# Soil P Characteristics in Tree Islands of the Florida Everglades

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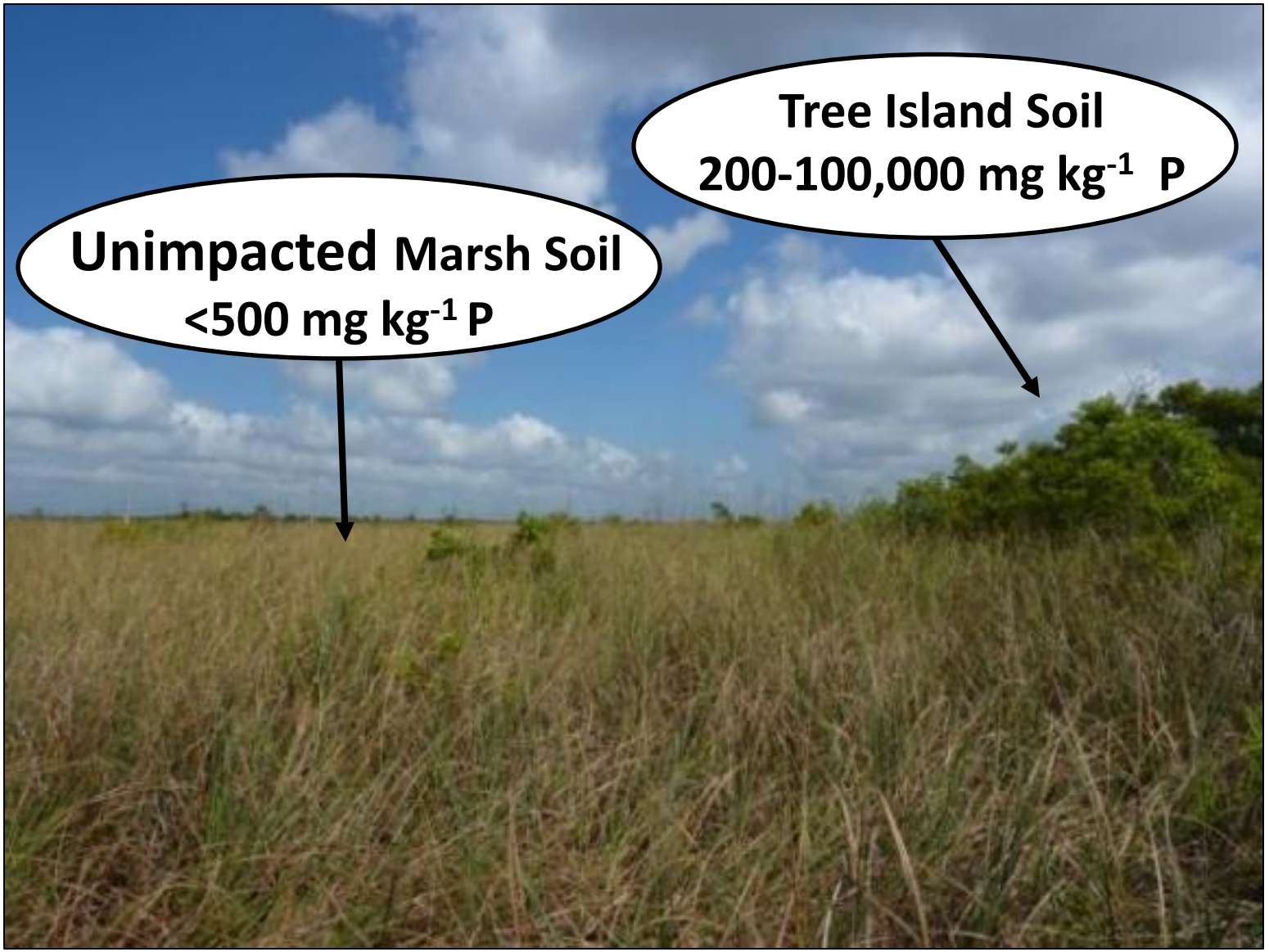
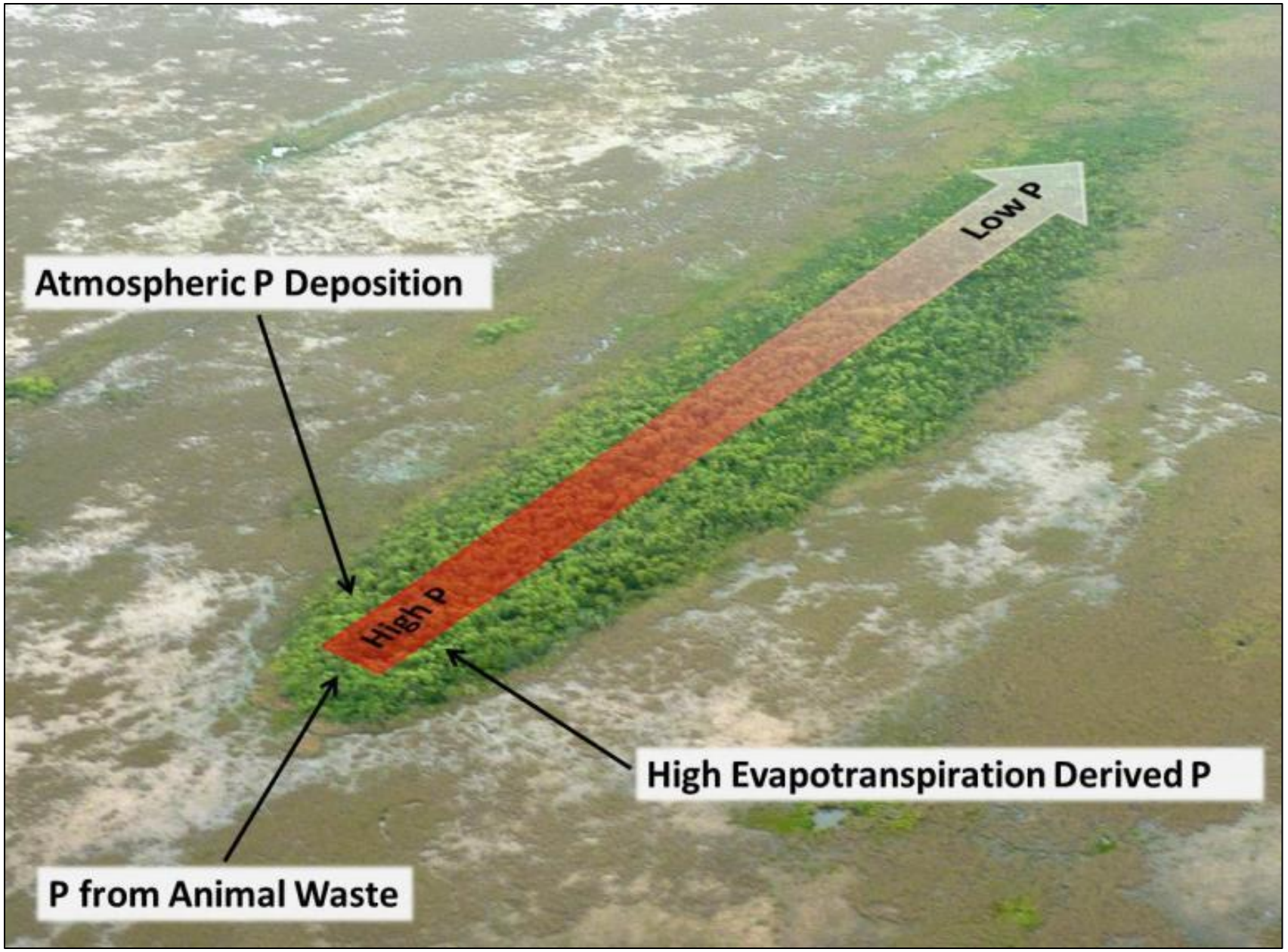
# Generalized Everglades Soil P Pattern



# Tree Island Soil and P Characteristics

- Soil classification: Histosol, also Mollisol
- P is typically highest in the head region
- Linkage with island height, bulk density and non-carbon material
- Orthophosphates were dominant at a wading bird colony
- P ranges among islands (~200-100,000 mg $kg^{-1}$)

# P Accumulation Mechanisms



# Research Questions and Objective

What is the dominant form of P in Everglades tree island soil?

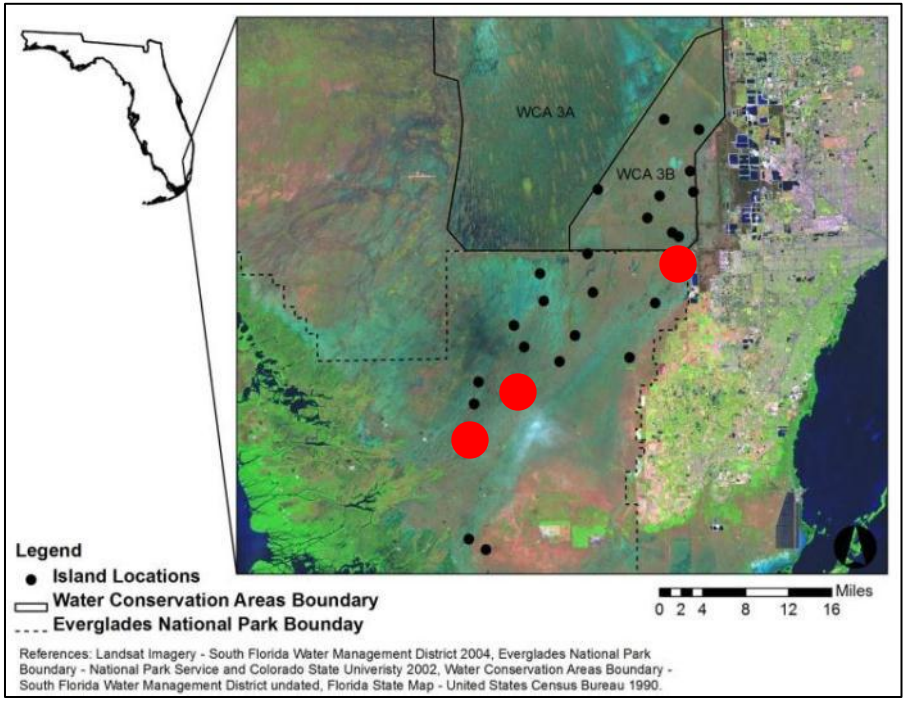
Is biogenic apatite a significant soil P source?

***Objective***

**Determine if soil P characteristics indicate a mechanism for P accumulation in tree islands**

# Materials and Methods

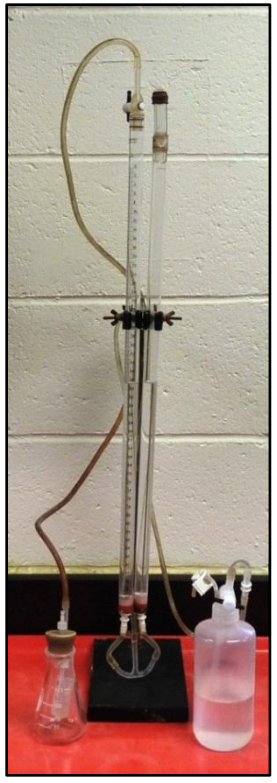
- 26 islands
- Surface soil (0-10 cm)
- Tropical hardwood hammock communities



# Chemical Analysis

## Total Elemental Analysis

- Organic matter (OM) by LOI at 550° C
- C and N by dry combustion
- Al, Ca, Fe, Mg & P by dry combustion, acid dissolution
  - P measured colorimetrically
  - Cations measured by ICP-OES

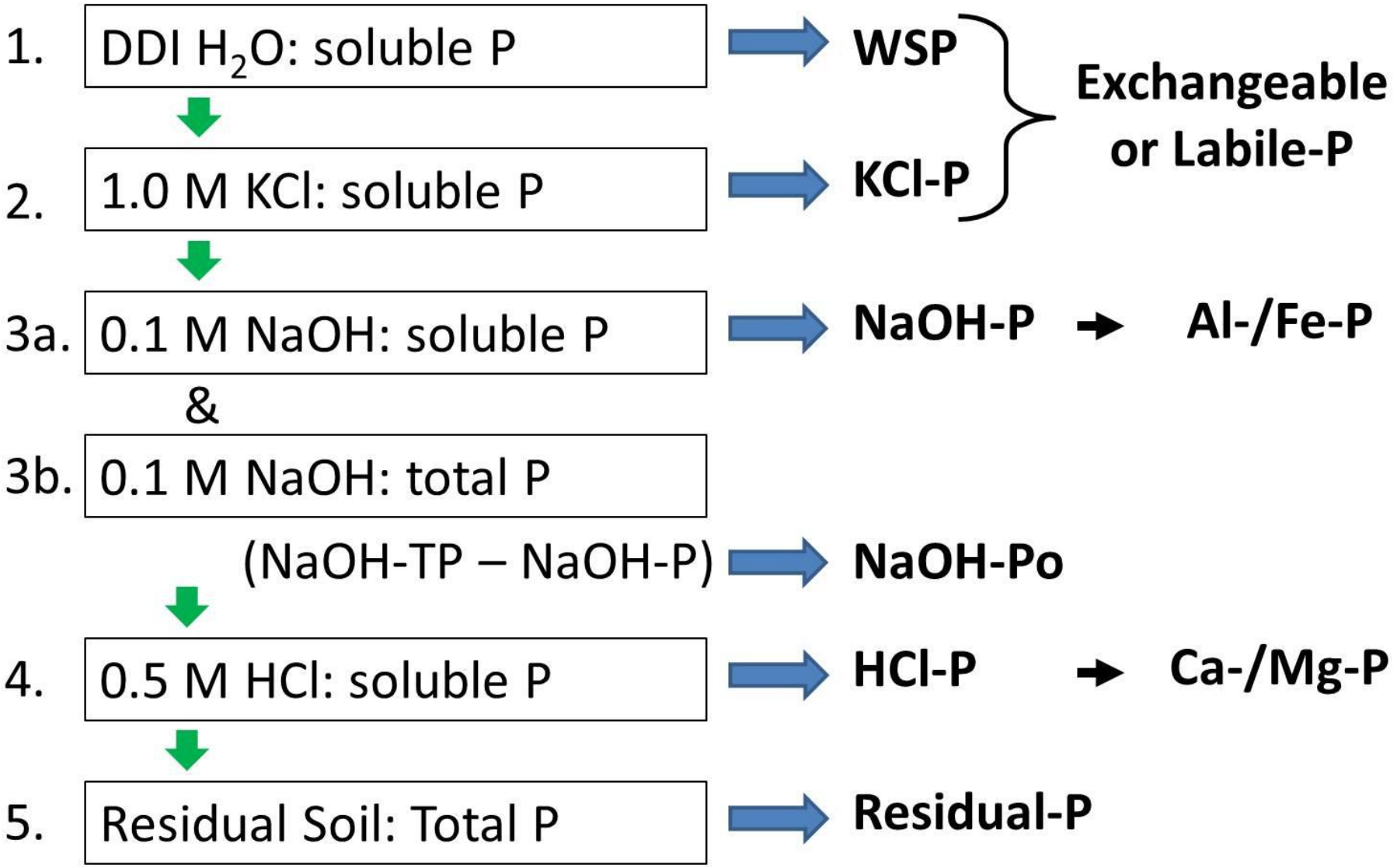


## Inorganic C & Carbonate Ca

- Non-carbon material = 100 - (OM% + $CaCO_3$%)

- Non-carbonate Ca = total Ca – carbonate Ca

# Soil P Extraction Sequence




(Modified from Koch and Reddy, 1992)

# Mineralogical Analysis

## Mineral Identification by X-ray Diffraction (XRD)

- 3 islands with high (~7 % P) concentration
- No pretreatment for organic matter or carbonate removal
- Powder, cavity mount

# Physical Fractionation and Analysis

## Wet Sieving Separation

**(Soukup et al. 2008)**

- >2 mm: bioapatite fragments
- 2 mm – 45 µm: Sand
- <45 µm: Silt & Clay


## Analysis

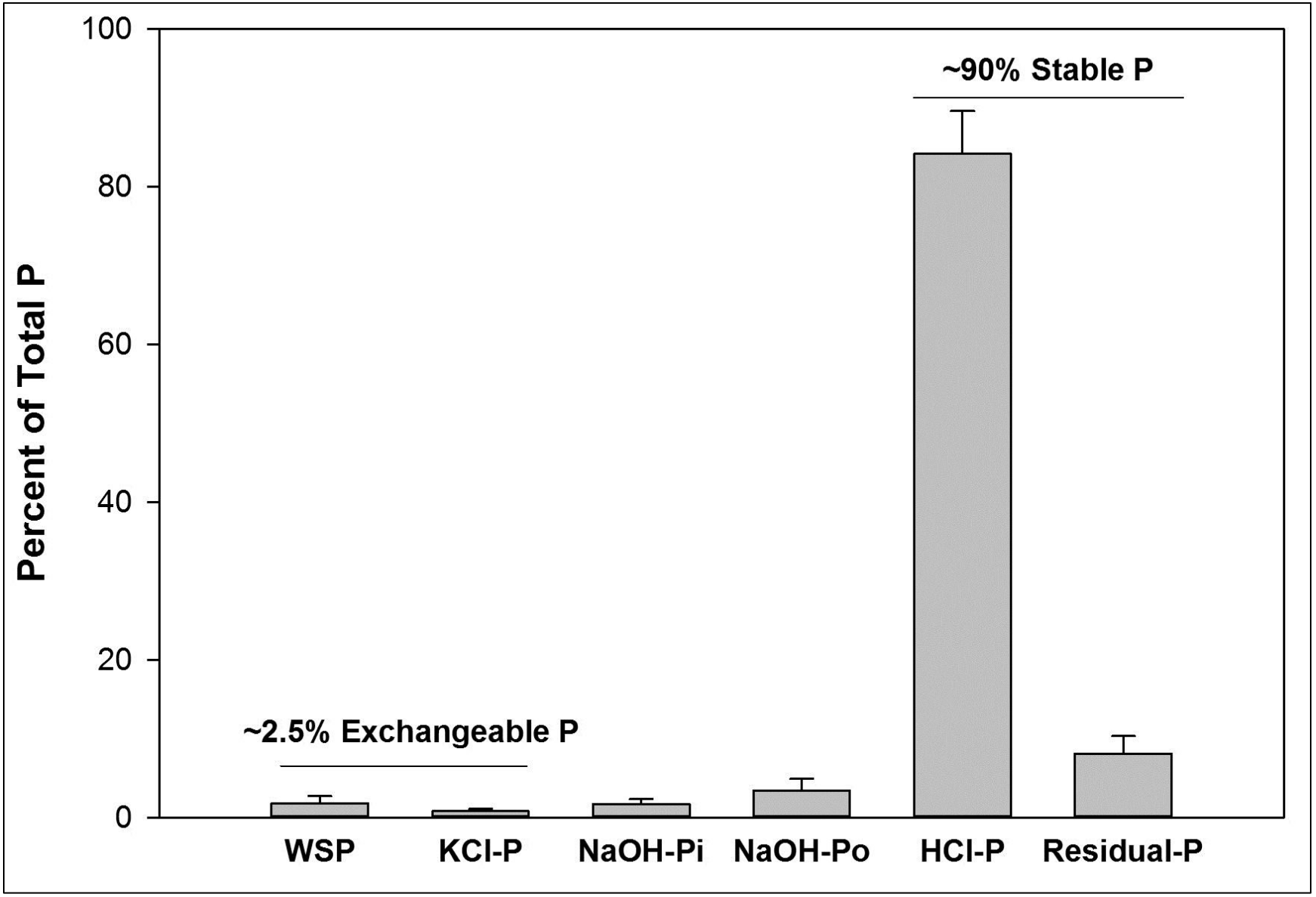
- Total P & select P associated cations
- Inorganic carbon
- Mineral identification
- Micro-elemental analysis & surface imaging (SEM-EDS)

# Results

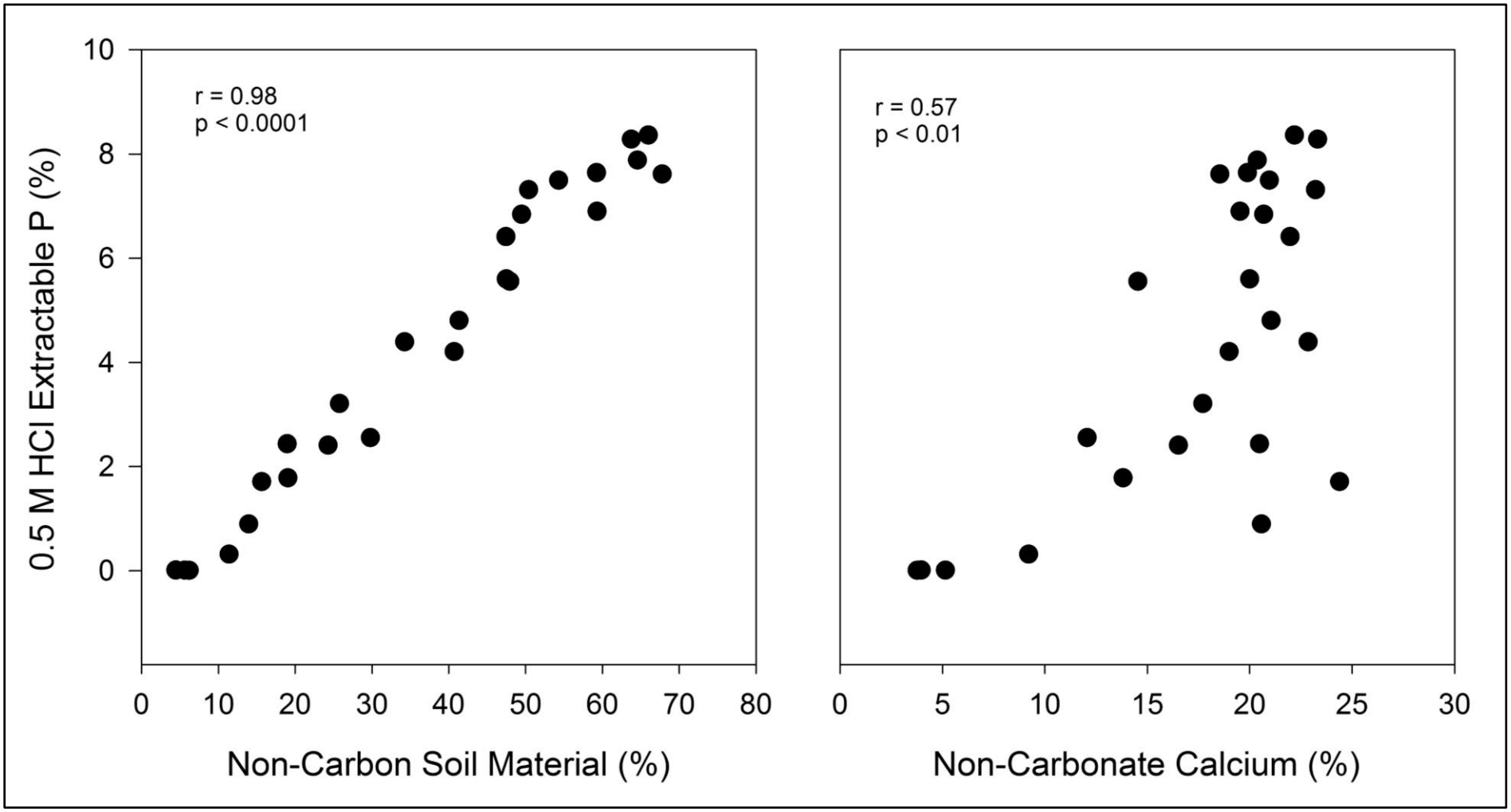
## Select Soil Properties (n = 26)

| Parameter (%) | Mean | Median | Min. | Max. |
|---|---|---|---|---|
| Organic Matter | 40.3 | 30.5 | 19.8 | 89.9 |
| Carbon | 20.0 | 16.6 | 9.6 | 40.7 |
| Nitrogen | 1.3 | 1.1 | 0.7 | 2.4 |
| Phosphorus | 4.7 | 5.2 | 0.08 | 8.8 |
| Aluminum | 0.3 | 0.2 | 0.1 | 0.7 |
| Calcium | 19.5 | 21.4 | 4.3 | 30.0 |
| Iron | 0.5 | 0.4 | 0.1 | 1.3 |
| Magnesium | 0.5 | 0.4 | 0.2 | 1.0 |

# Distribution of Soil P Forms

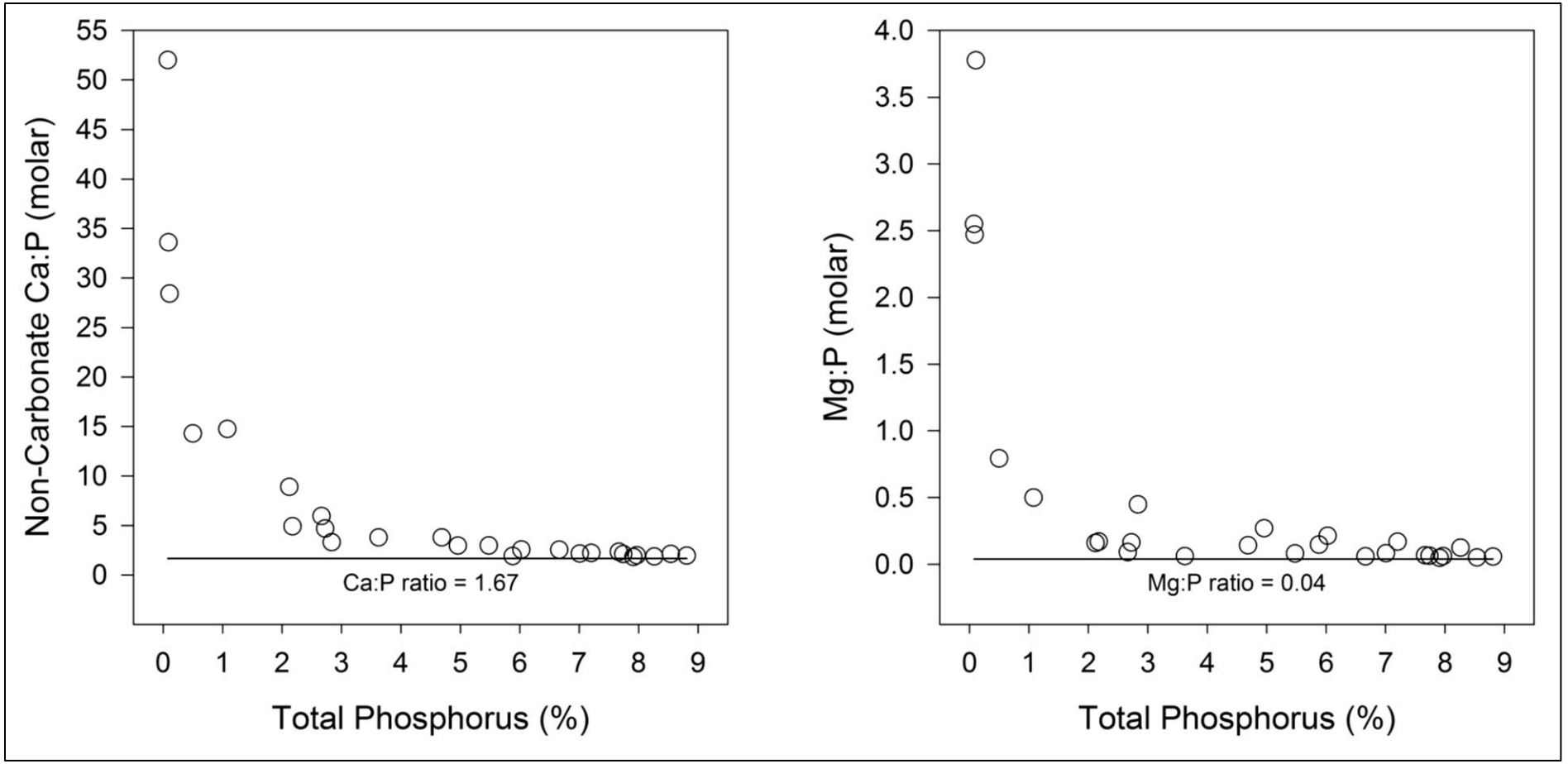


# Soil Mineral and Phosphorus Relationships



# Soil P and Elemental Molar Ratios

- Non-carbon Ca:P ratio approaches **1.67** with increasing P
- Mg:P ratio approaches **0.04** with increasing P

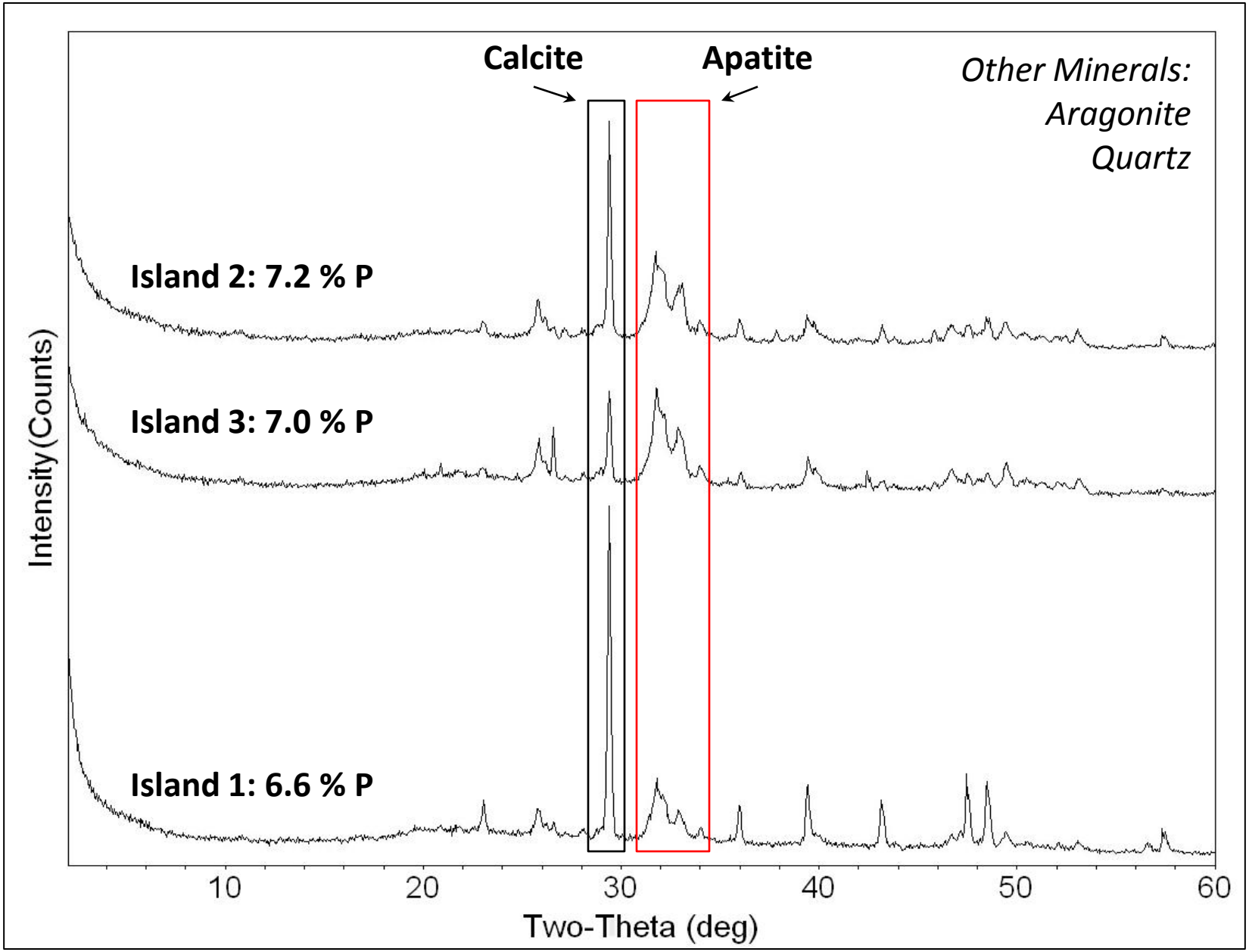


# Animal Derived P: Biogenic Apatite

Apatite (Ca-P mineral)

- $Ca_{10}(PO_4)_6OH_2$
- Ca:P (molar) ratio = 1.67
- Everglades bird and snake bioapatite data (Irick et al. unpub)
  - Ca:P (molar) ratio ≈ 1.63
  - Mg:P (molar) ratio ≈ 0.04


# Spatial Soil Mineralogy and Total P Data



# Particle Size Separation

| | Particle Size Class | | |
|---|---|---|---|
| **Parameter (%)** | >2 mm | Sand | Silt & Clay |
| Mean Weight | - | 48 | 52 |
| Median Weight | - | 53 | 47 |
| Non-Carbonate Ca | - | 25.9 ± 1.5a | 15.1 ± 0.4 b |
| Phosphorus | 13.5 ± 0.03 a | 10.2 ± 1.2 a | 5.6 ± 0.5 b |

Bone P (Blitz and Pellegrino 1969)

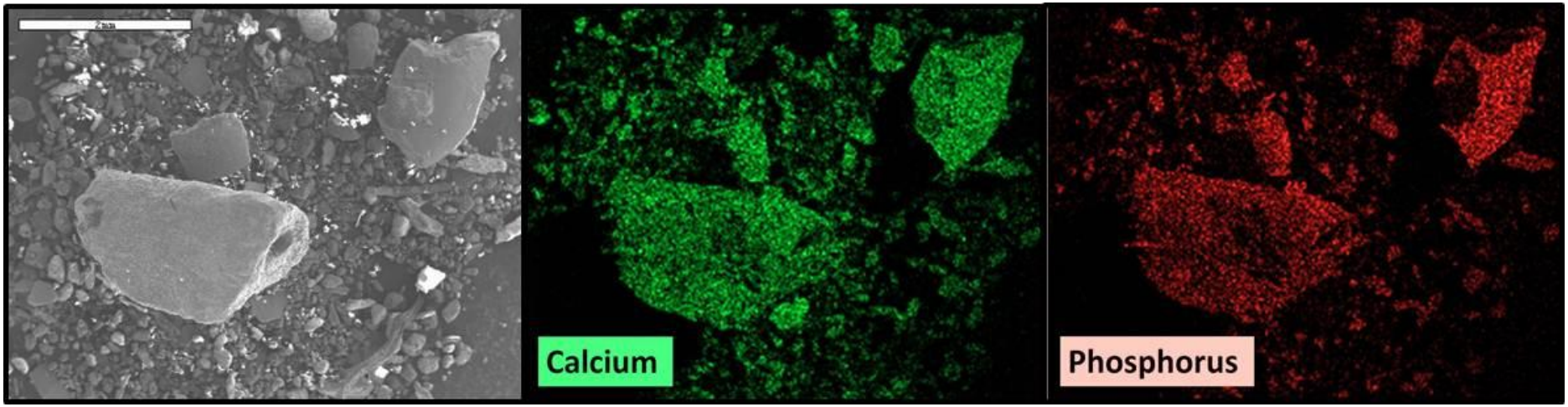
- **≈10-13% P**

Everglades Tree Island Bone Samples (Irick et al. unpub)

- **≈ 11% P**

# Micro-elemental Analysis & Surface Imaging

## SEM-EDS Data – Sand Fraction



# Conclusions

- **Ca bound P (Ca-P) dominates the soil P pool**
- **Ca-P is primarily apatite, not P adsorbed to or precipitated with calcite**
- **Bioapatite is a significant source of soil P in tree islands**
- **Tree island soil P accumulation is promoted by the presence of relatively stable forms of P**
- **Changes in vegetation, local hydrology or animal use may affect soil P accumulation and stability in tree islands.**

**Acknowledgements**

- Dr. Kati Migliaccio
- Guiqin Yu
- Dr. Yigang Lou
- Dr. Kathy Curtis
- Dr. Li's Lab Group
- Dr. Inglett's Lab Group
- Dr. Len Scinto & Lab Group
- Chumki Banik