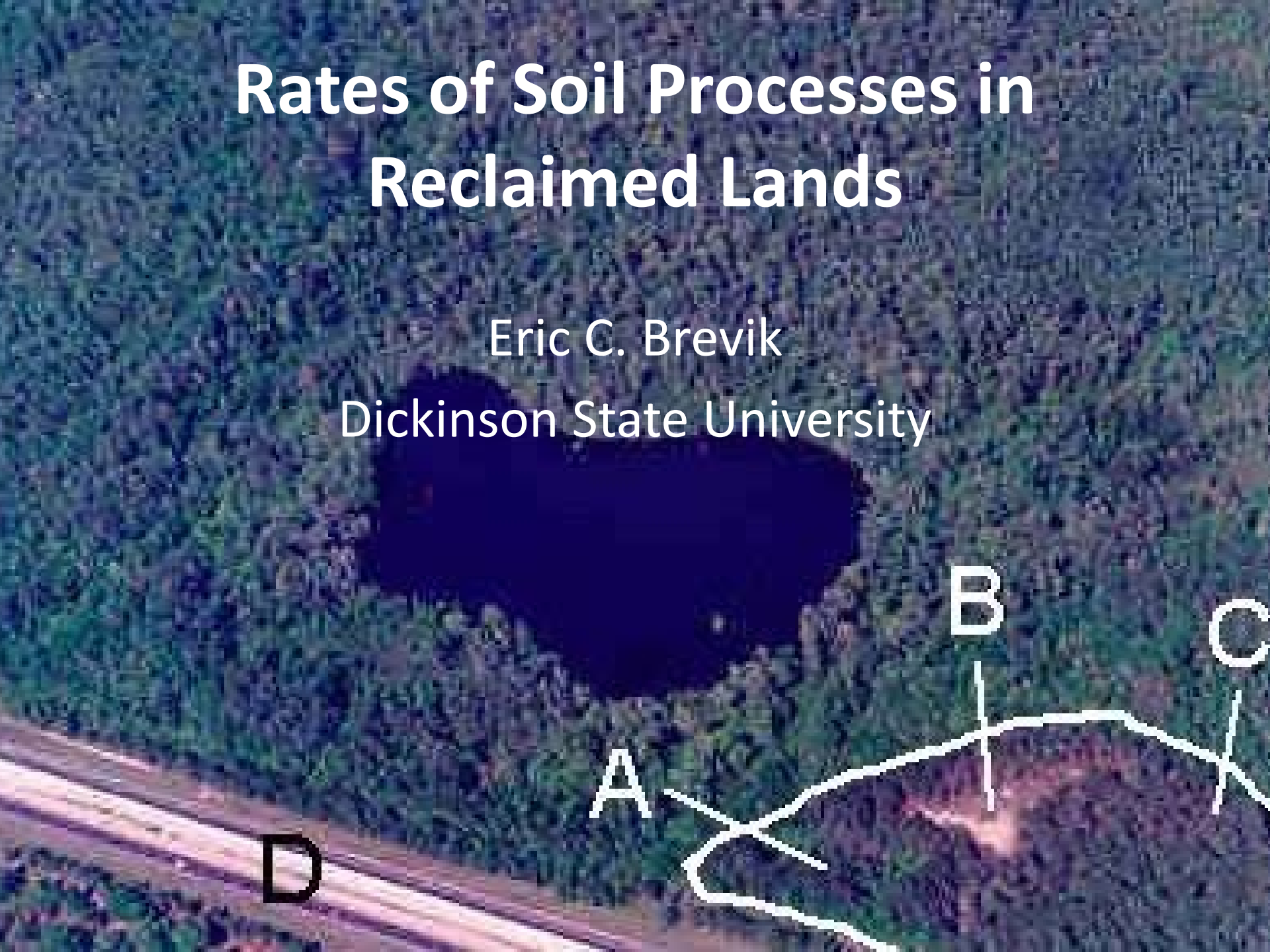


Rates of Soil Processes in Reclaimed Lands

Eric C. Brevik

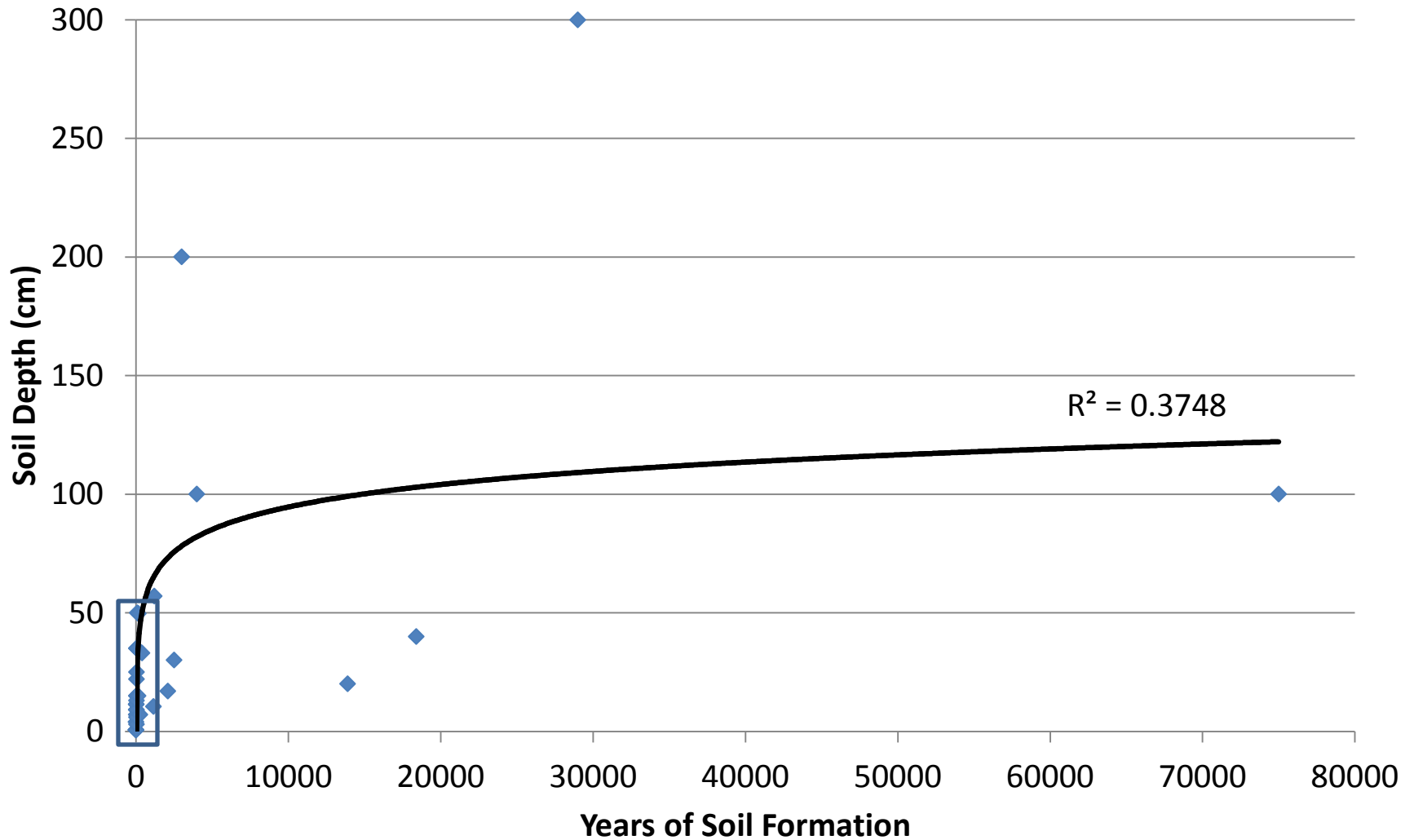
Dickinson State University



Soil Formation

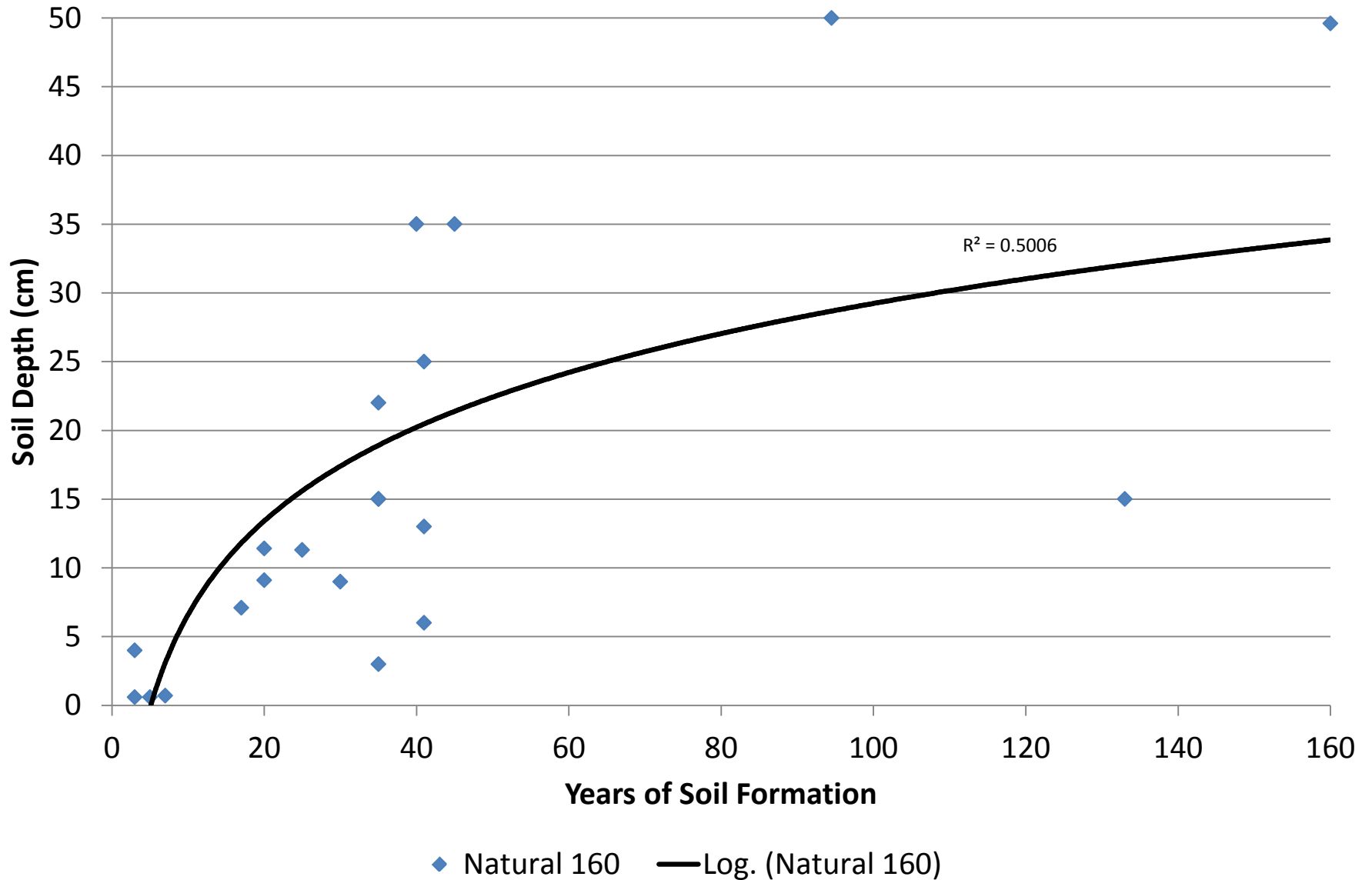
- Natural soil formation at any given place is controlled by the five soil forming factors:
 1. Parent material
 2. Organisms
 3. Topography
 4. Climate
 5. Time
- Soil formation rates in newly exposed parent materials tend to be high and decline with time/depth (Brevik, 2013; Troeh et al., 2004)

Natural Soil Formation Rates



◆ Natural Soils — Log. (Natural Soils)

Natural Soil Formation Rates



Reclaimed Soil Formation

- In reclaimed lands, the 5 traditional soil forming factors are not easily applied (Sencindiver and Ammons, 2000)
 - The time factor is extremely short
 - Topography is due to earth-moving equipment, and does not predict spatial variations in parent material properties
 - Human actions have a major influence on soil formation rates

Reclaimed Soil Formation

- Soil formation can occur very rapidly in shallow reclaimed soils:
 - A horizons greater than 5 cm can form in 3 years or less (Roberts et al., 1988)
 - C content of upper 10 cm may equal surrounding native soils in 30-50 years (Sencindiver and Ammons, 2000)
 - Physical and chemical weathering breaks down rock fragments very rapidly in the upper few cm (Ciolkosz et al., 1985)

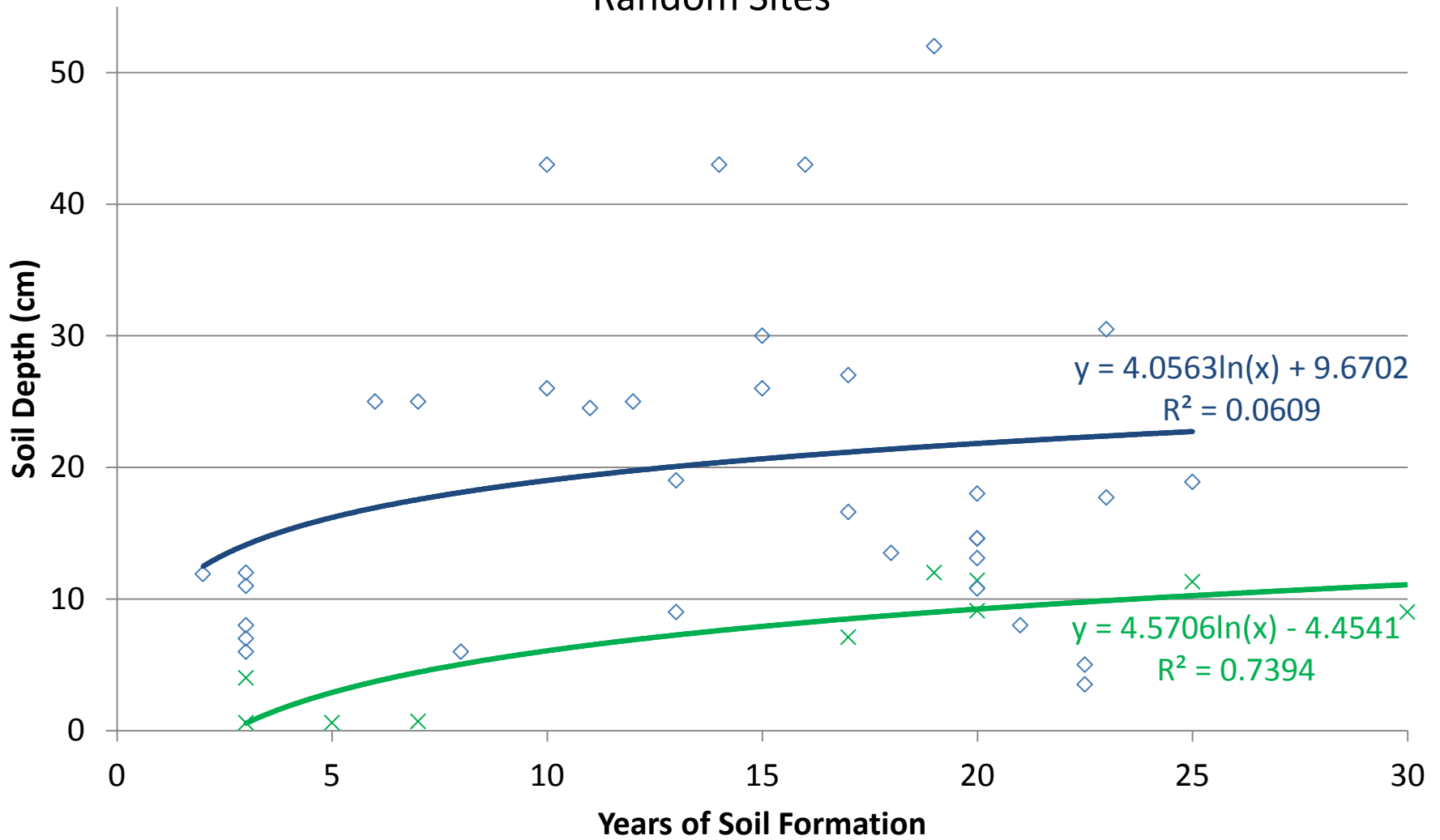


Reclaimed Soil Formation

- Soil formation below 10 cm takes place very slowly
 - 400 years or more may be required to reach organic C levels comparable to native soils (Sencindiver and Ammons, 2000)
- This is similar to studies of natural soil formation, where deep soil processes take long periods of time (Brevik, 2013; Troeh et al., 2004)
 - 1000 years to form 1 inch of soil is for a depth of ~40 inches

Reclaimed Soil Formation Rates

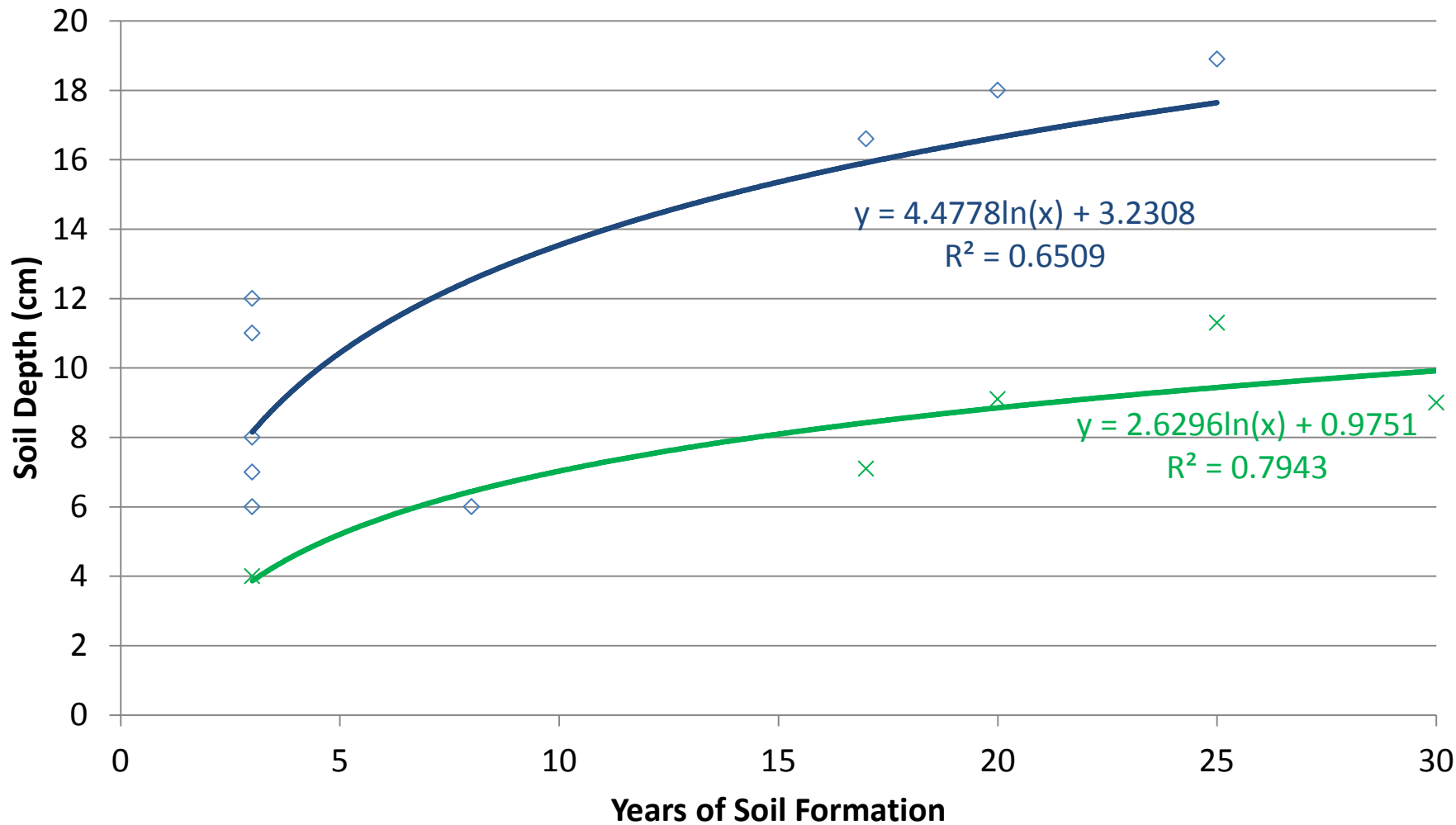
Random Sites



◇ Reclaimed Soils × Natural Soils — Log. (Reclaimed Soils) — Log. (Natural Soils)

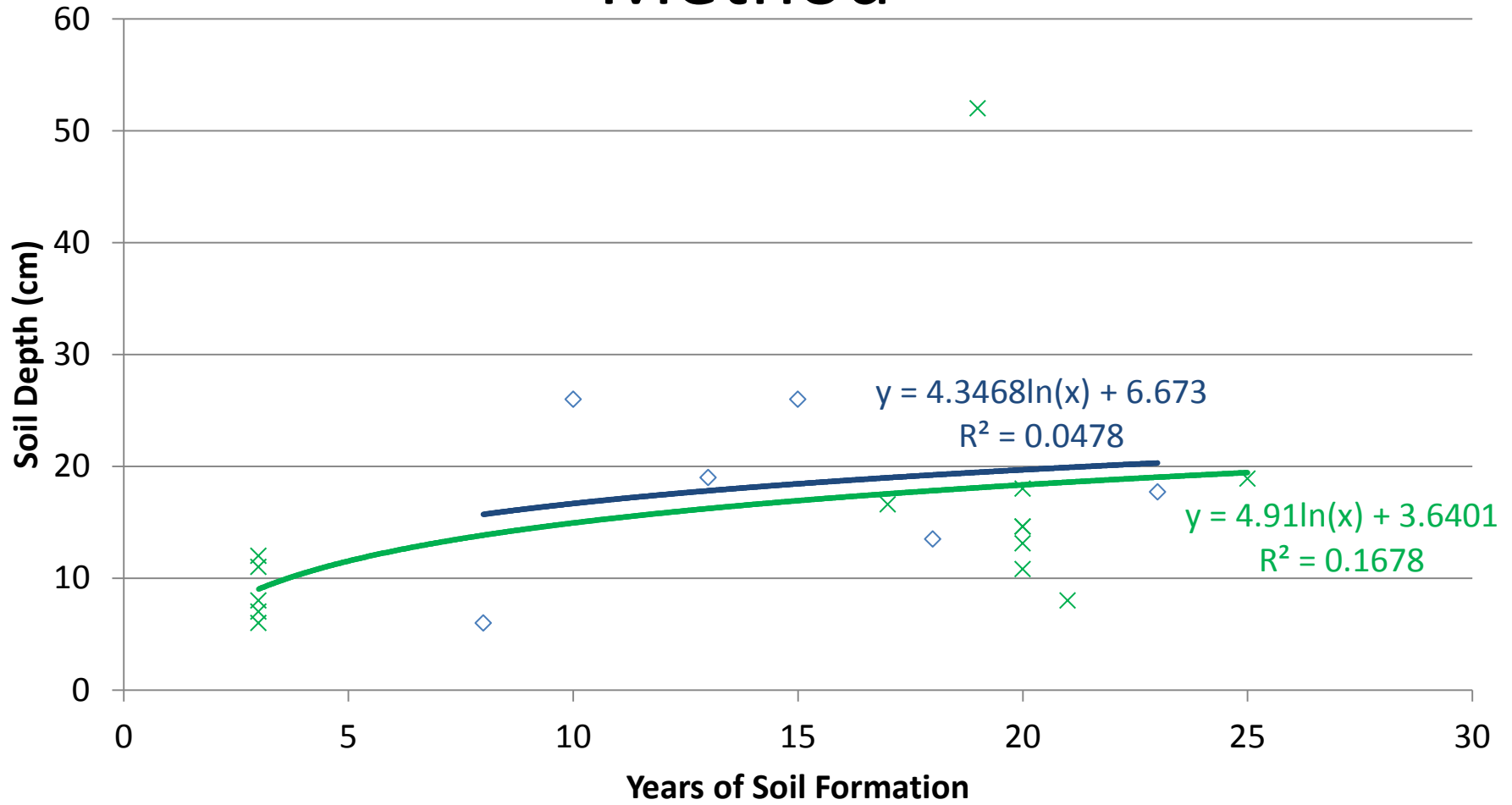
Reclaimed Soil Formation Rates

Common sites



◇ Reclaimed Soils × Natural Soils — Log. (Reclaimed Soils) — Log. (Natural Soils)

Soil Formation Rate by Reclamation Method



- ◇ Plantings Only
- × Fertilizer and/or OM
- Log. (Plantings Only)
- Log. (Fertilizer and/or OM)



Other Ways to Quantify Reclamation

- Several other measures are frequently used to quantify the relative success of soil reclamation efforts:
 - Organic C and N accumulation in the soil
 - Reduction in bulk density and void creation
 - Formation of soil structure
 - Improvements in pH and/or base saturation %
 - Crop yields or above ground biomass production
 - Plant species diversity
 - Measures of microbial activity

Other Ways to Quantify Reclamation

- Alexander (1989) investigated reclamation of tin mines over 23 years using plantings of eucalyptus trees in Nigeria; no lime, fertilizer, or OM additions utilized
- Noted an increase of 0.008-0.010% organic C per year with reclamation and 0.006-0.008% organic C per year without reclamation
- Also noted decreased pH and base saturation under eucalyptus, leading to soil degradation
- Selection of reclamation techniques is important

Other Ways to Quantify Reclamation

- Pietrzykowski and Krzaklewski (2007) investigated reclamation of sand quarries in Poland over 25 years using native tree species and OM, lime, and fertilizer additions
- Organic C increased 0.031-0.039% per year with reclamation and 0.029-0.032% per year without reclamation
- Total N increased 0.0020-0.0038% per year with reclamation and 0.0013-0.0022% per year without reclamation

Conclusions

- Reclamation efforts can improve soil properties versus natural succession
- Rates of horizon development may not increase under reclamation, but the initial parent material conditions can be improved
- Rates of soil formation decrease with time in both natural and reclaimed environments
- It is important to carefully consider reclamation techniques, as there are some examples of situations where reclamation may have actually set the soil back

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