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

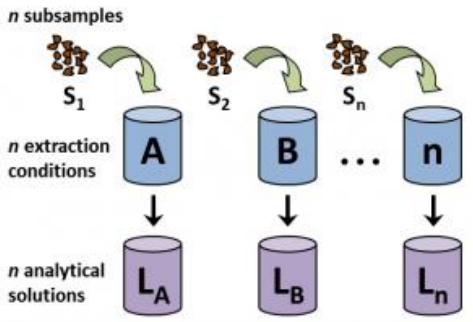
EN

English version

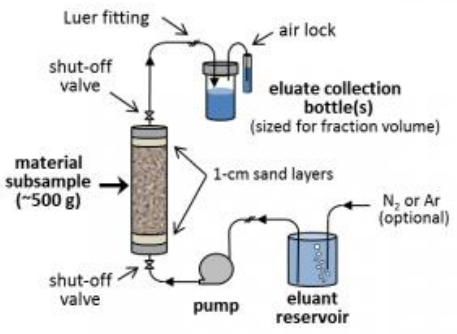
Characterization of waste – Leaching
Compliance test for leaching of granular waste materials and sludges
Part 2: One-stage batch test at a liquid to solids ratio of 10 l/kg for materials with a particle size below 4 mm (with or without size reduction)

Enhancing Israeli Capability in Use of LEAF and LeachXS

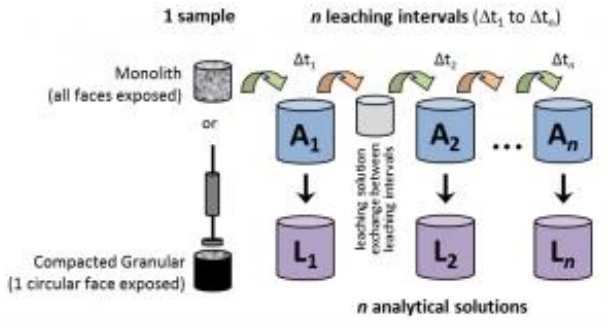
Increase Israeli familiarity in use of EPA Leaching Environmental Assessment Framework (LEAF) test methods and interpretation approaches, along with use of LeachXS as a data management and evaluation tool.



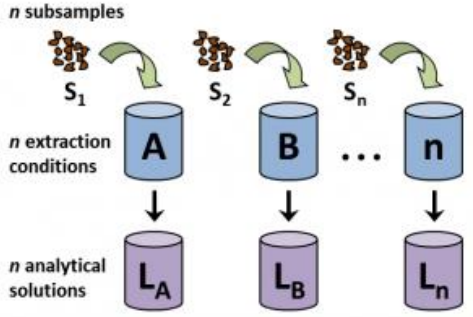
Method 1313 – pH-dependence



Method 1314 – Percolation Column



Method 1315 – Mass Transfer Rates



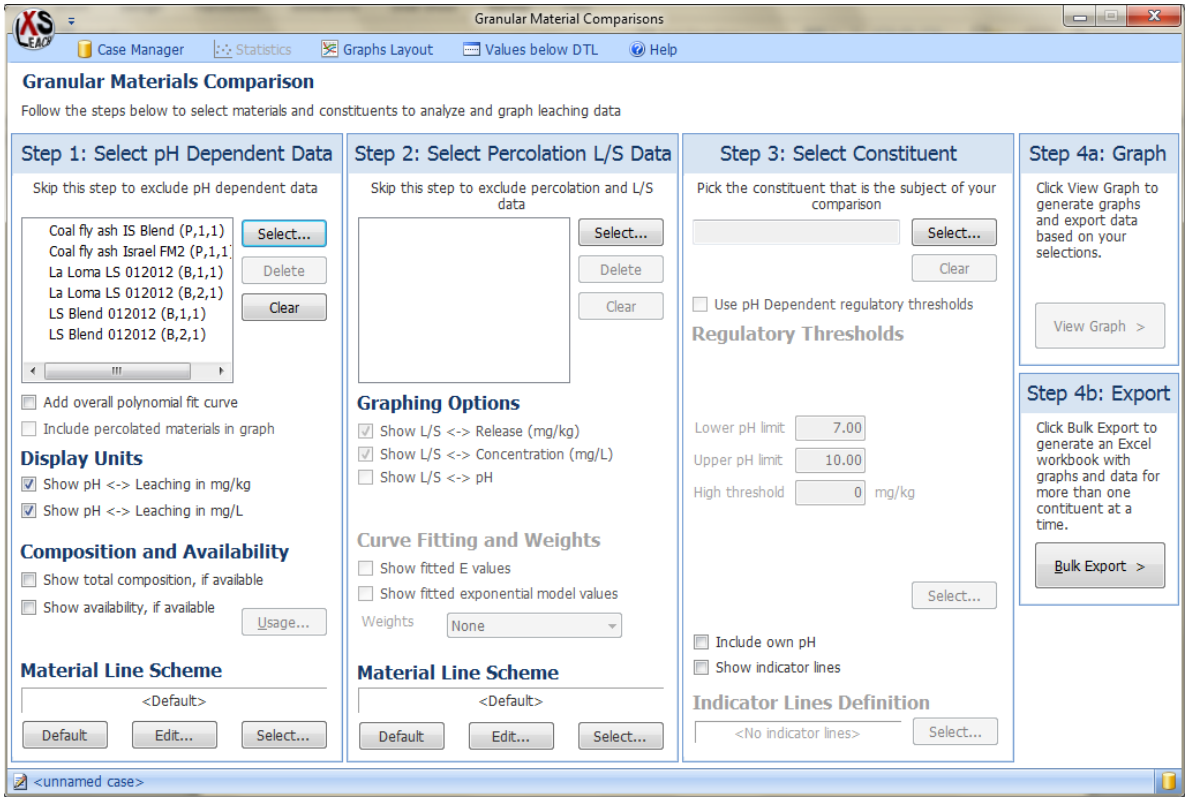
Method 1316 – Batch L/S

Israeli LeachXS Database

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

L E A F
Leaching Environmental Assessment Framework

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



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)

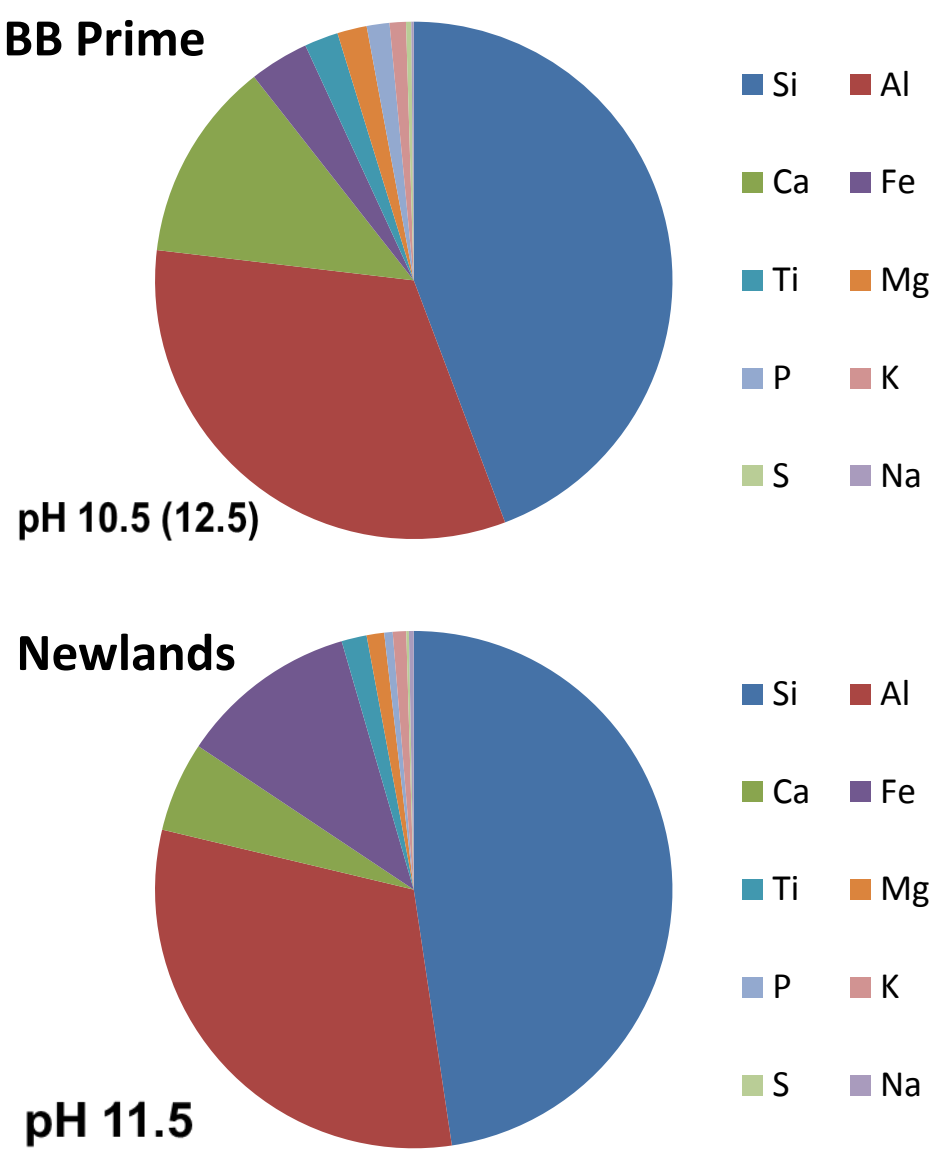
Leaching:

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

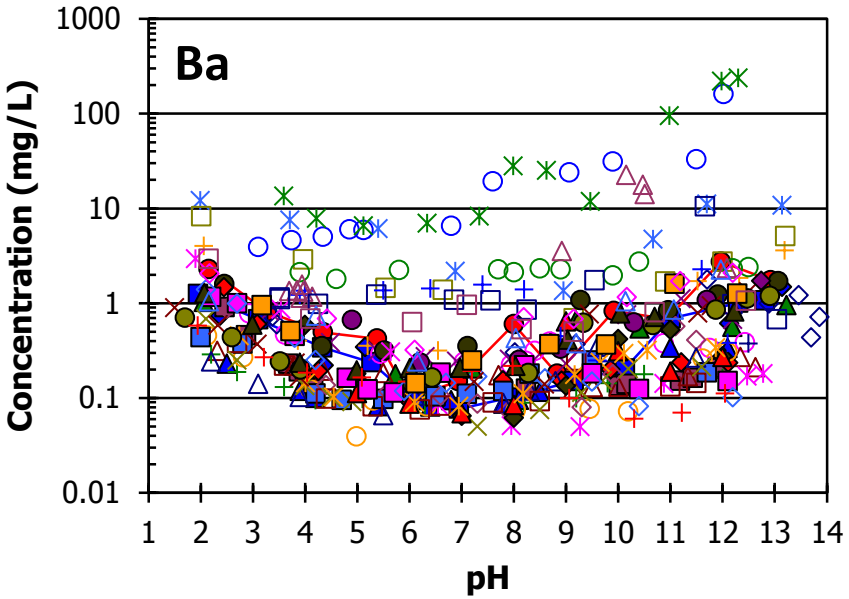
EN 12457-2 (2008-2013) natural (high pH)

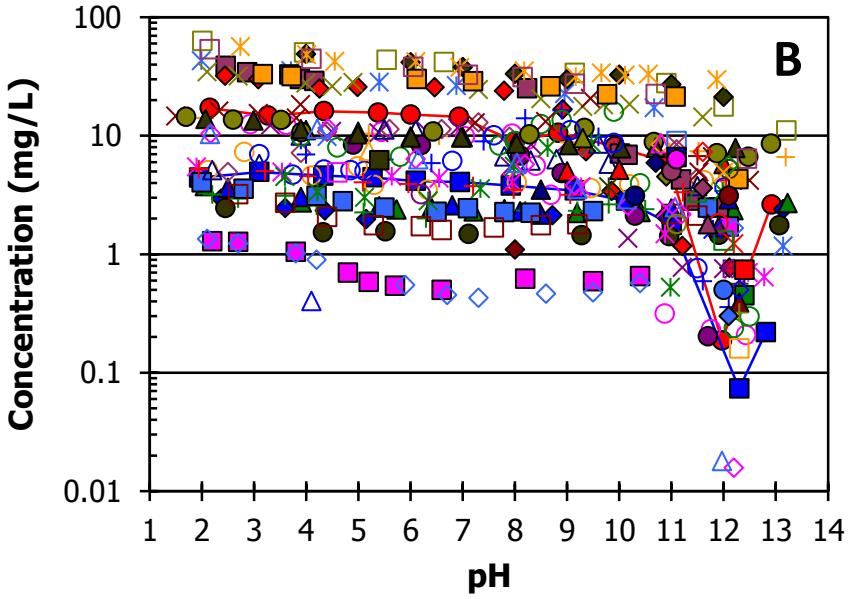
Sampled	Mind	Provider	Country
15.2.11	BB Prime	Billiton	
4.5.11	Newlands	MIM	

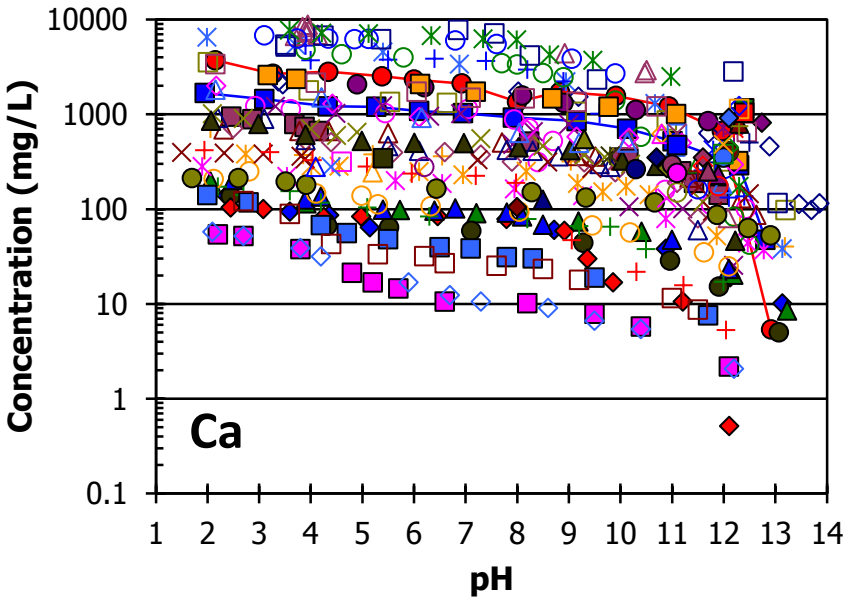
Fly ash composition

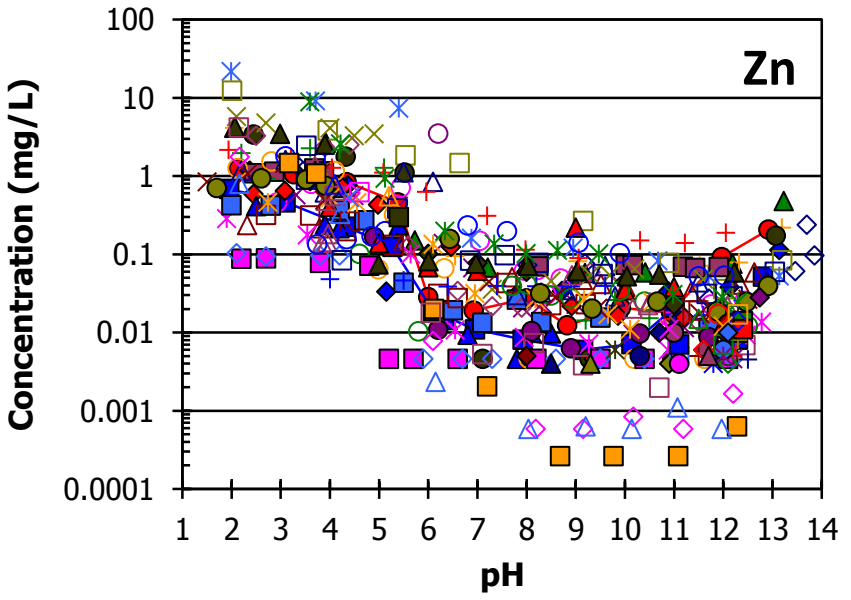


pH dependence BB-Prime & Newlands with worldwide data
Israeli Data Implementation

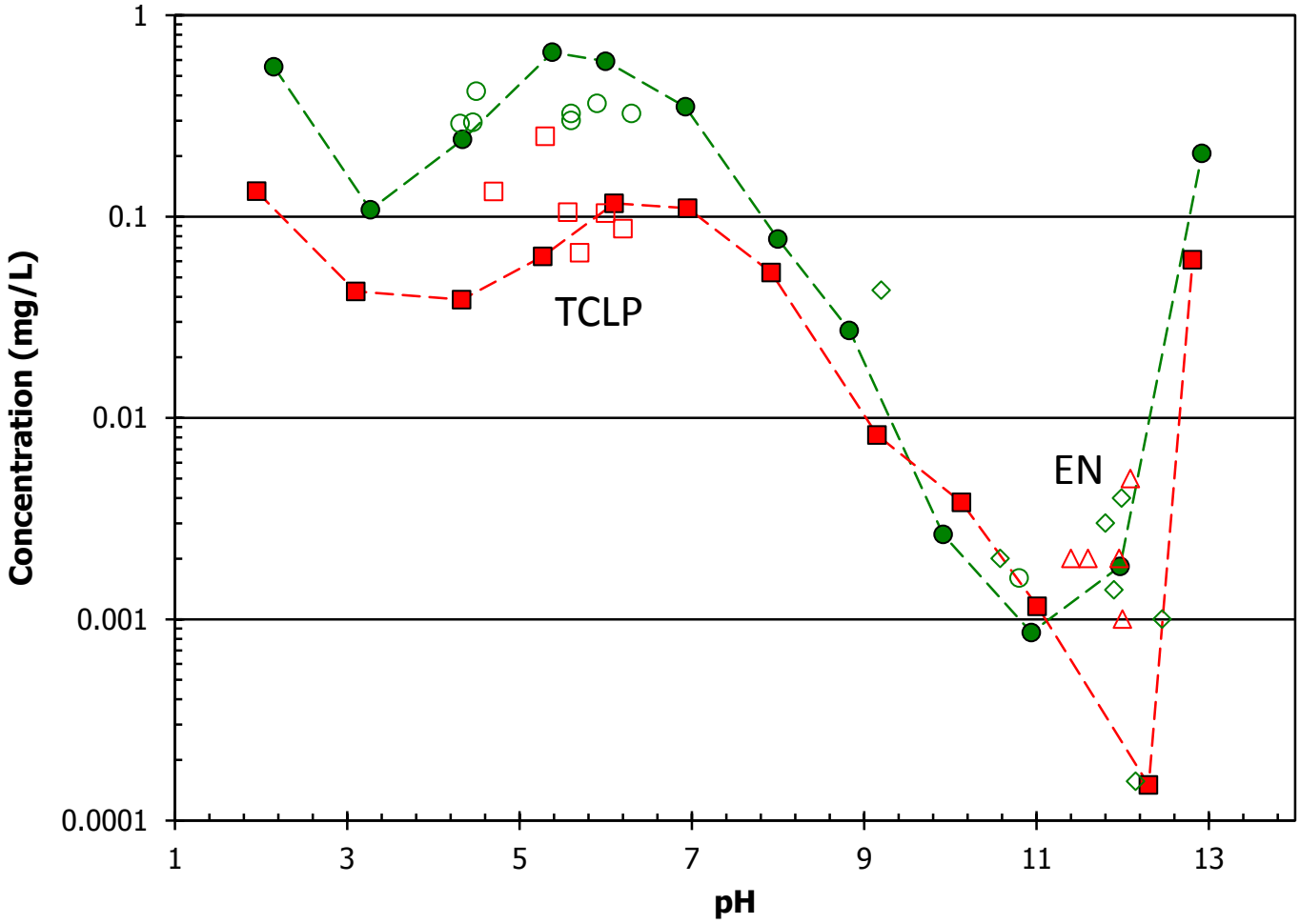






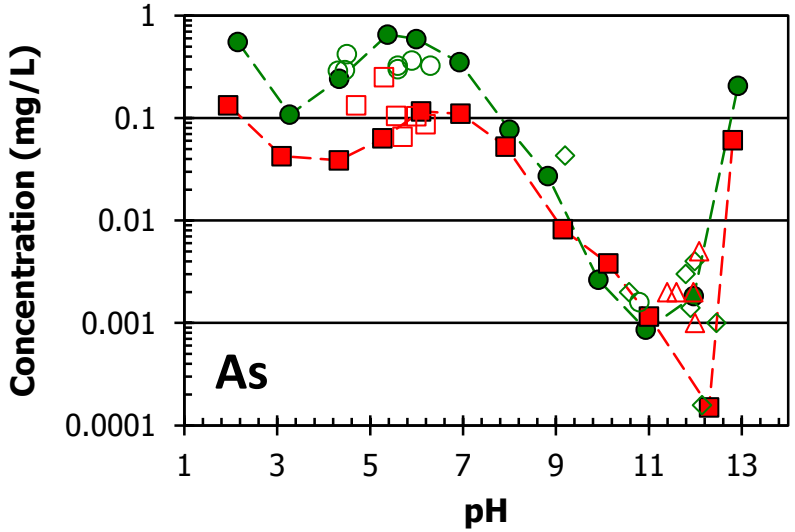


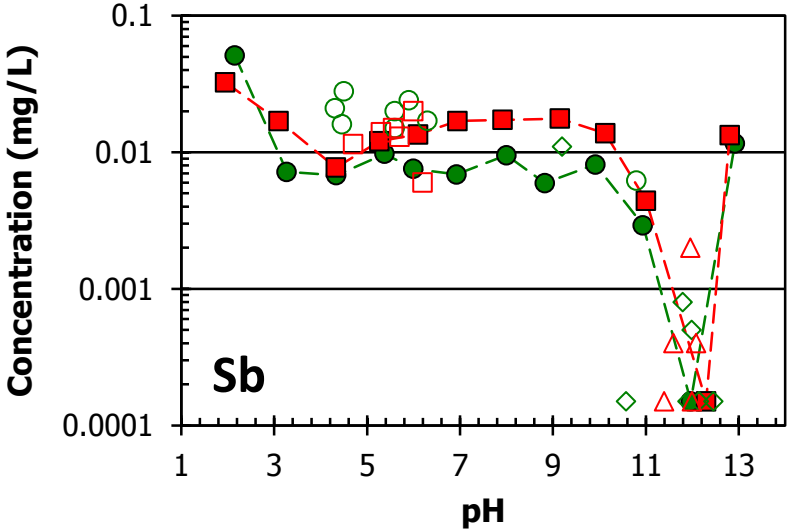
pH dependent concentrations of As
BB-Prime & Newlands with EN & TCLP

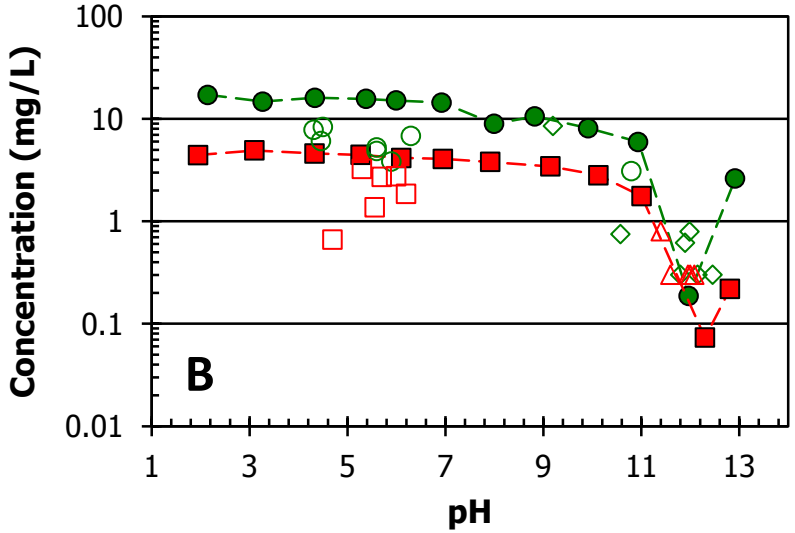


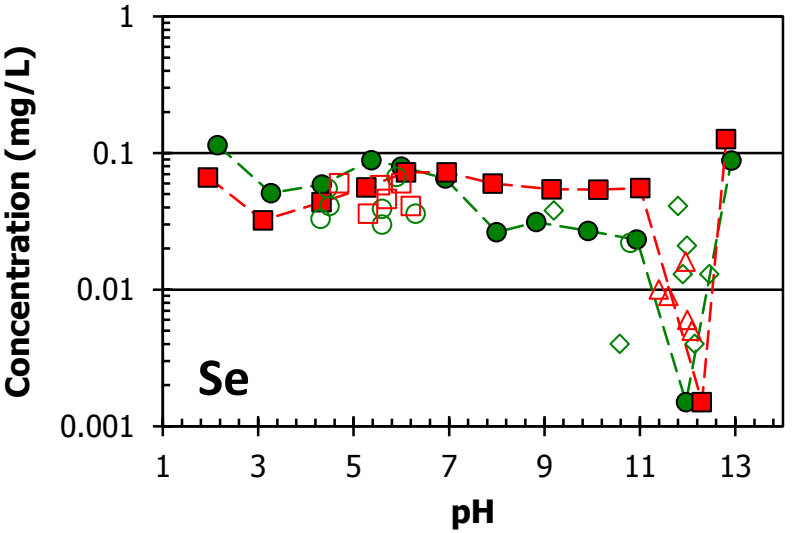
Oxyanions release in pH ~12

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

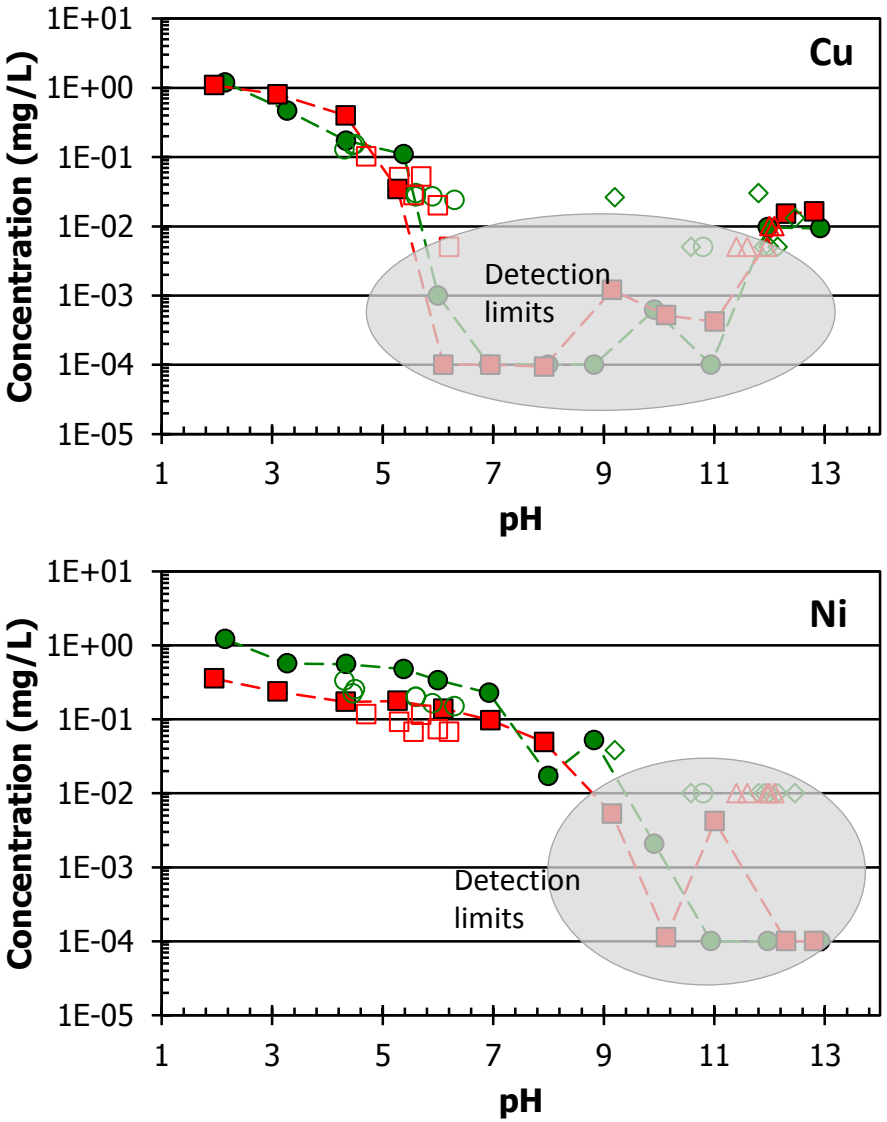








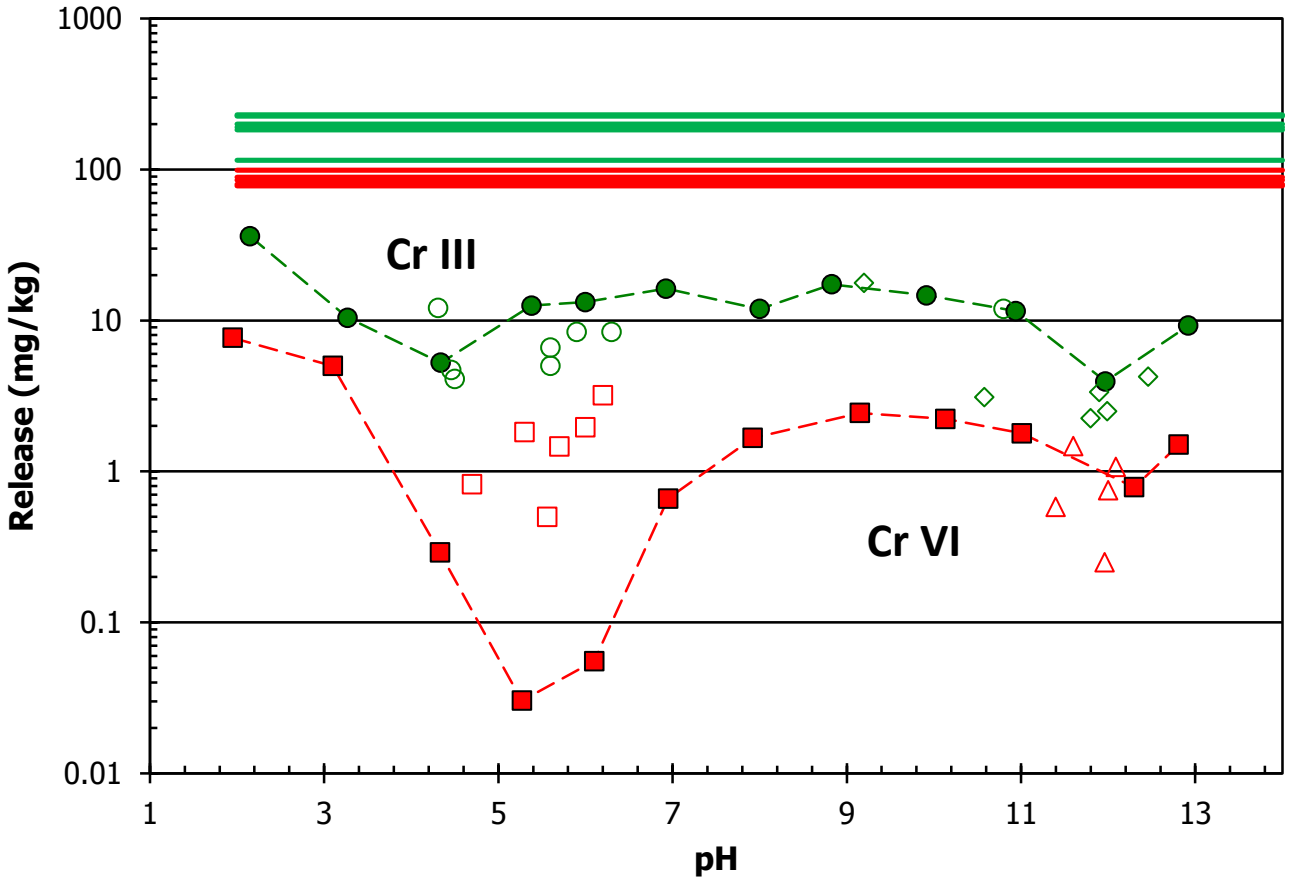
Metal ions BB-Prime & Newlands with EN & TCLP



pH dependent concentrations of Cr

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

Different behaviour of the two FA

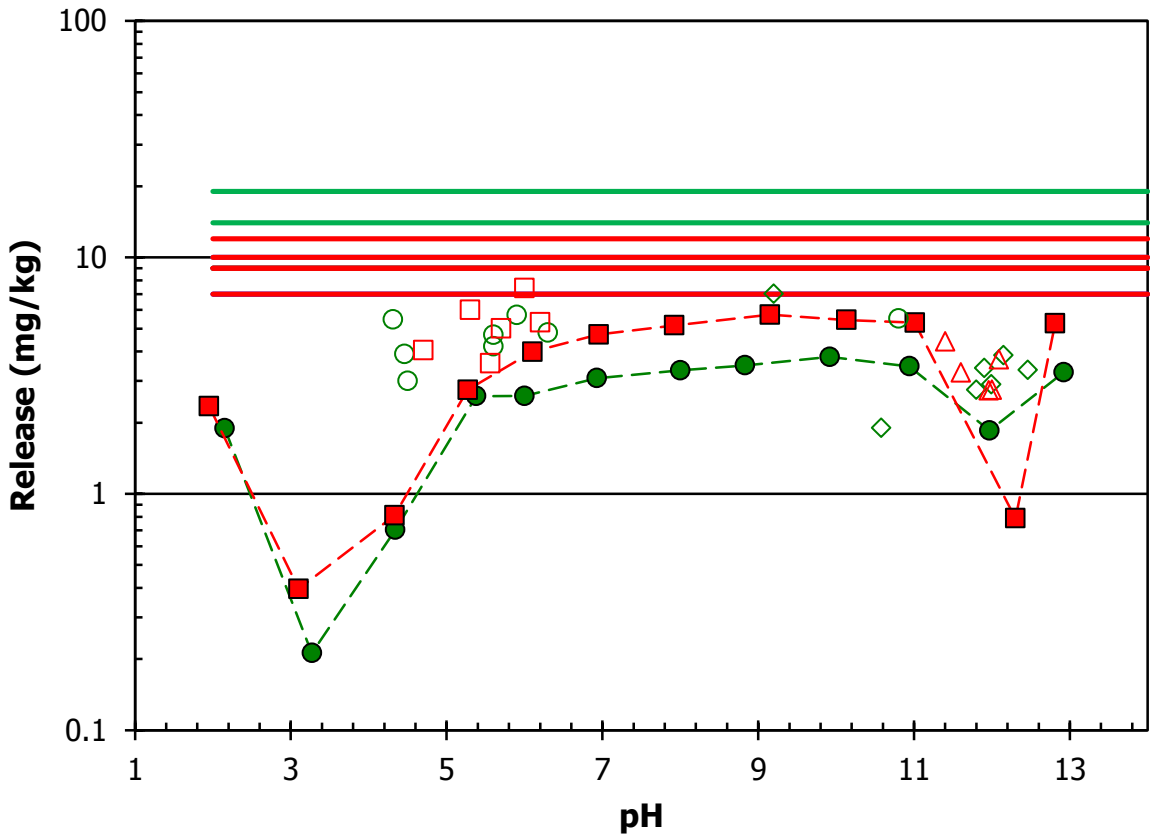


Leach mg/L is 0.1 x mg/kg (L/S = 10)

pH dependent concentrations of Mo

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

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

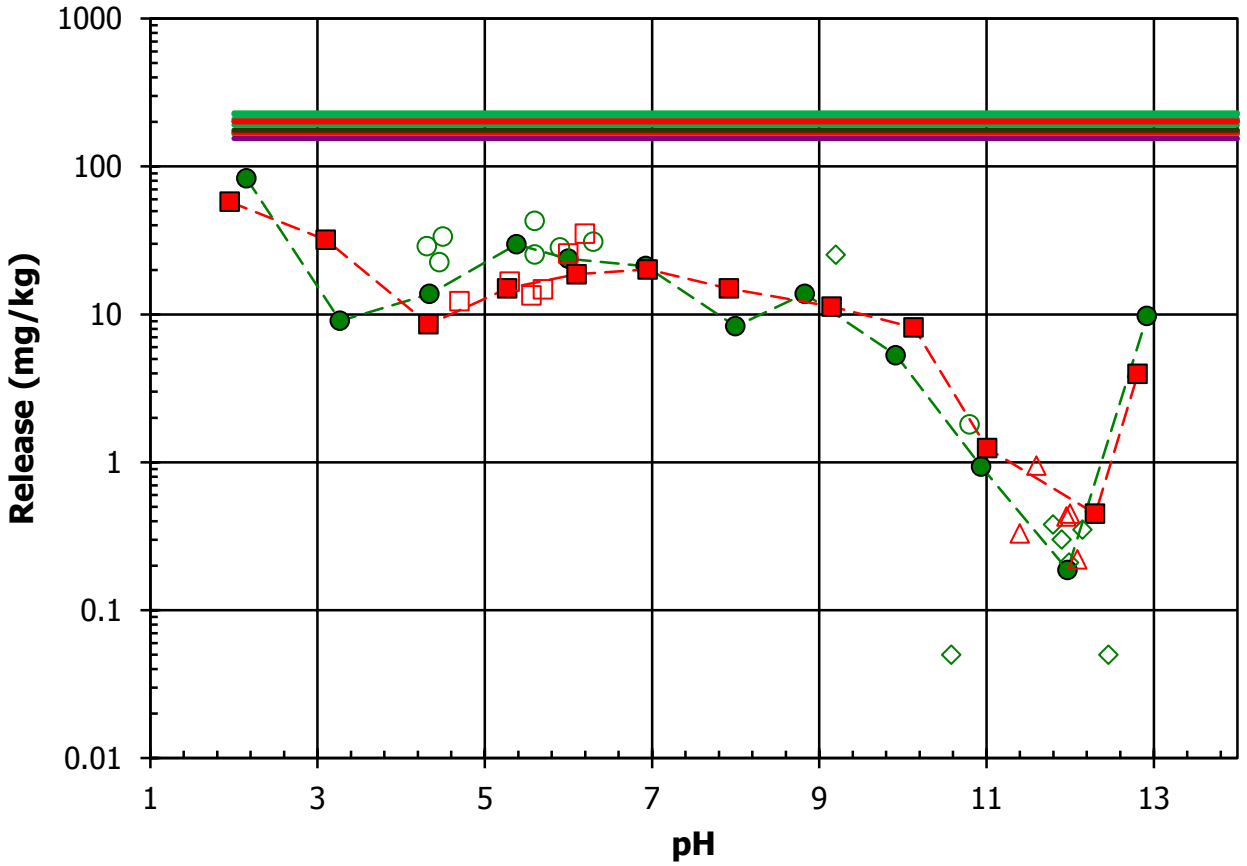


Leach mg/L is 0.1 x mg/kg (L/S = 10)

pH dependent concentrations of V

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

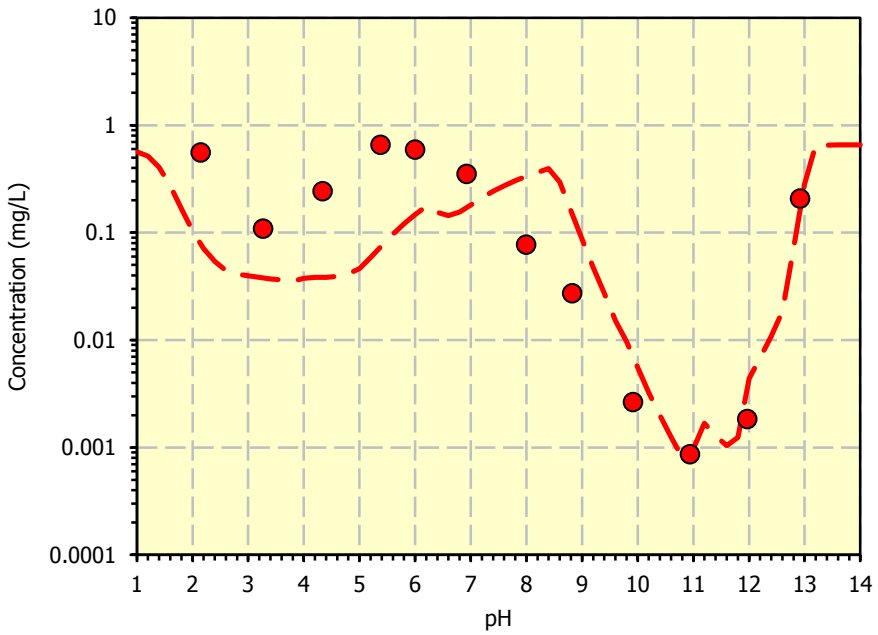
Strong similarities between the FAs with leaching properties



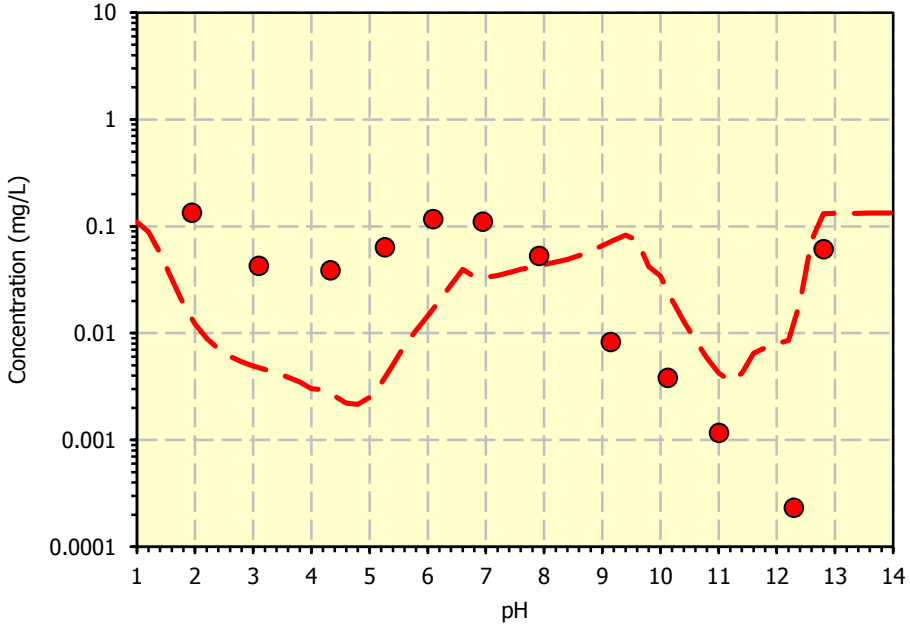
A taste of modeling

Modeled expected As vs. measured in pH dependence test

BB-prime



Newlands



A bit more of modeling
Phase distribution of As