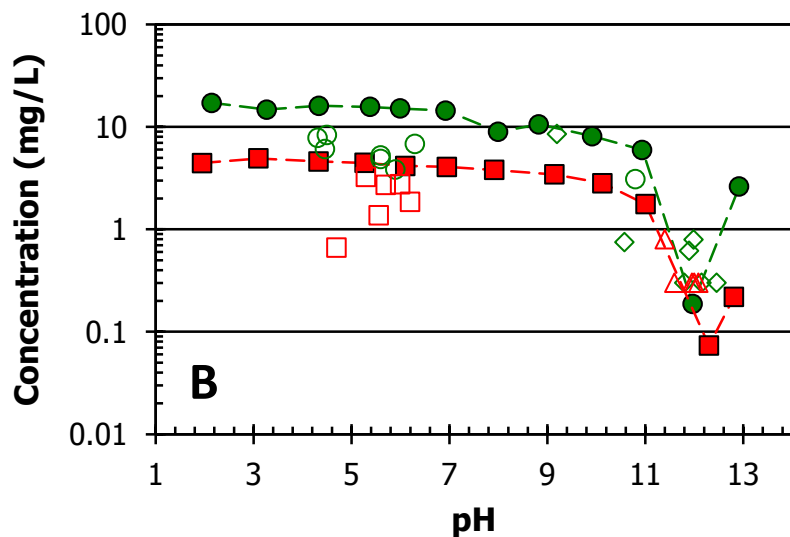
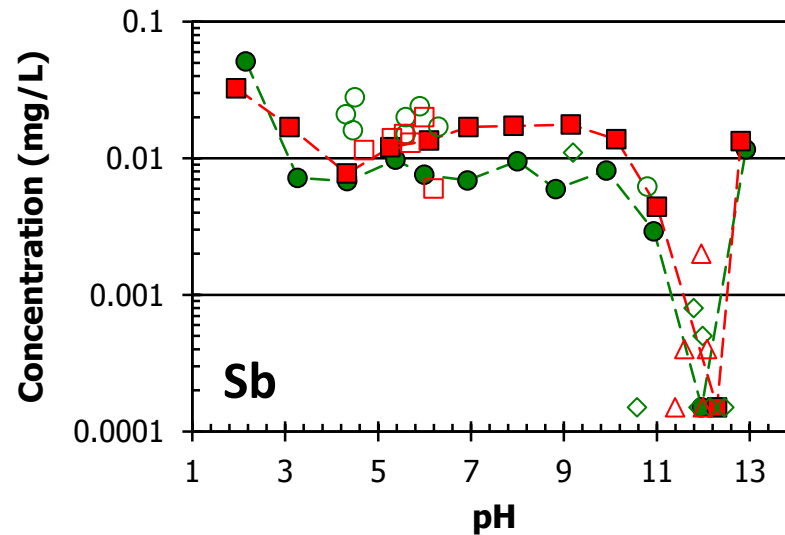
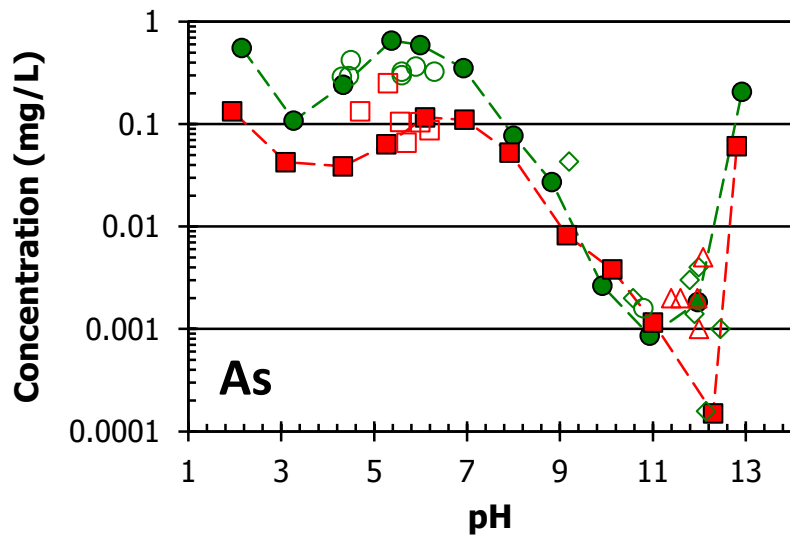
pH dependent concentrations of As

BB-Prime & Newlands with EN & TCLP

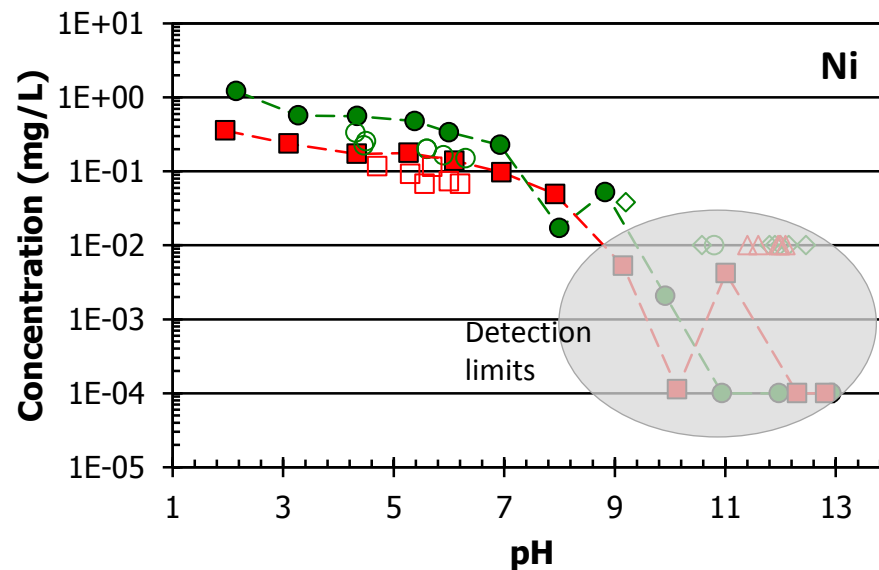
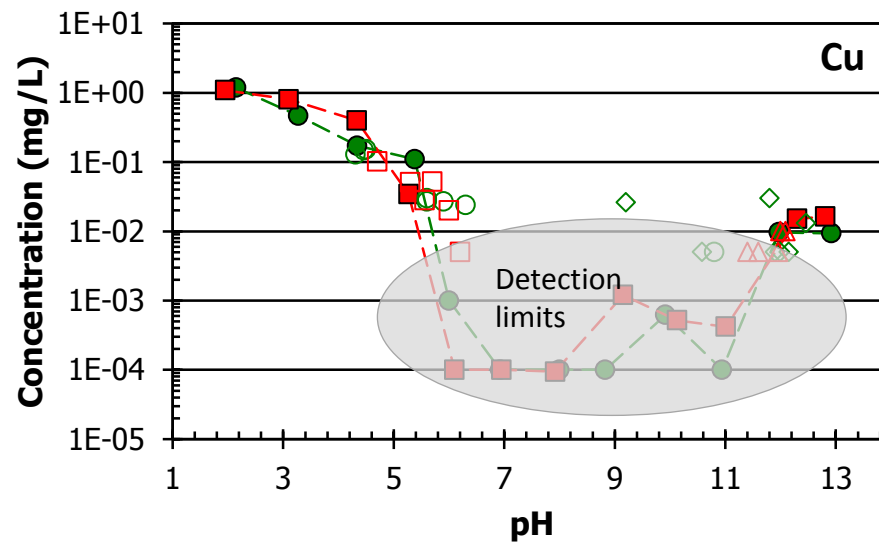


Oxyanions release in pH ~12

BB-Prime & Newlands with EN & TCLP (Ettringite?)



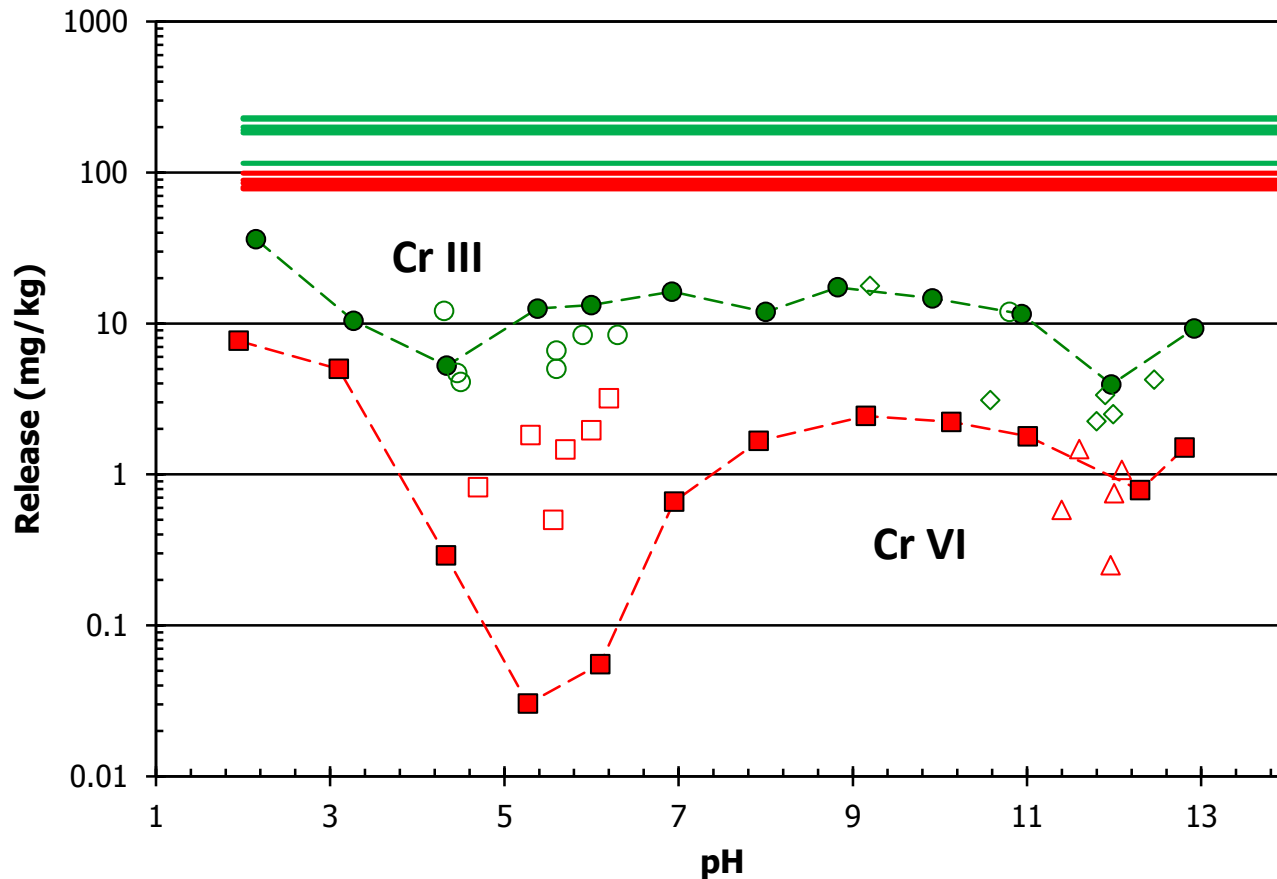
Metal ions **BB-Prime** & **Newlands** with EN & TCLP



pH dependent concentrations of Cr

BB-Prime & Newlands with total content, EN & TCLP

Different behaviour of the two FA

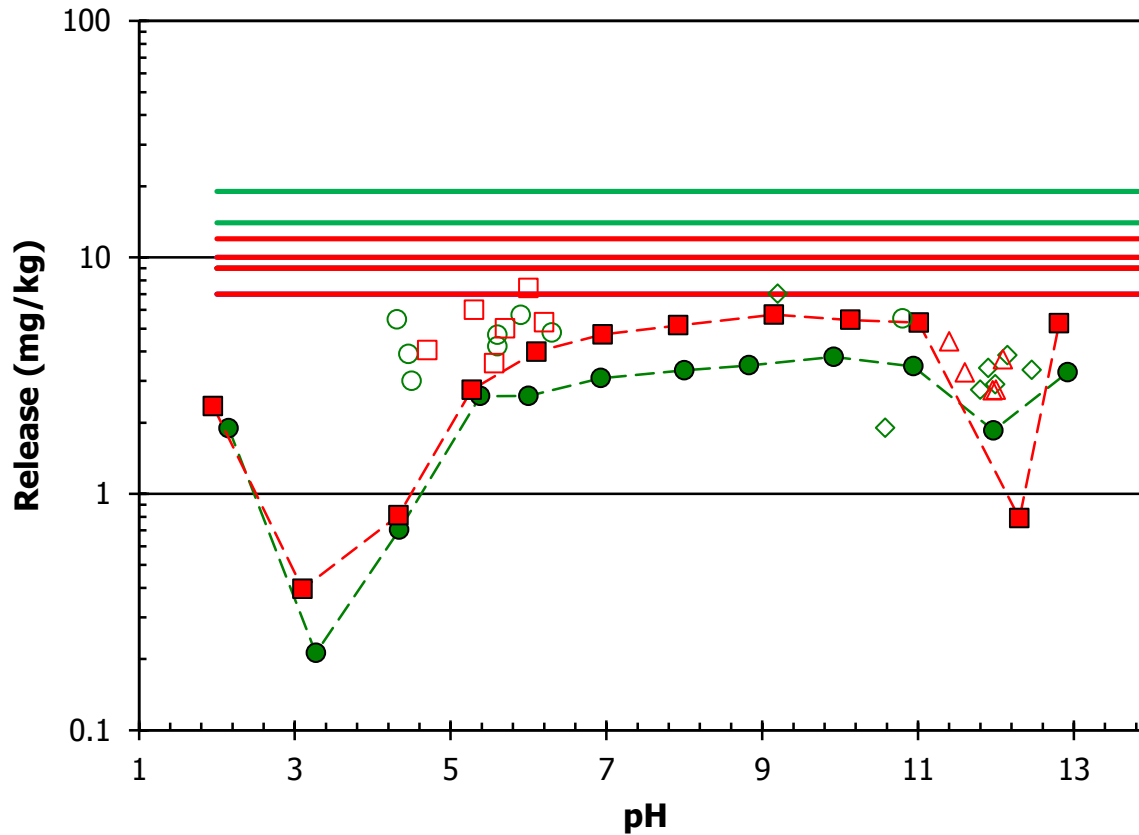


Leach mg/L is 0.1 x mg/kg (L/S = 10)

pH dependent concentrations of Mo

BB-Prime & Newlands with total content, EN & TCLP

Substantial amount of Mo is being leached (more for BB Prime)

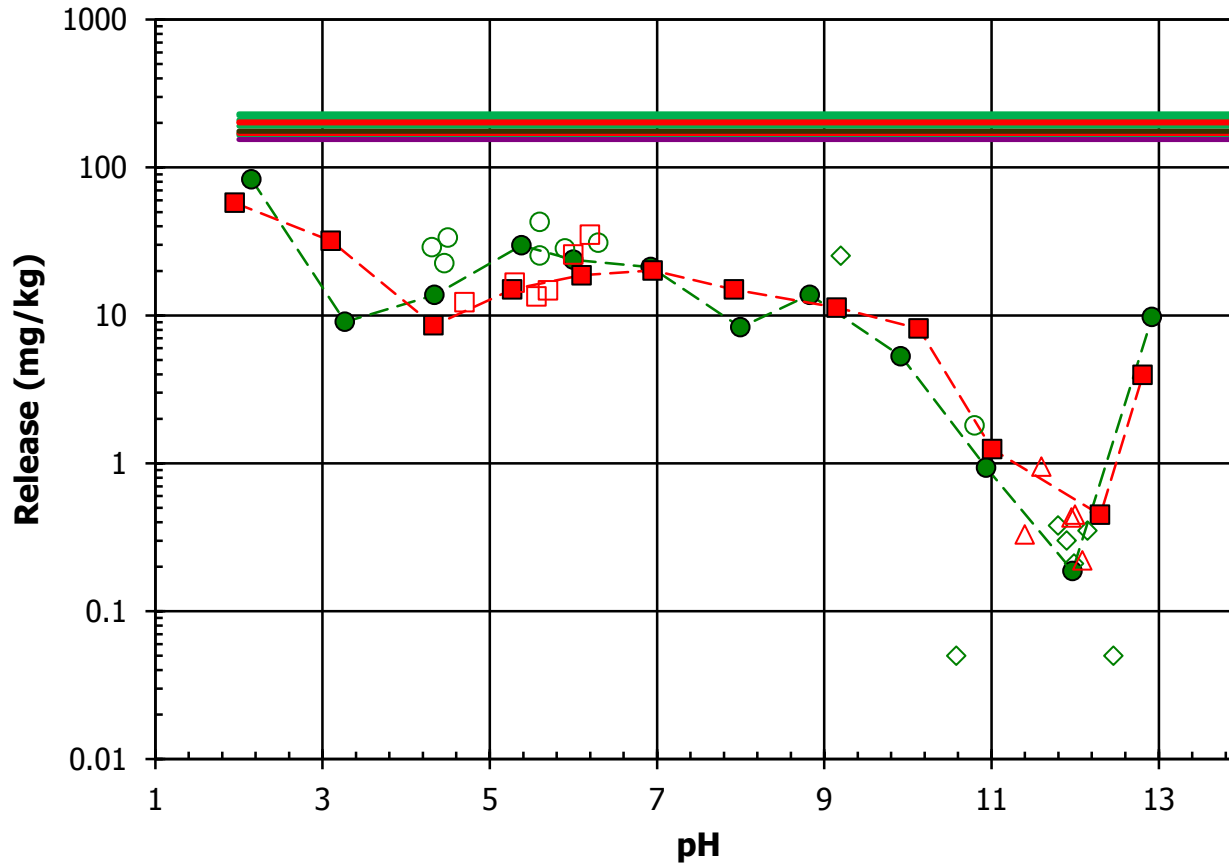


Leach mg/L is $0.1 \times \text{mg/kg}$ ($L/S = 10$)

pH dependent concentrations of V

BB-Prime & Newlands with total content, EN & TCLP

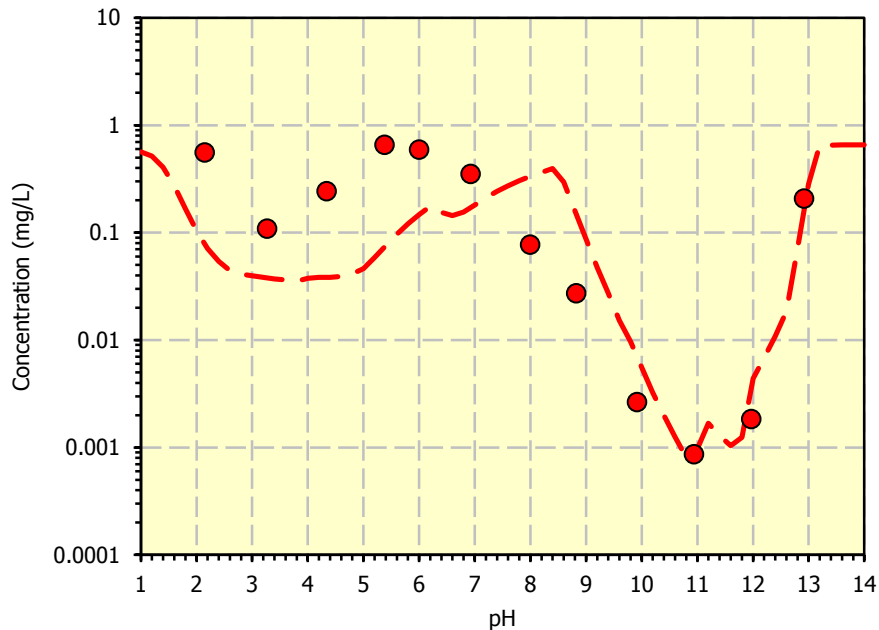
Strong similarities between the FAs with leaching properties



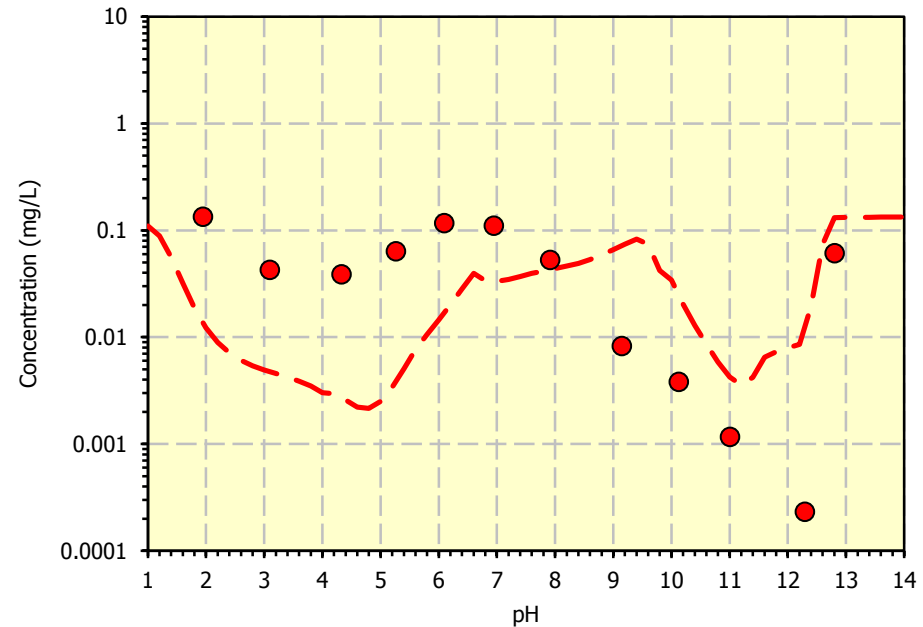
A taste of modeling

Modeled expected As vs. measured in pH dependence test

BB-prime



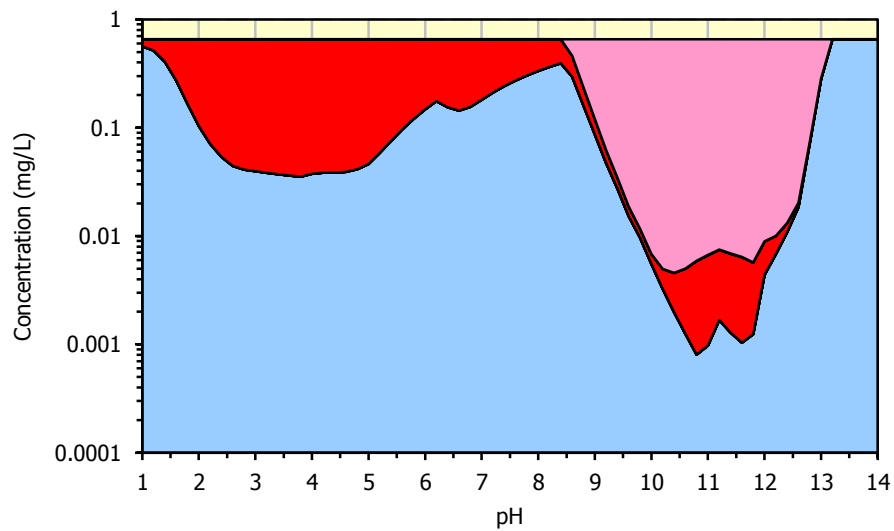
Newlands



A bit more of modeling

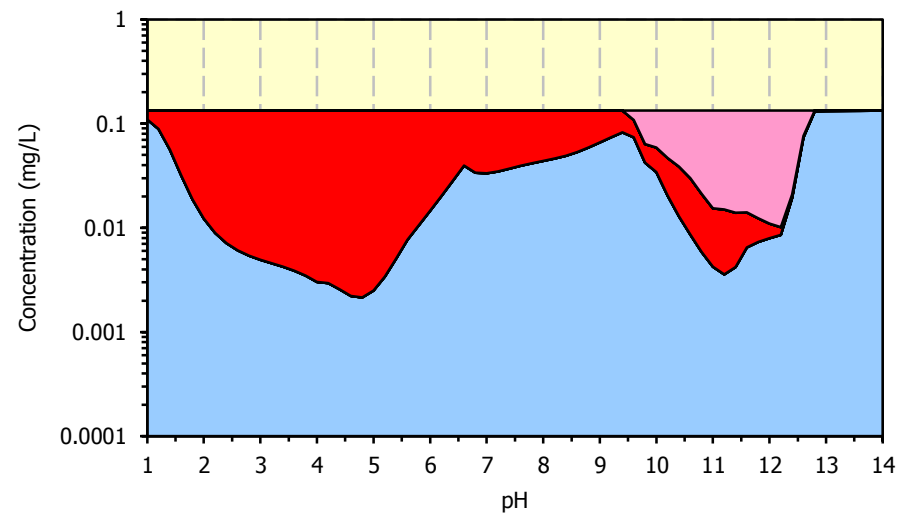
Phase distribution of As

BB-Prime



Free DOC-bound POM-bound FeOxide Clay ettr_ss Ca5[OH][AsO4]3[c]

Newlands



Free DOC-bound POM-bound FeOxide Clay ettr_ss Ca5[OH][AsO4]3[c]