Parent material, surface soil, and fertilization controls over decomposition rates

Collaborators

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Overview

- Background – why use wood stakes?
- Some results
- Pondering the results

  (or what this might mean for managers)

Background – why look at decomposition?

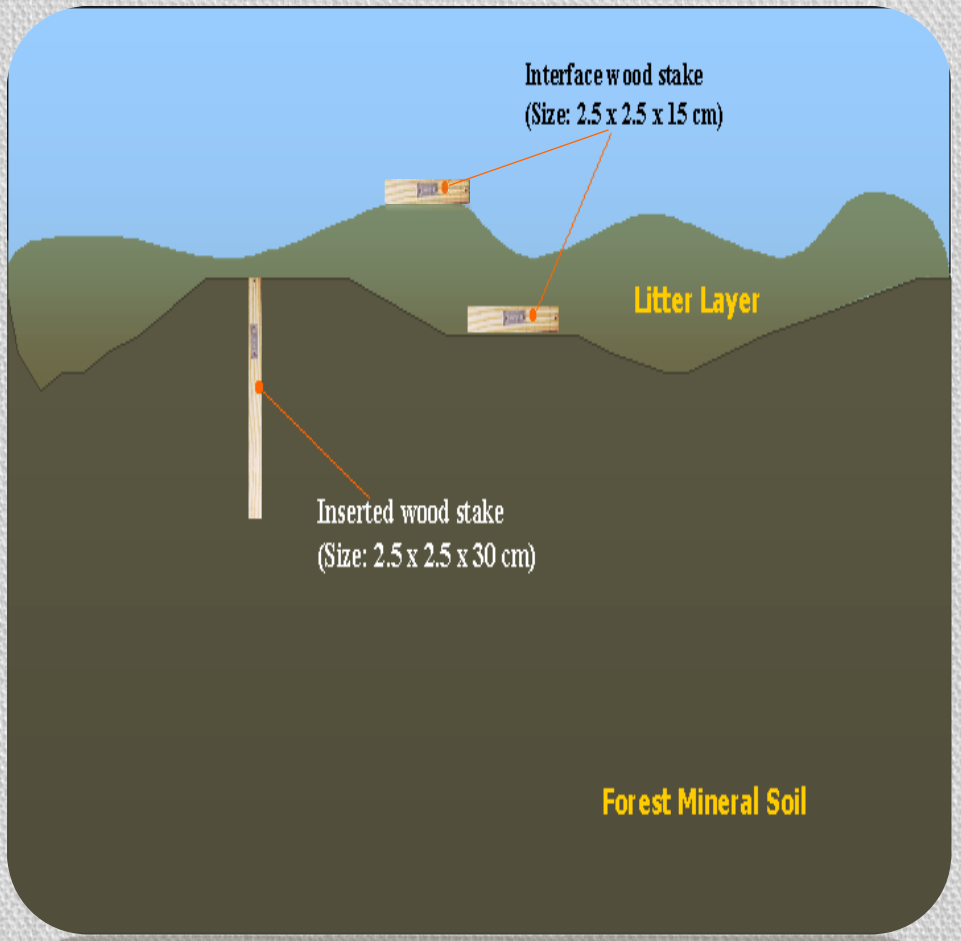
- Soil organic matter maintains site productivity because of its role in:
  - Water availability
  - Aggregate stability
  - Nutrient cycling
  - Disease prevention
  - Carbon sequestration rates
- Organic matter decomposition is controlled by the same factors that govern tree growth
  - Soil temperature and moisture
  - pH
  - Nutrients
- Organic matter provides ecosystem services
  - Water quality, resistance to erosion, soil fertility, fiber, fuel, climate mitigation

Decomposition – Past studies

- Most decomposition studies have been conducted
  - With litterbags
  - On top of or within the litter layer
- Inconsistent material
- Trials are short-lived
- Few mineral soil studies

Using wood stakes

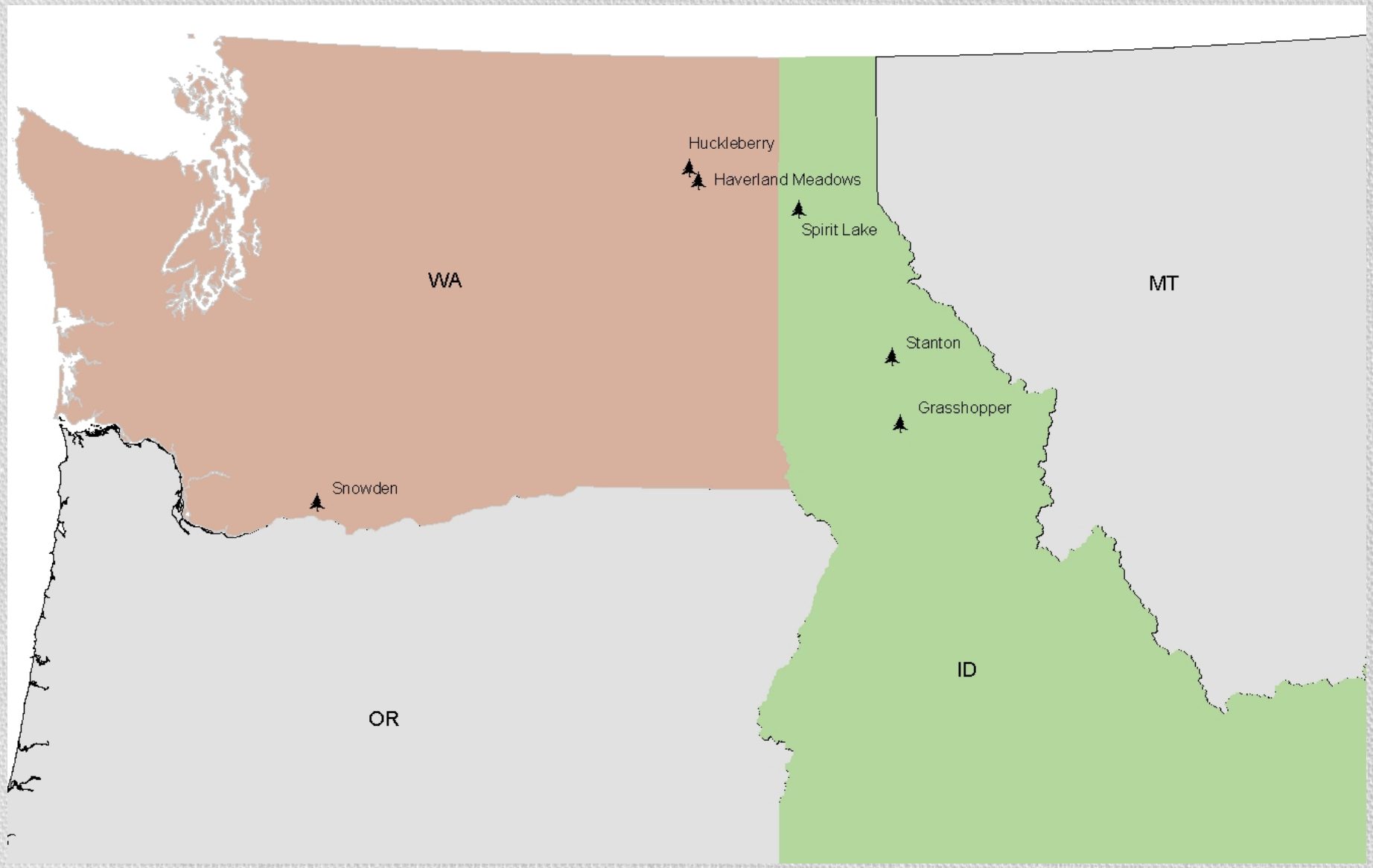
- Mimics coarse roots or branches
- A standard substrate can be used to test:
  - Different forest management activities
  - Differences with and without surface OM
  - Depths within the mineral soil
  - Compare site to site



Our study with IFTNC

- Six sites
- 3 fertilizer treatments and a control
- Grand fir or cedar overstory

IFTNC Decomposition Sites



IFTNC Forest Health Sites

Site	Rock type(s)	Surface Material	Major overstory species
Grasshopper	Granite and tertiary sediments	Ash-cap	Cedar
Haverland	Granite	Ash-cap	Grand fir
Huckleberry	Metasediments		Grand fir
Snowden	Basalt and tertiary sediments		Grand fir
Spirit Lake	Granodiorite and metasediments	Ash-cap	Cedar
Stanton	Granite and metasediments		Cedar

Four Treatments

- Plots were fertilized in 1994, 1995 or 1996 with:
  - N (300 lbs/acre)
  - K (170 lbs/acre)
  - N+K (300 + 170 lbs/acre)
  - Control (unfertilized)

Soil properties

- Parent Material
  - Basalt
    - Low in silica, high in K
  - Granite
    - Moderate amount of silica, moderate K
  - Metasediments
    - High in silica, low in K
- Surface Soils
  - Tertiary sediments
  - Glacial
- And don’t forget about an ash cap!

Wood stakes

- Pine, aspen, and Douglas-fir were used.
- Contrasting cellulose and lignin contents
- Douglas-fir is a ‘local’ species

Stake Installation

- 25 stakes (2.5 x 2.5 x 30 cm) of each species were inserted into the mineral soil of each subplot. *(DF only placed at Spirit Lake and Grasshopper)*
  - 2800 stakes in the mineral soil (total for all sites)

- 25 stakes (2.5 x 2.5 x 15 cm) of each species were placed on top of forest floor and 25 more were installed at forest floor/mineral soil interface at each subplot.
  - 4800 surface and interface stakes (total for all sites)

Installation into the mineral soil

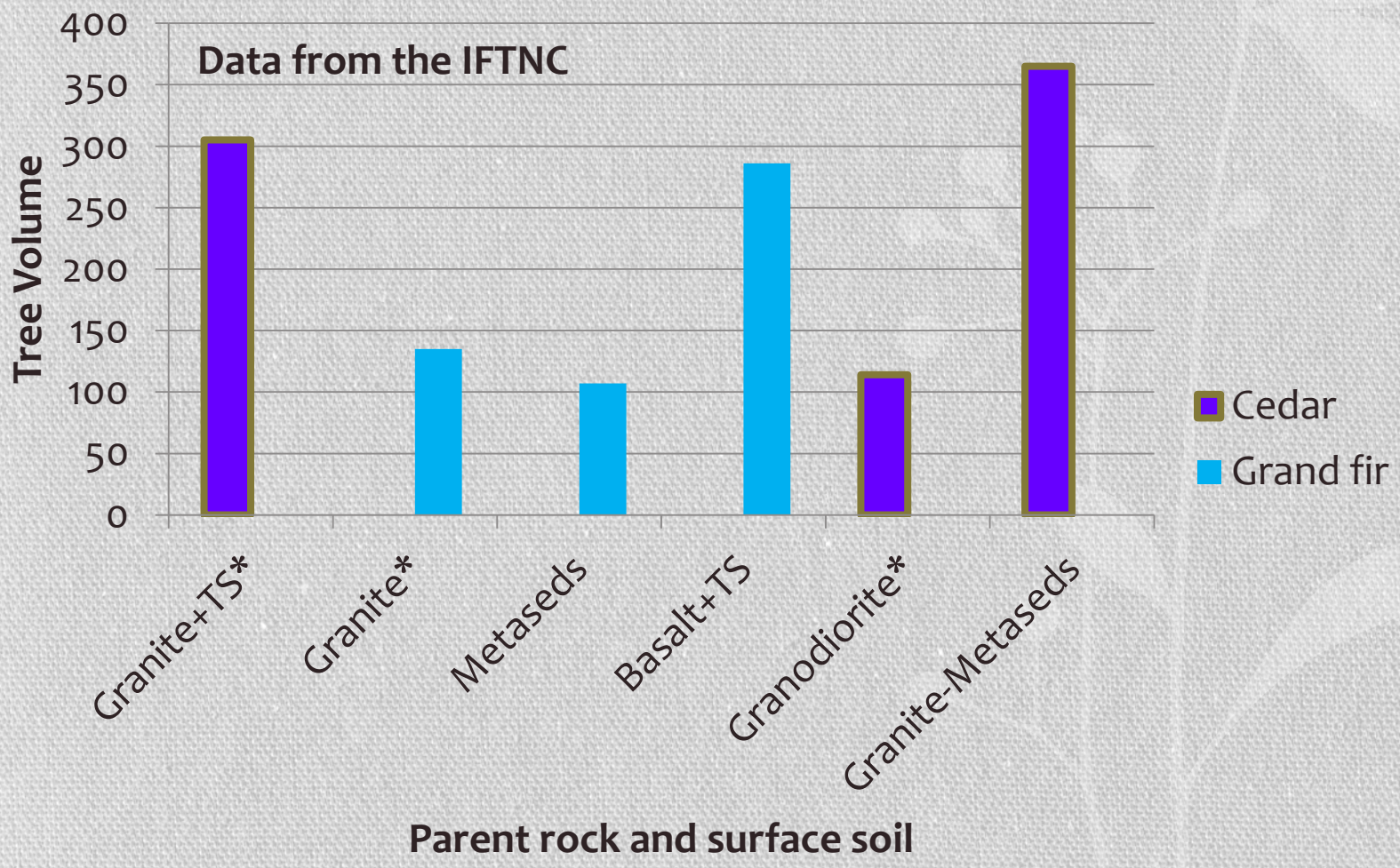
- A 1” square hole is made in the mineral soil
- Stake is inserted *gently*
- Avoids altering wood properties

Surface and interface stakes

What happened?

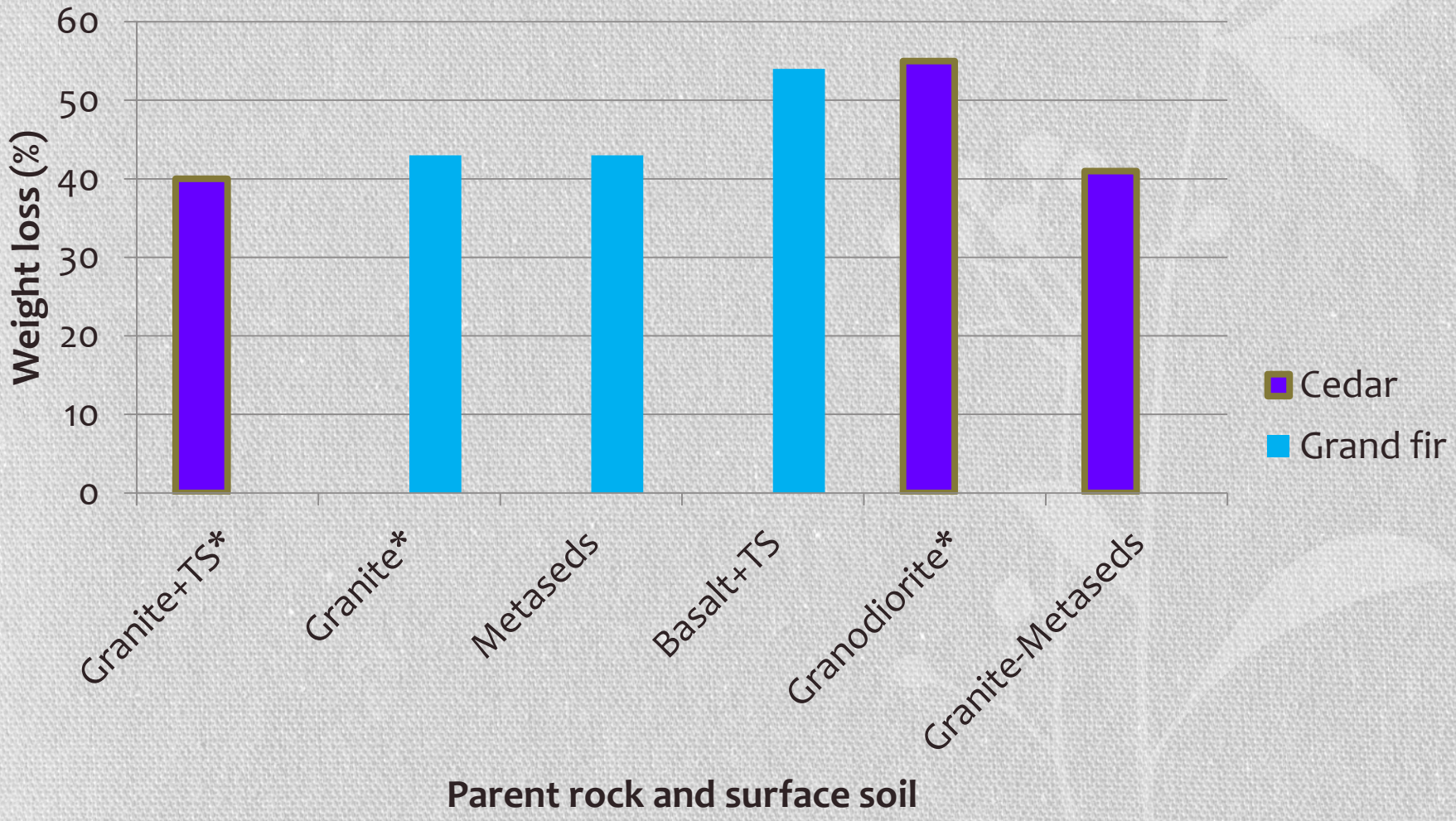
The big picture – parent material

6 year volume growth (productivity)



TS=tertiary sediments; *= ash cap

Overall decomposition rate on different parent materials and soil



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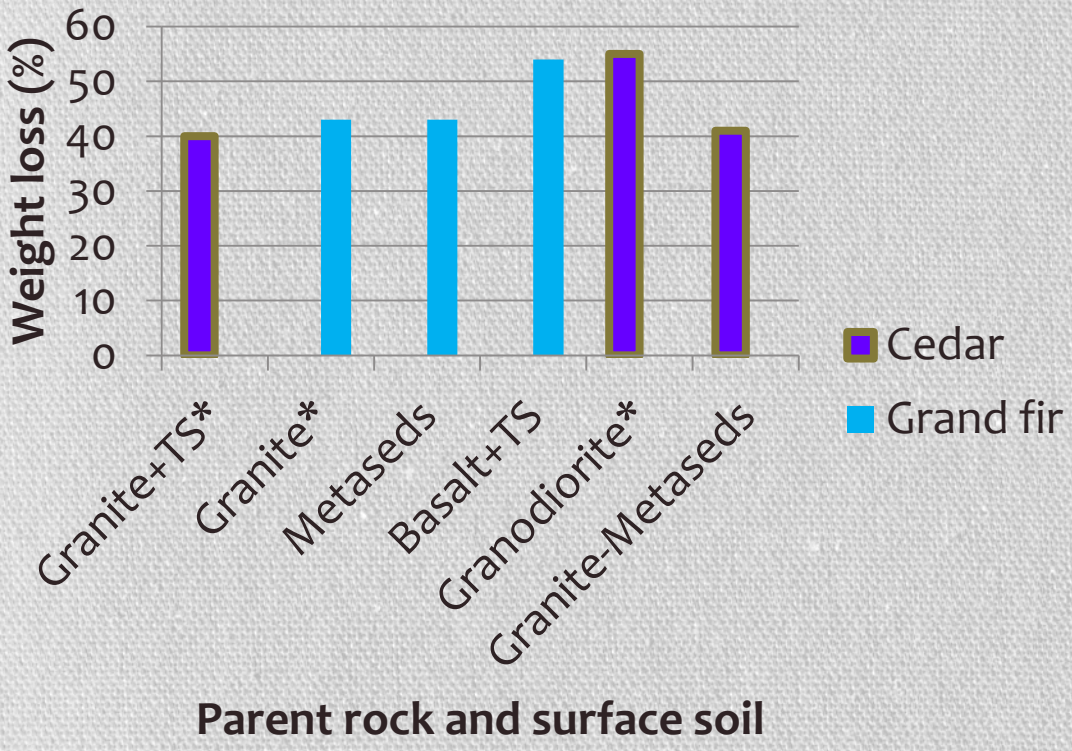

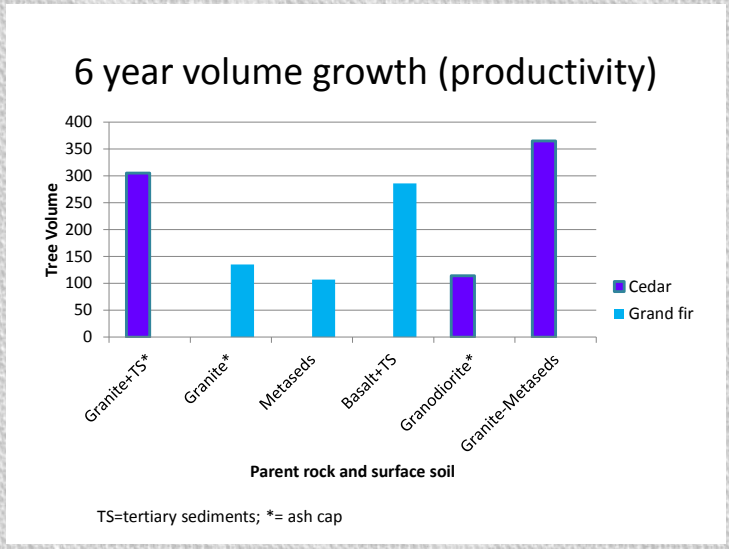

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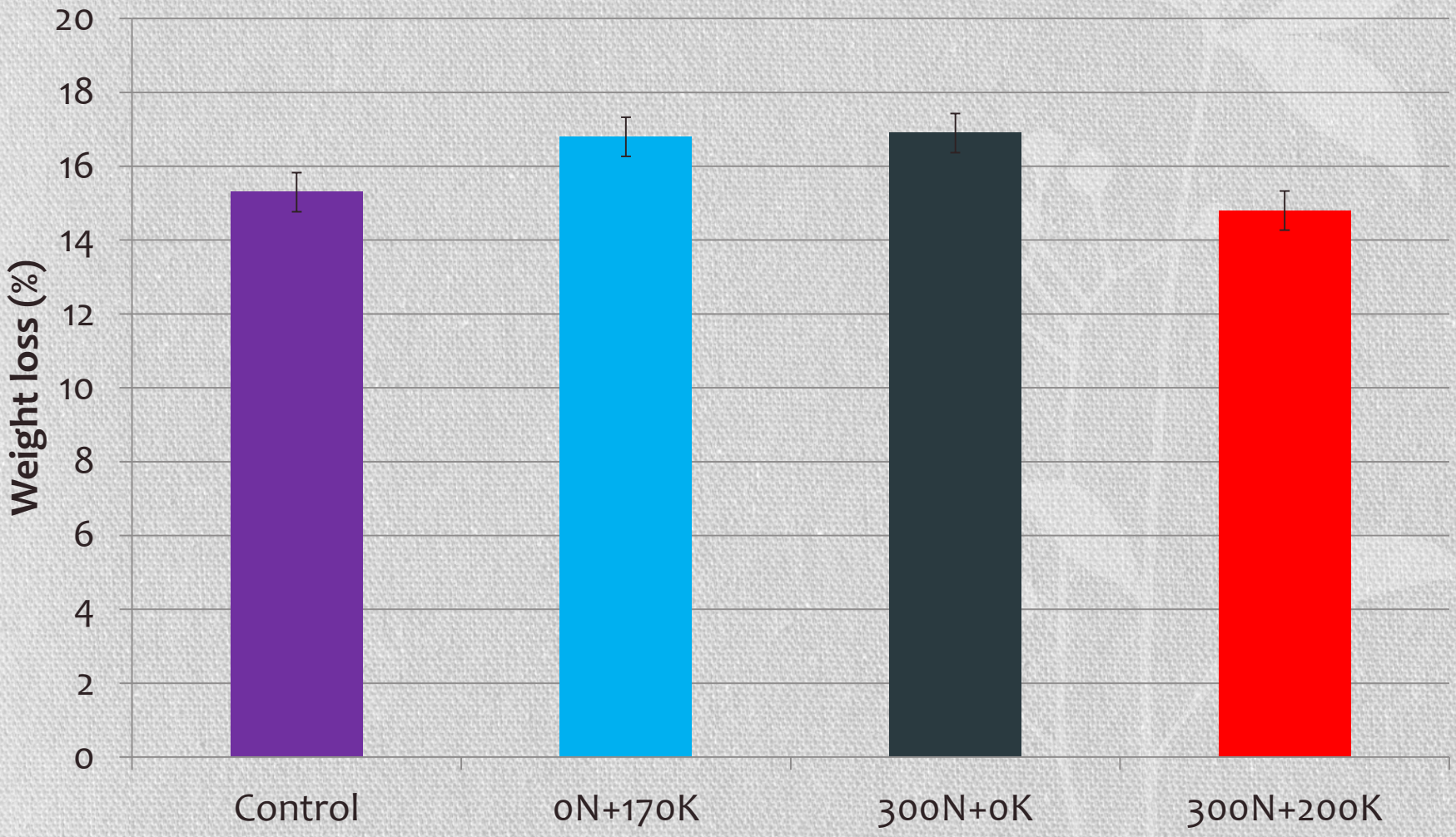
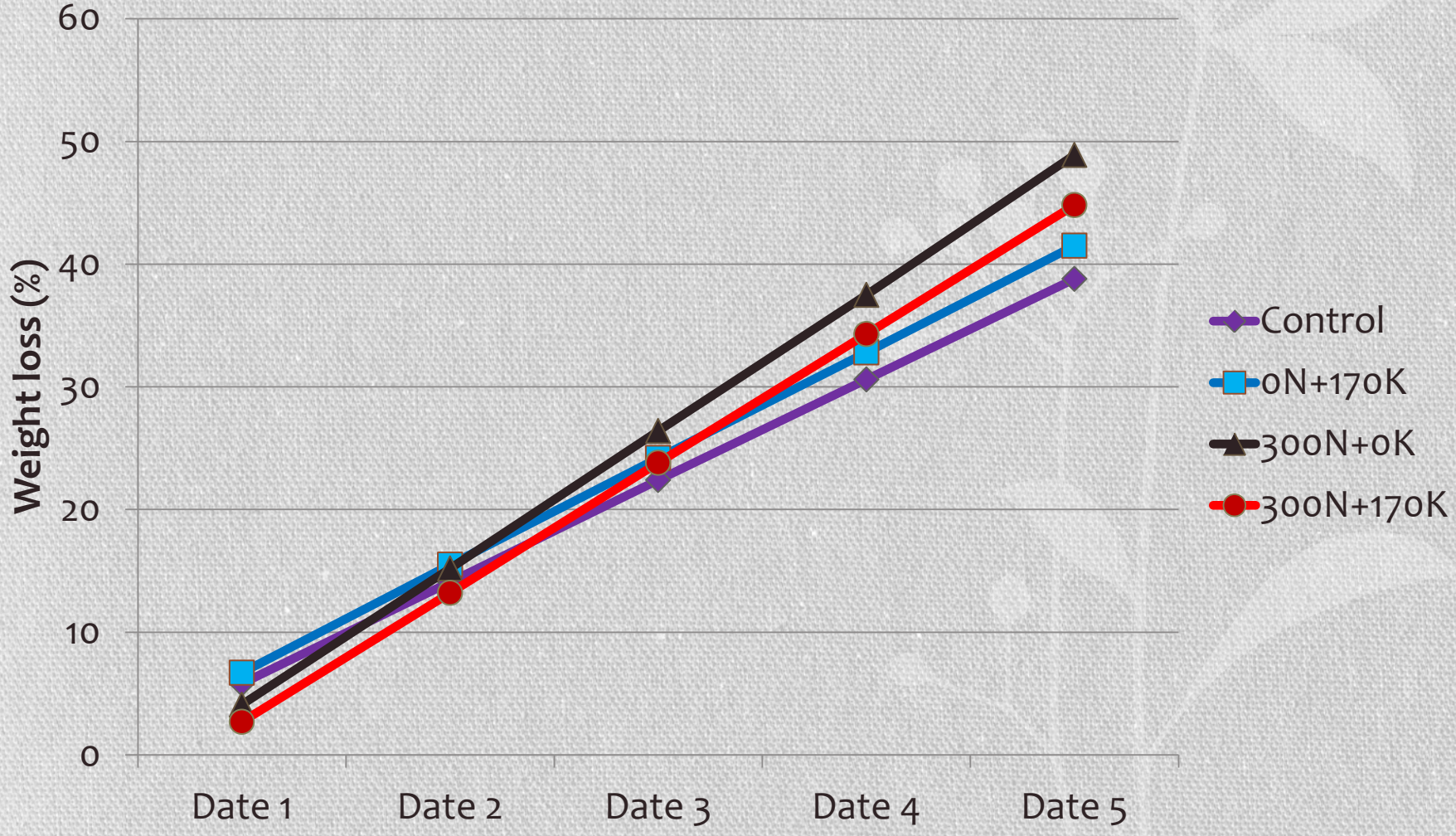
The big picture – fertilizer

Overall fertilizer influence on decomposition

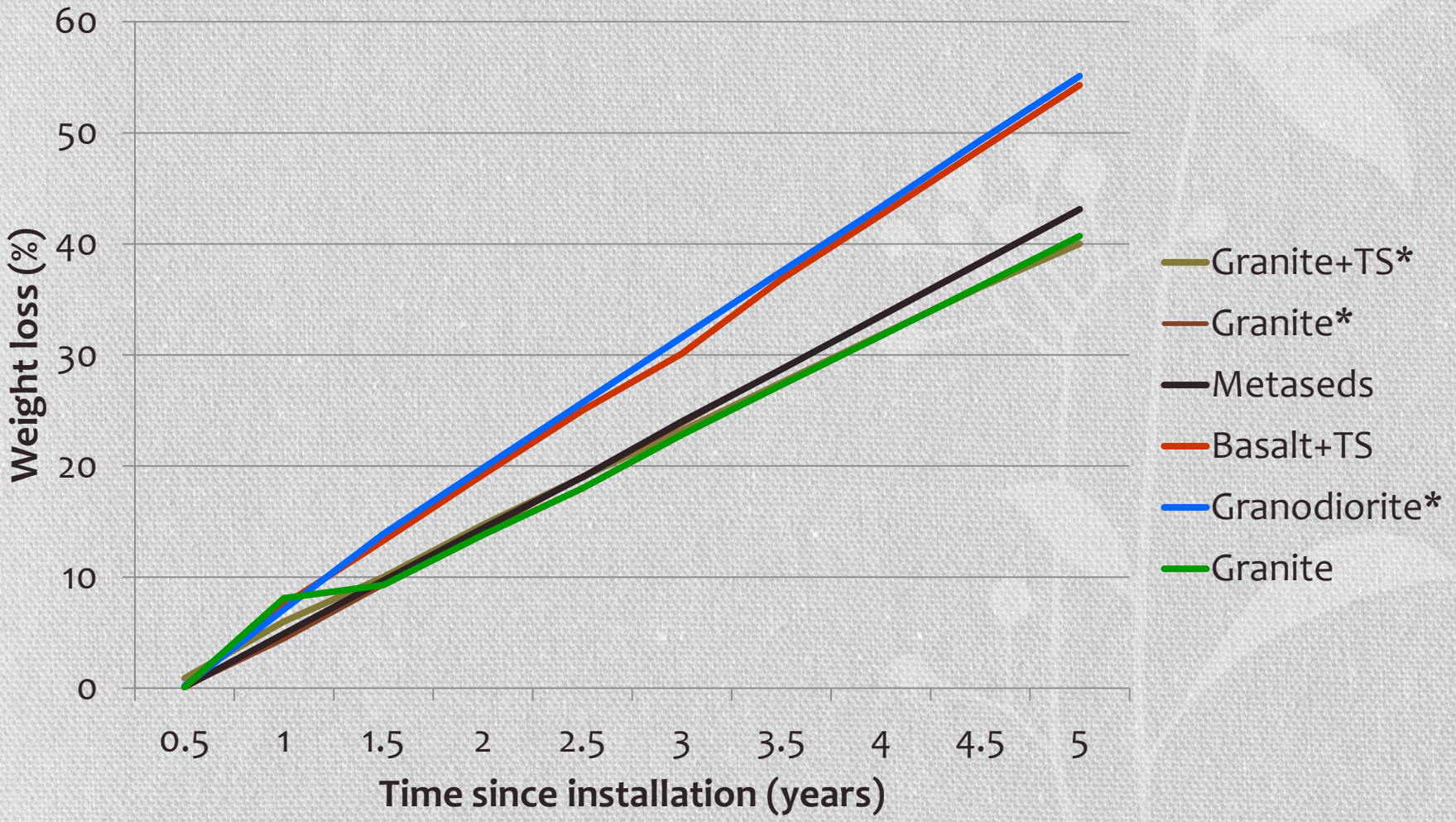


Overall decomposition at each sample date



Finer details of the study

Decomposition on different parent material and soil



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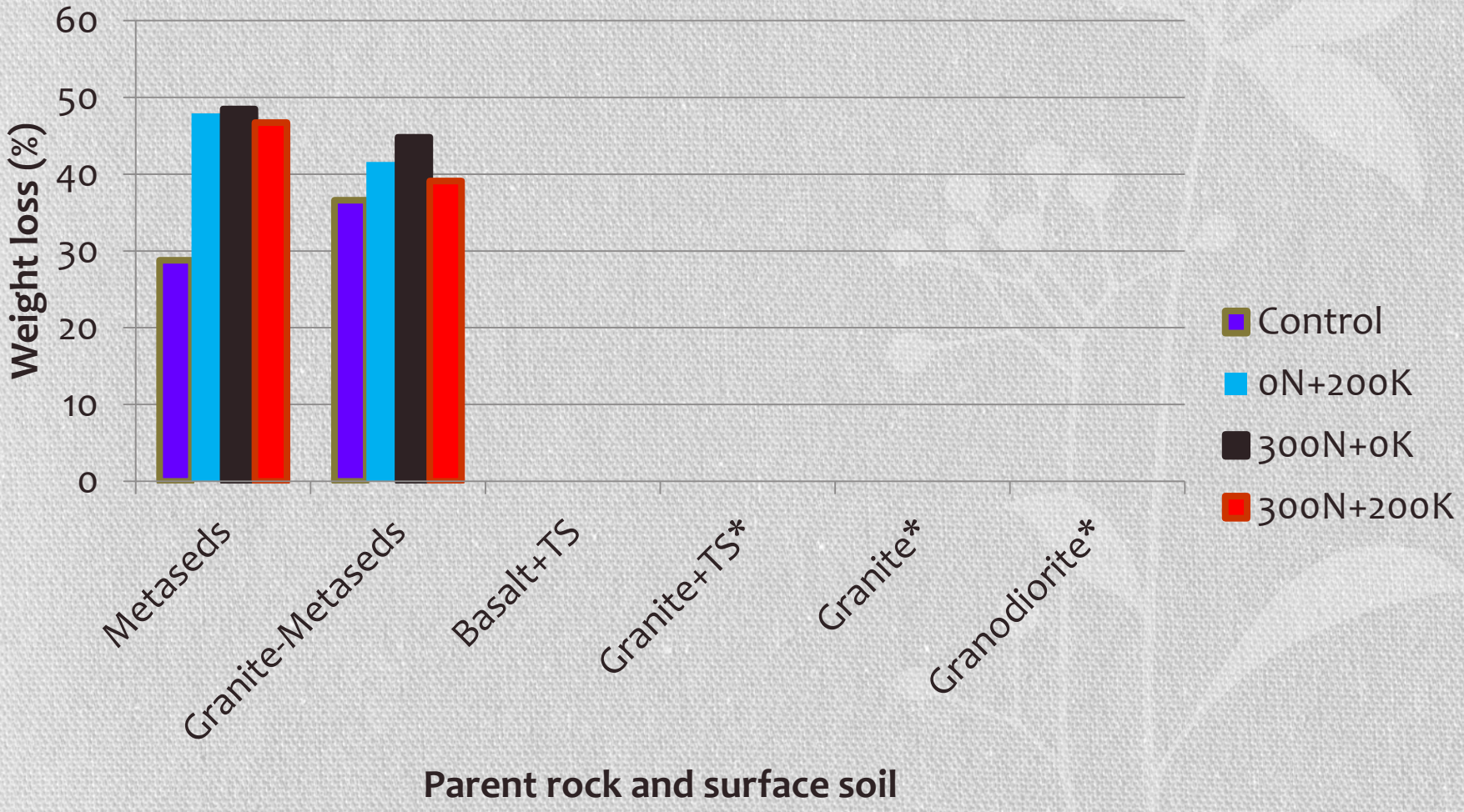
Decomposition on different parent material and soil (Grouped by surface soil)



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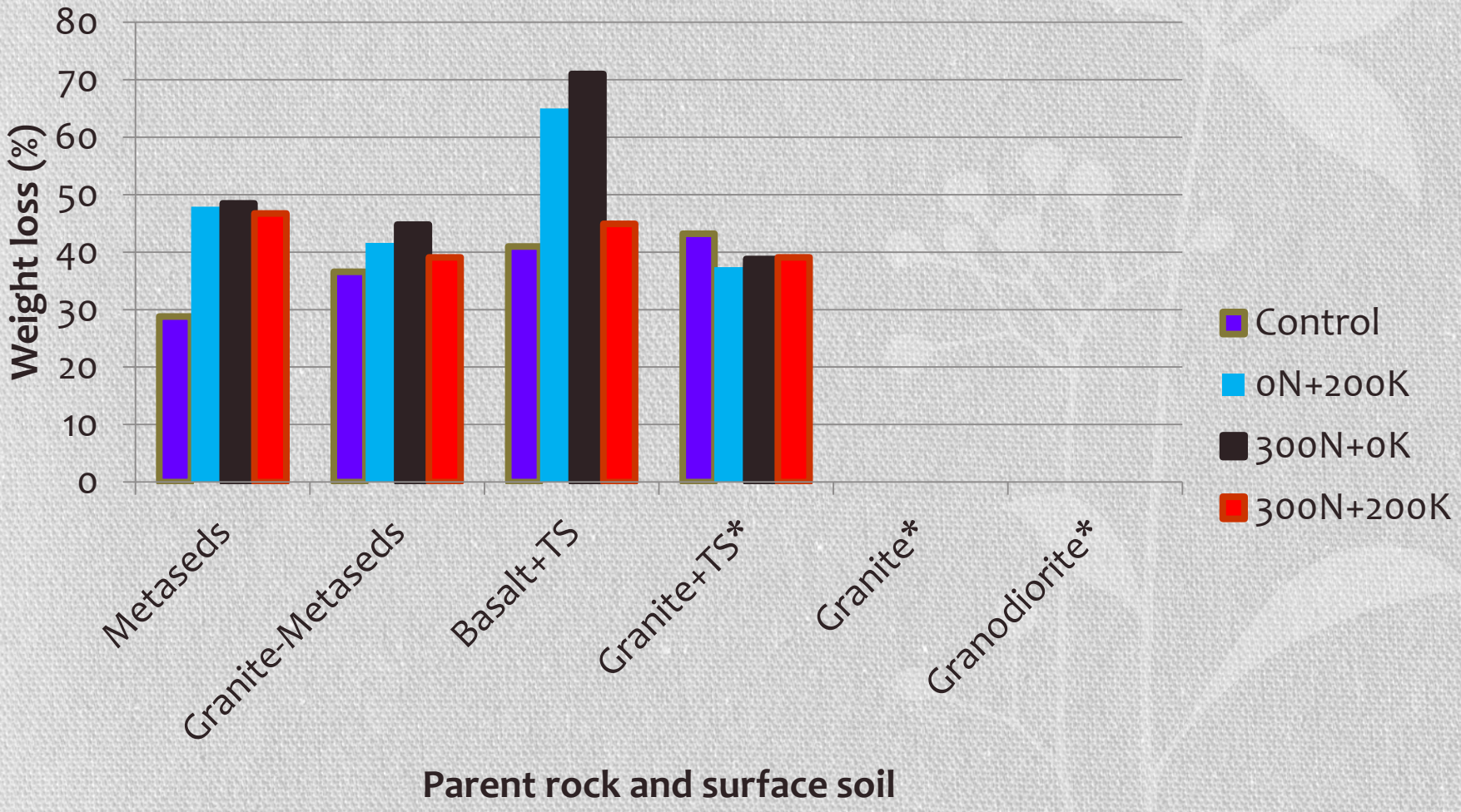

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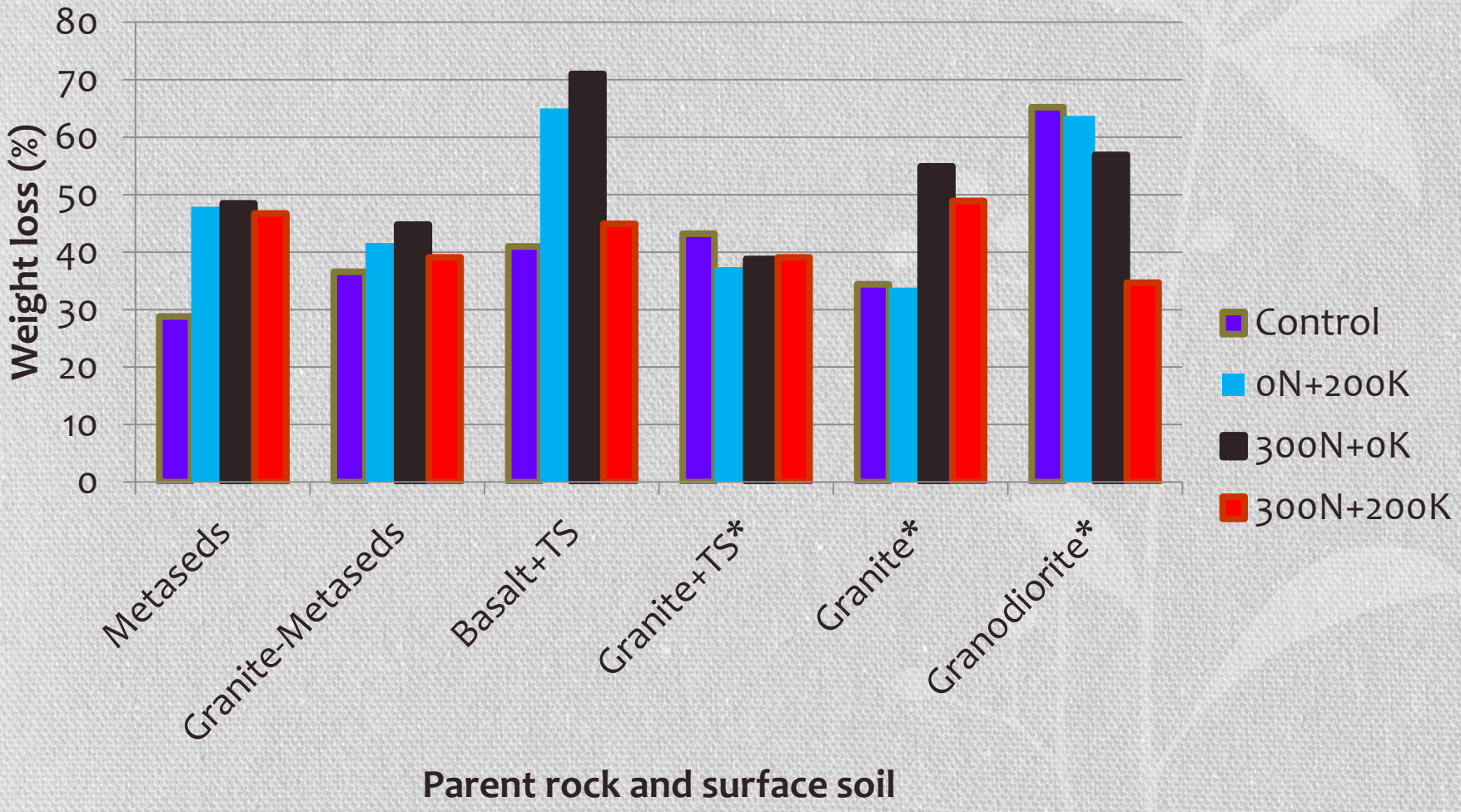

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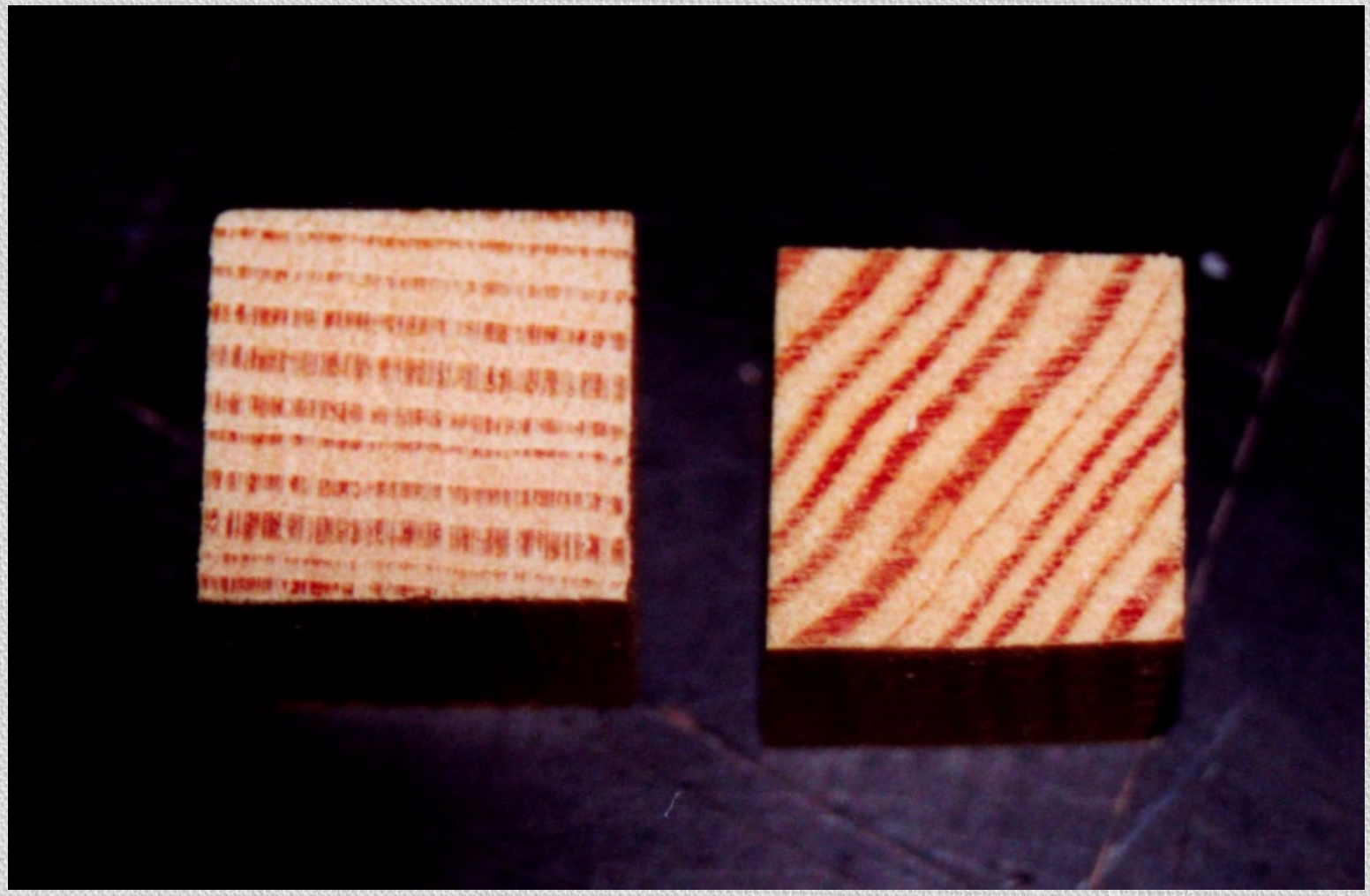
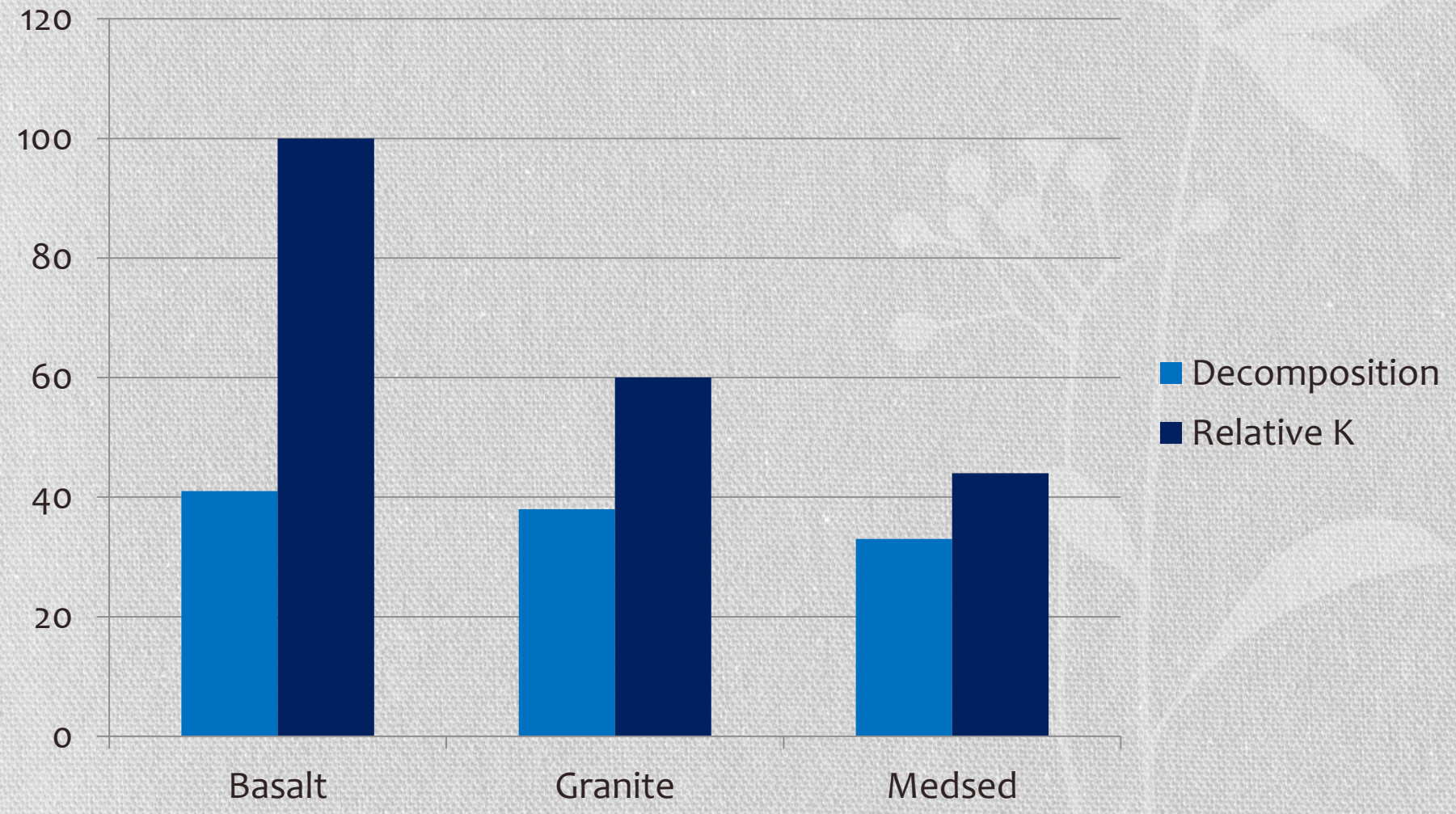
What does it all mean?

- Metasediments:
  - Positive relationship between fertilization and decomposition (except with both N and K)
- Basalt and tertiary sediments
  - Decomp dramatically increases with either N or K, but not both
- Granite and tertiary sediments (with ash cap)
  - Decomposition is less in all fertilization treatments than the control
- Granite (and ash cap)
  - Slight decrease with K only fertilization; N and N+K greater than control
- Granodiorite (with ash cap)
  - Control had highest decomposition rates, but every fertilization treatment showed a decline in decomposition
- There ARE parent material responses

Some details about decomposition and parent material



General trends of decomposition and ecosystem K in the control treatments



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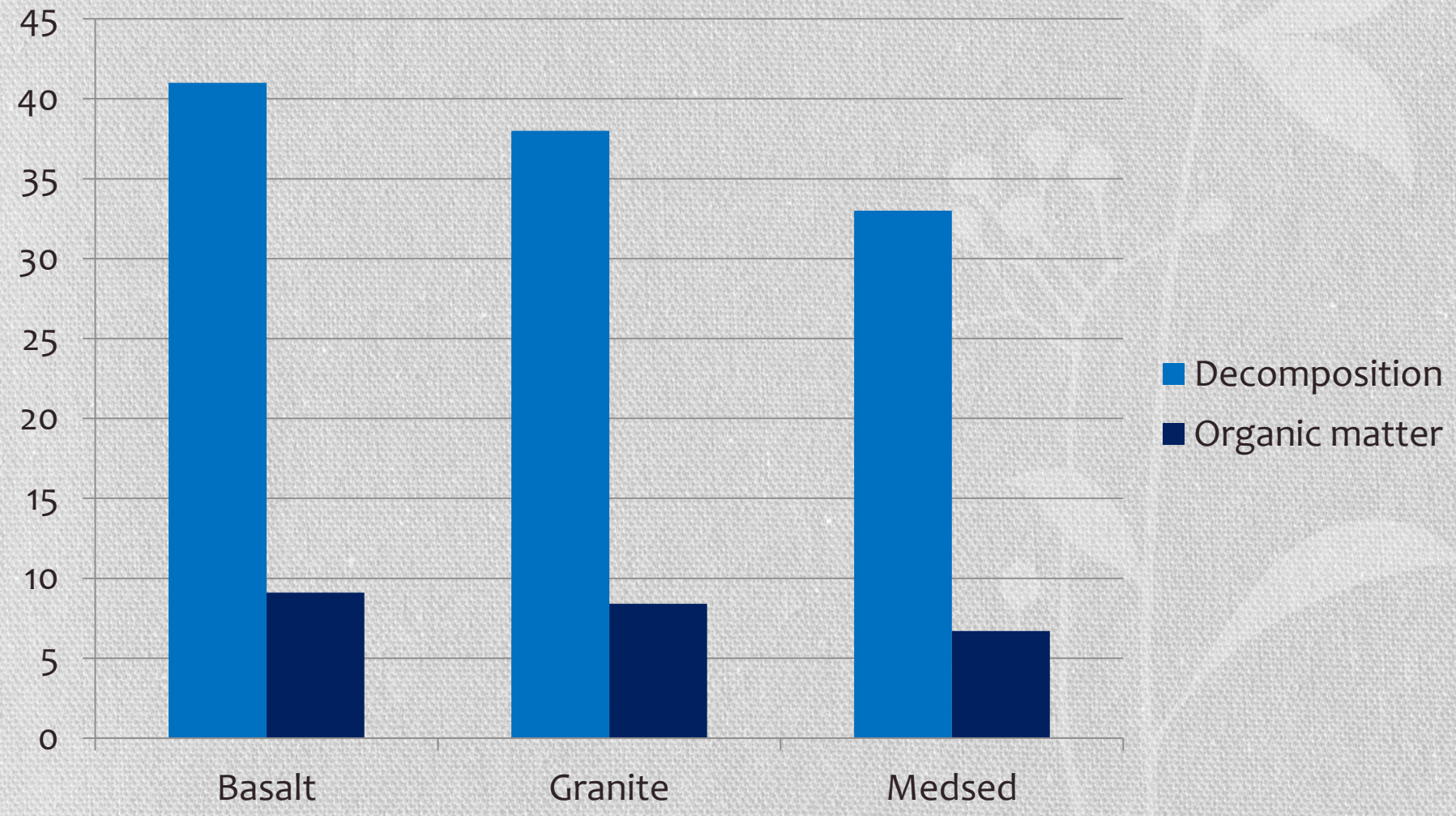

Some results

- Overall below-ground decomposition rates are slightly correlated with
  - Ecosystem K
  - Mineral soil organic matter content
- Many details need to be explored
  - Stake species differences
  - Position in the mineral soil or on the soil surface
  - Within plot variability
  - Relationship within a site to ash-cap depth
  - Fungal species relationships
- Development of the links between soil temperature and moisture with decomposition rates

Management Implications

- Understanding both above- and below-ground responses to fertilization
  - Where responses may be positive or negative
- This study helps describe the need to leave branches and leaves for nutrients on sites where fertilization isn't used
  - How much to leave and where?
- Implications for large woody residue retention and carbon sequestration

Thank you