Volcanic Ash and Sulfate Sorption in Inland Northwest Forest Soils:

Implications for Forest Nutrient Management

Presented by

Mark Kimsey
Graduate Research Assistant
University of Idaho

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Presentation Outline

- Introduction
- Objectives
- Methodology
- Results
- Take Home Points

Introduction

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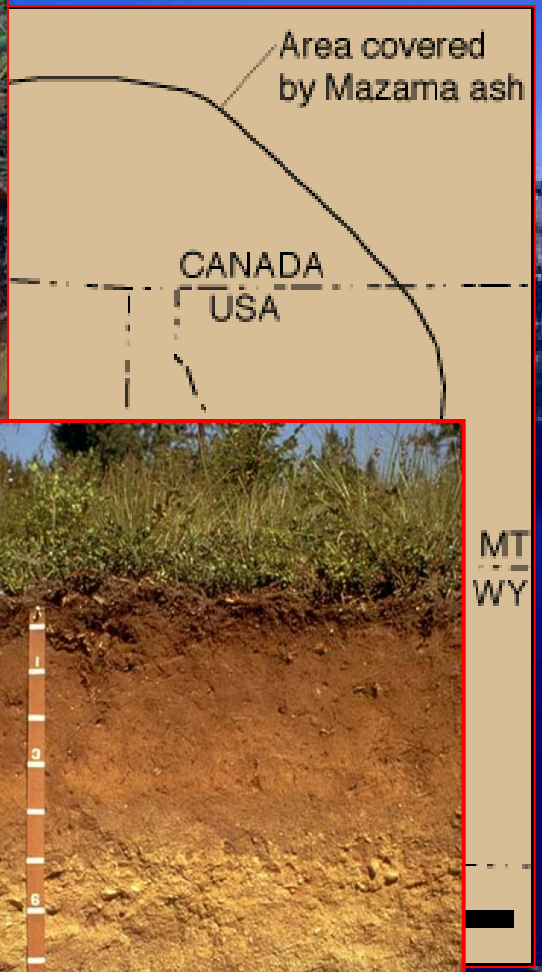


Why Volcanic Ash and Sulfur?

- Nutrient cycling in forest soils an important component of balanced silviculture prescriptions
- Sulfur, along with N, K, B, are among the most widely deficient nutrients around the Inland Northwest
- Soil – nutrient interactions play a crucial role in determining nutrient availability to plants (i.e. CEC, AEC)

Why Volcanic Ash and Sulfur?

- Sulfur, commonly applied as SO_4^{2-}, contains a negative charge and is thus affected by soils with an AEC
- Volcanic ash weathers to form poorly crystalline Fe and Al oxides which possess a variable electrical charge
- Variable charge minerals are able to have an AEC at pHs typically found in INW forest soils

Why Volcanic Ash and Sulfur?

- Thus, we hypothesized that forest soils that were influenced by volcanic ash would exhibit a sulfate retention capacity

- Our questions were:

Operationally applied sulfate (SO_4^{2-})

Non-ash soil

Volcanic ash soil

More sulfur available to plant

Less sulfur availiable to plant

SO_4^{2-}

?

SO_4^{2-}

Clay colloid

Amorphous Fe & Al Oxides

SO_4^{2-}

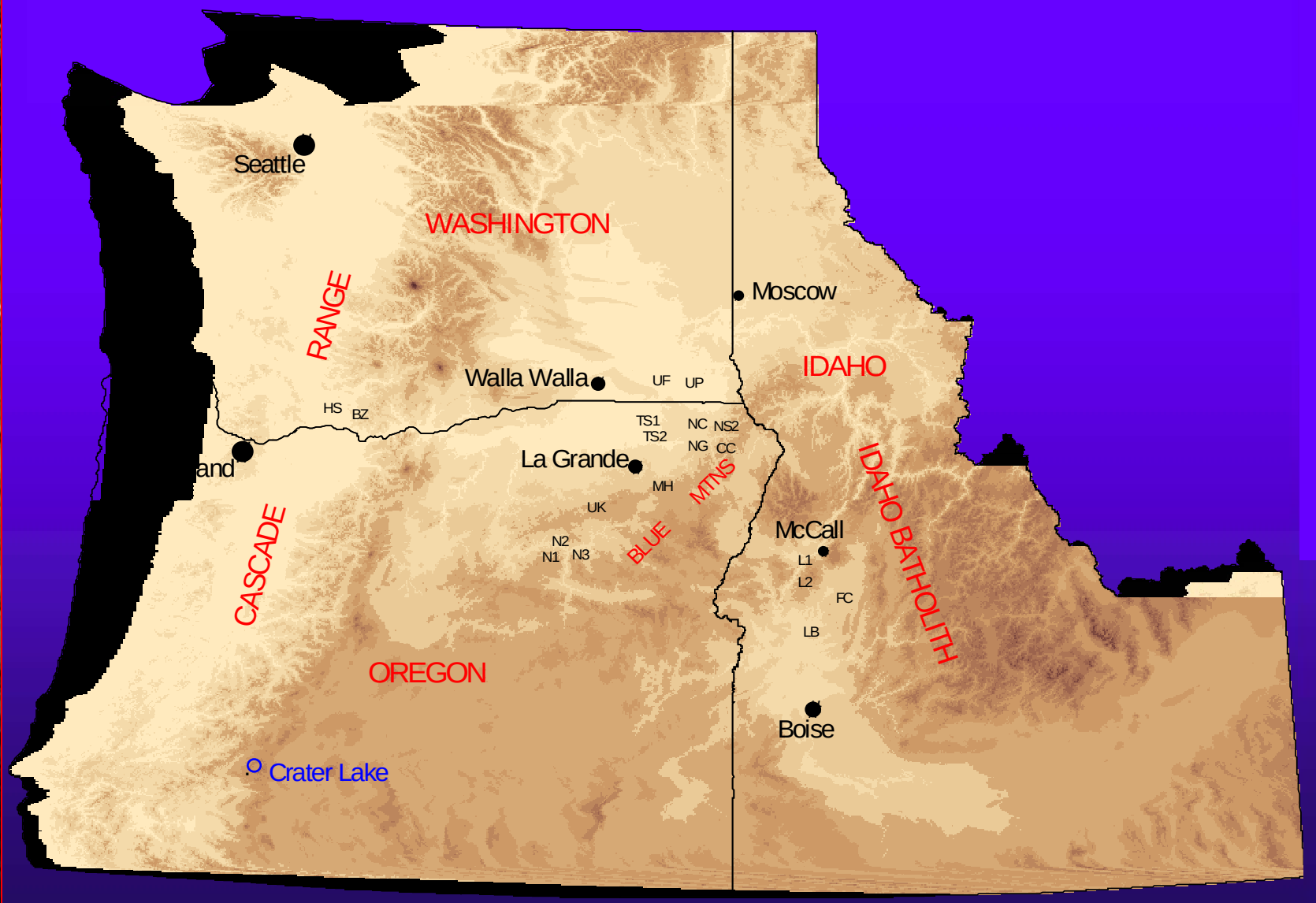
?

SO_4^{2-}

Objectives

- Determine the sulfate sorption capacity of forest soils around the Inland Northwest
- Establish simple diagnostic criteria whereby sulfate retention could be calculated for any forest soil
- Determine soil desorption rates of added sulfate
- Discover any correlation between soil sulfate adsorption capacity and sulfur status of conifer species

Methodology – Research Locations



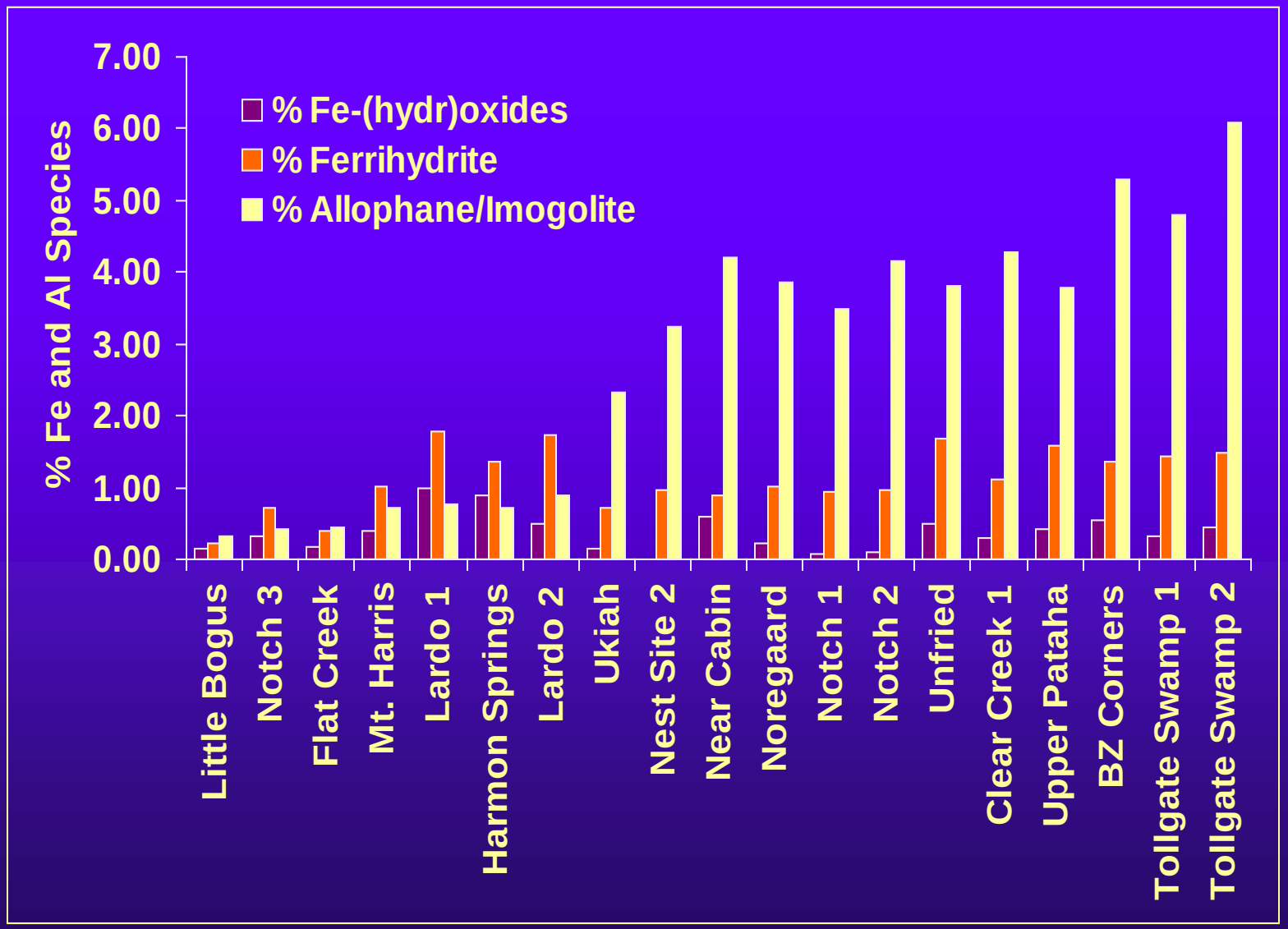
Methodology - Field

- Soil Collection
  - Five random soil cores collected from top 30 cm of control plots
  - Composited into one bulk sample for physio/chemical analyses

Methodology - Lab

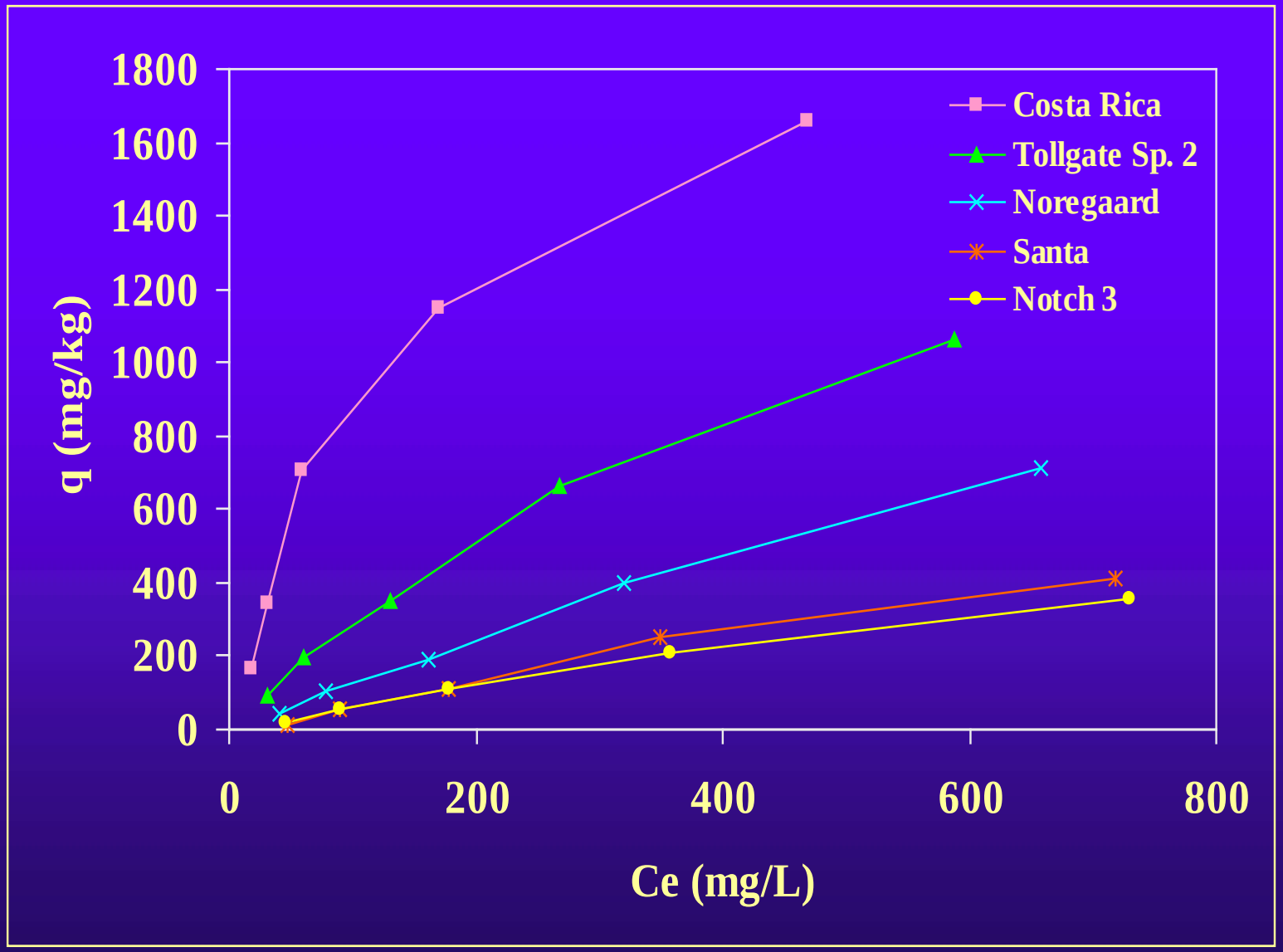
- Soil Analyses
  - Selective Soil Dissolution
  - Ion Chromatography
  - NaF pH

Results – Selective Dissolution

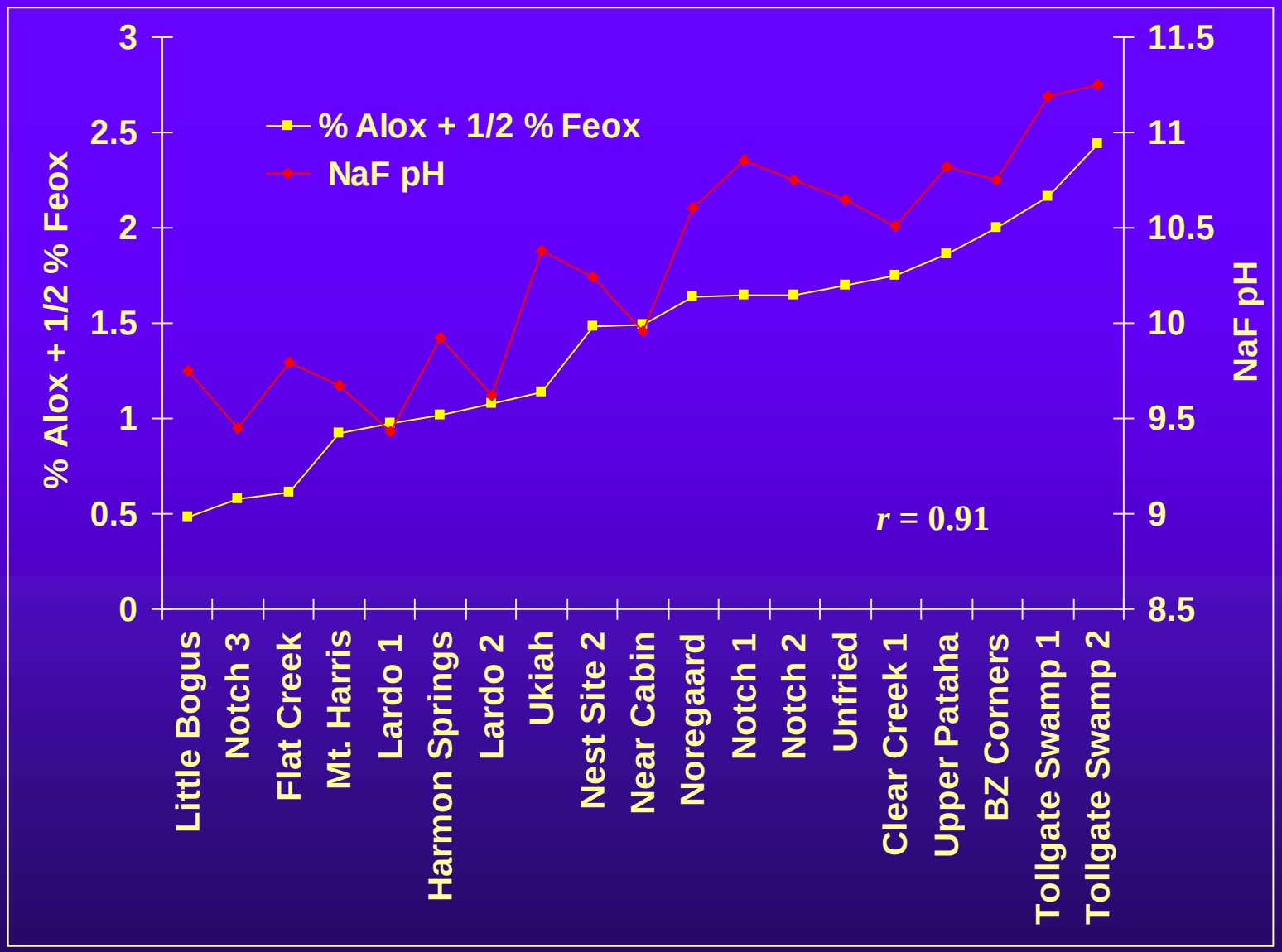


Increasing Volcanic Ash Influence

Results – Ion Chromatography

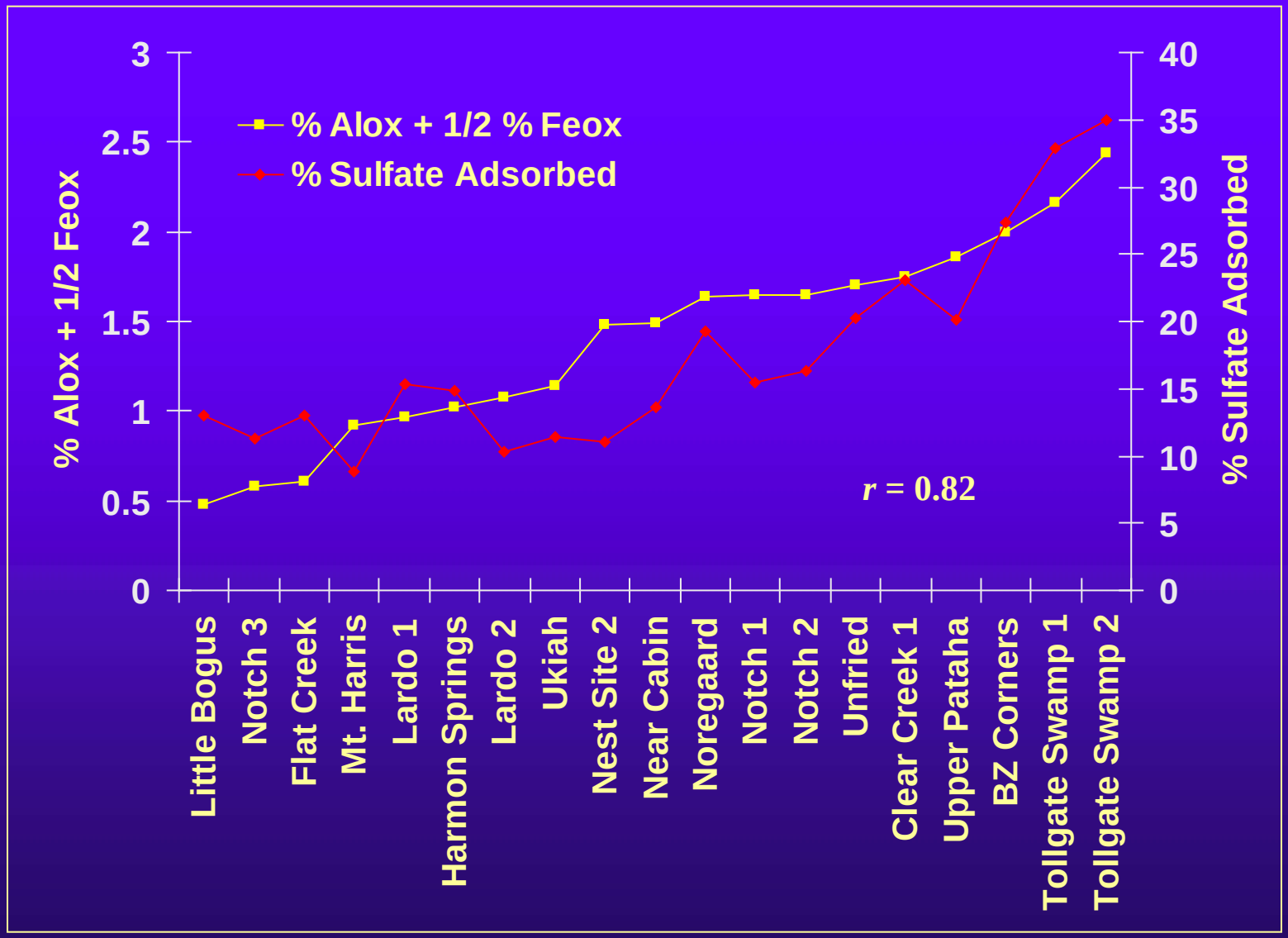


Results – NaF pH & oxalate Fe + Al content



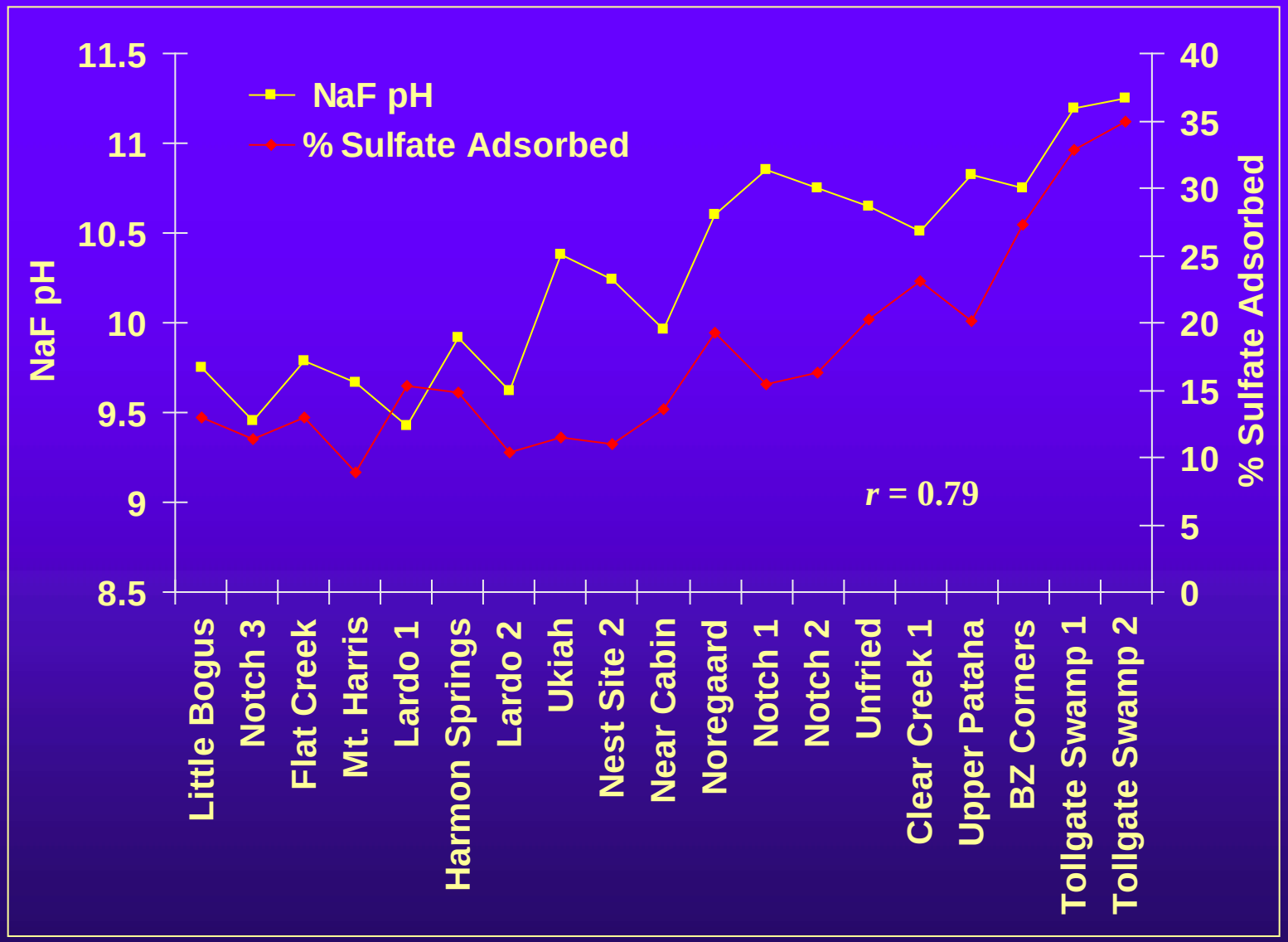
Increasing Volcanic Ash Influence

Results



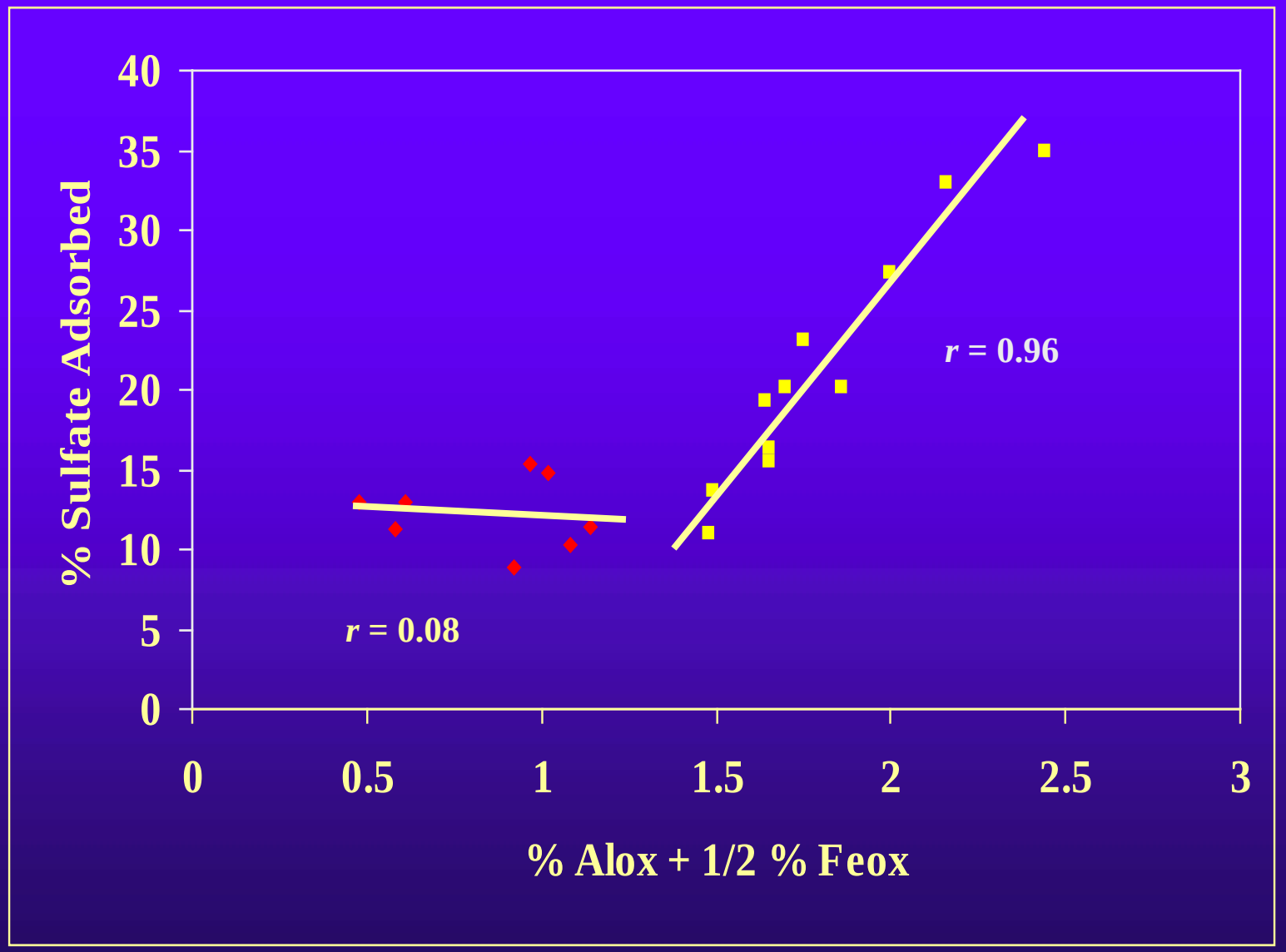
Increasing Volcanic Ash Influence

Results

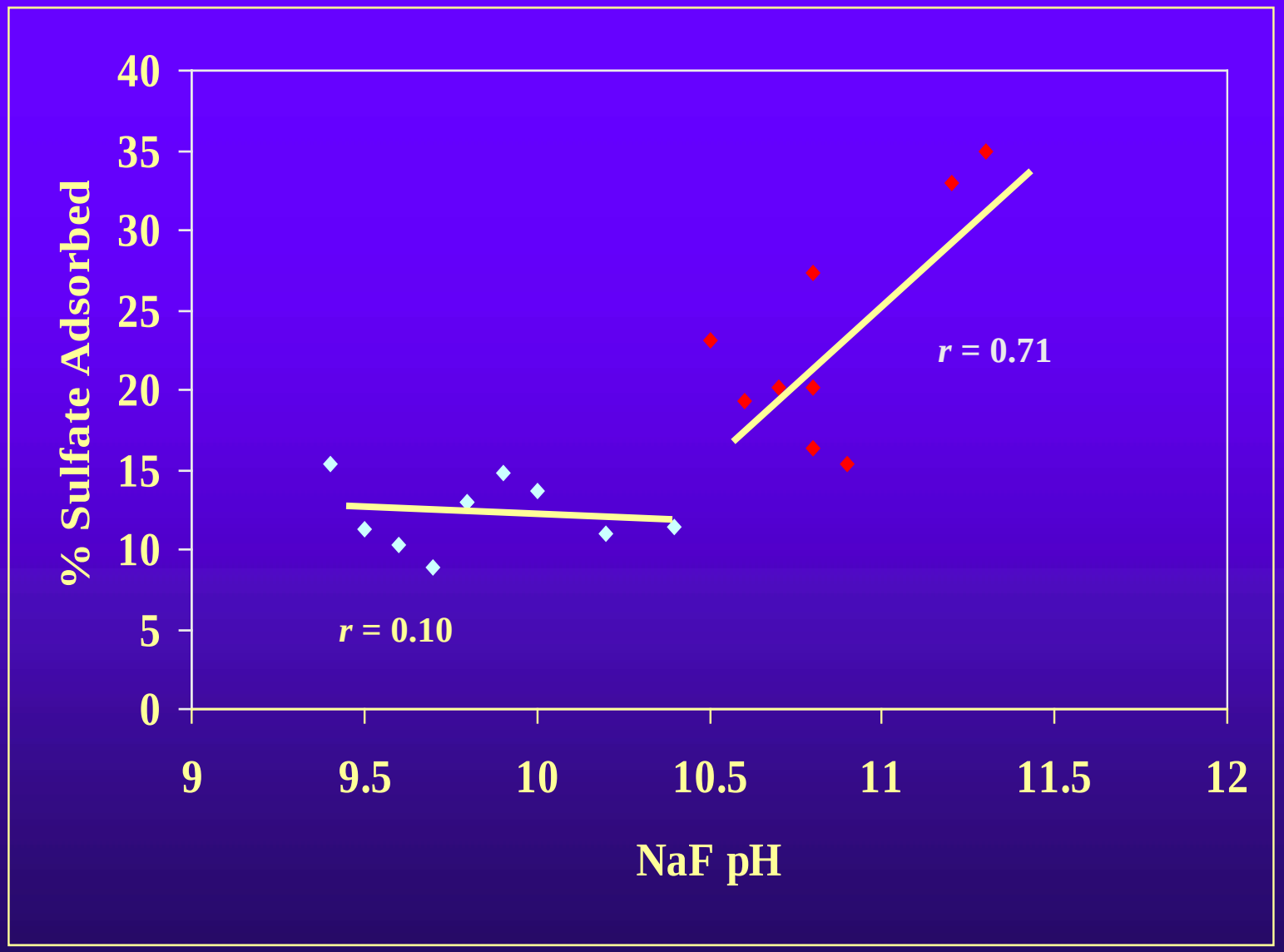


Increasing Volcanic Ash Influence

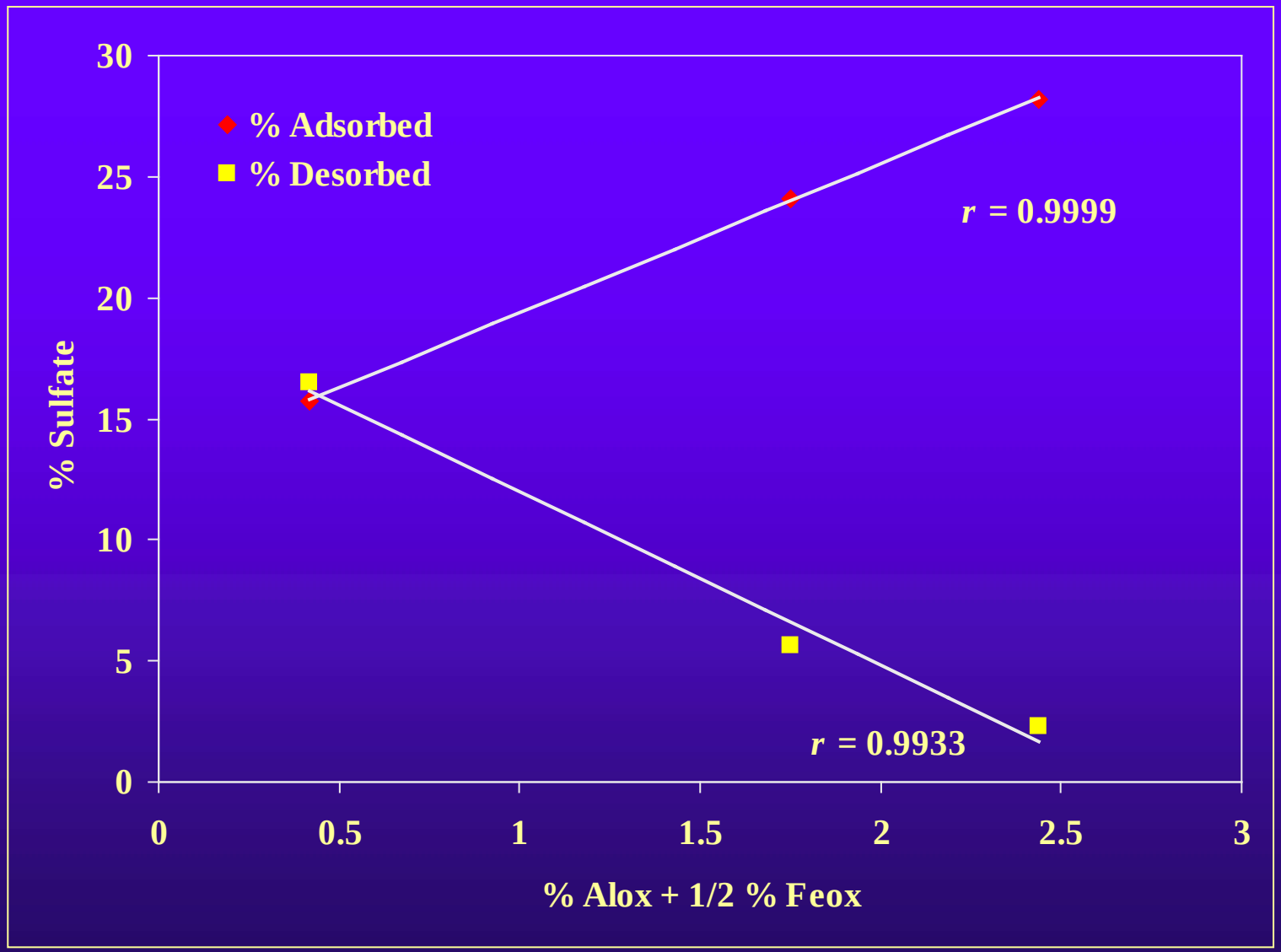
Results


% Sulfate Adsorbed
40
35
30
25
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
% Alox + 1/2 % Feox
r = 0.08
r = 0.96

Results


% Sulfate Adsorbed
40
35
30
25
20
15
10
5
0
9
9.5
10
10.5
11
11.5
12
NaF pH
r = 0.10
r = 0.71

Results - Desorption



Results – Forest Soil Nutrient Correlation

- **No correlation (r = 0.17) was found between soil sulfate sorption capacity and foliar sulfur status**
  - All foliar nutrient data was secondary data
  - Too many uncontrollable variables mask any correlation

Take Home Points - Knowns

- Inland Northwest forest soils have large range in volcanic ash influence
- All INW forest soils are able to retain between 5-15% applied sulfate
- Soils highly influenced by volcanic ash have large sulfate adsorption capacities (> 35%)

Take Home Points - Knowns

- A NaF pH > 10.5 and a % Al_{ox} + ½ % Fe_{ox} content > 1.47 indicates high sulfate sorption capacity (15 - 40%)

- Desorption rates decrease by up to 800% as poorly crystalline Fe and Al oxides increase in soil matrix

Take Home Points - Unknowns

- How irreversible are the bonds of irreversibly bound sulfate to poorly crystalline oxides?

  - under what conditions will it desorb, if at all

  - *f*(thermodynamics, kinetics)

- What are the long-run consequences of irreversibly bound sulfate?

THANK YOU

ANY QUESTIONS?