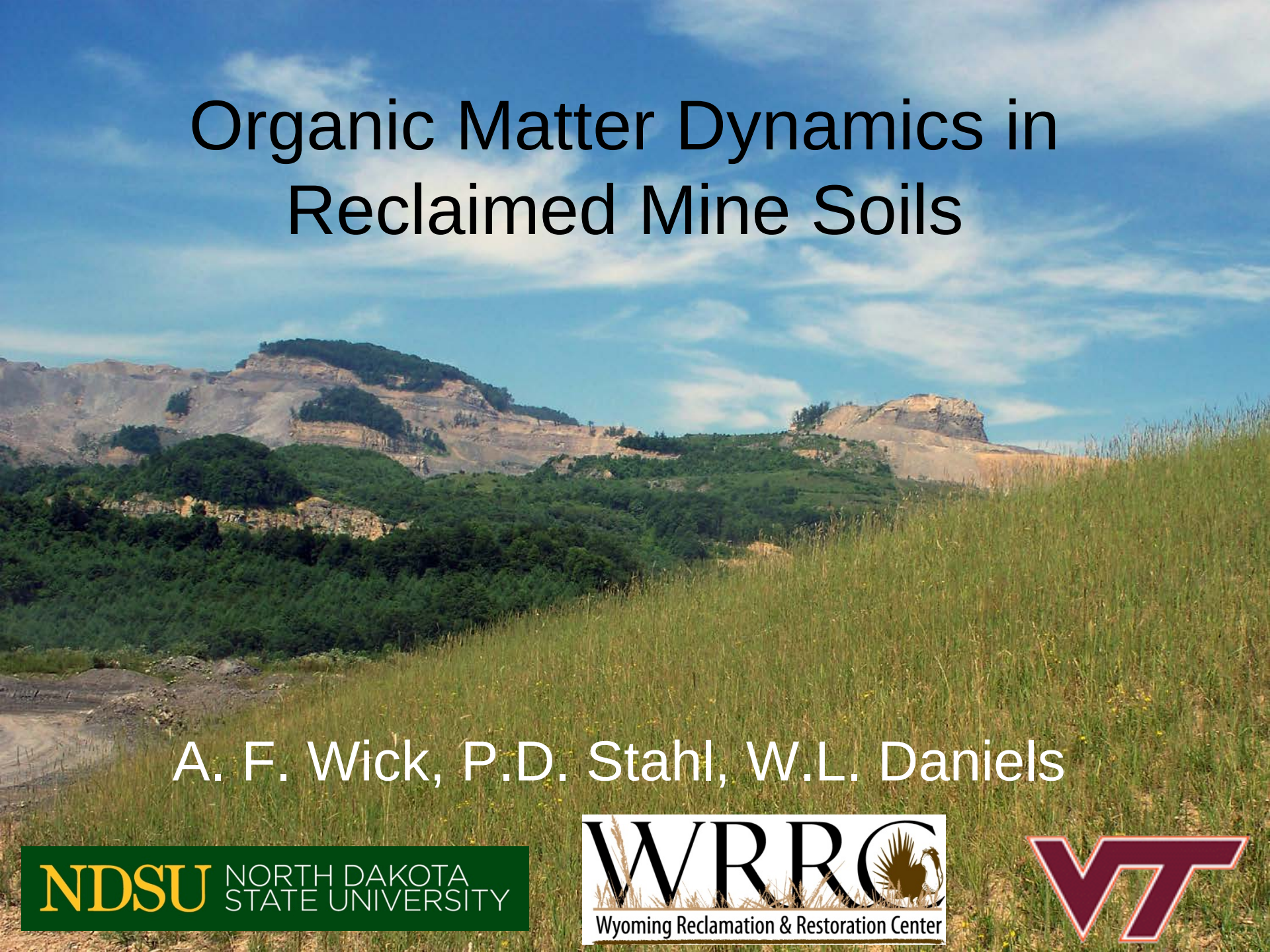
Organic Matter Dynamics in Reclaimed Mine Soils



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NDSU NORTH DAKOTA STATE UNIVERSITY

WRRC Wyoming Reclamation & Restoration Center

VT

Mining Disturbances

- **Appalachian:**
  - **390,217,000 short tons coal produced (33% of total production in US for 2008)**
- **Western:**
  - **633,597,000 short tons coal produced (54% of total production in US for 2008)**


Southwest Virginia Mine, view from 30,000’
-post mining: forest


Northeast Wyoming Mine, view from 30,000’
-post mining: wildlife areas, grazing
Image © 2010 DigitalGlobe

Differences in Reclamation

- **East**
  - Amendments/handling crushed rock
  - High precipitation (~120 cm)
  - Tree establishment desirable
  - 5 yr bond release

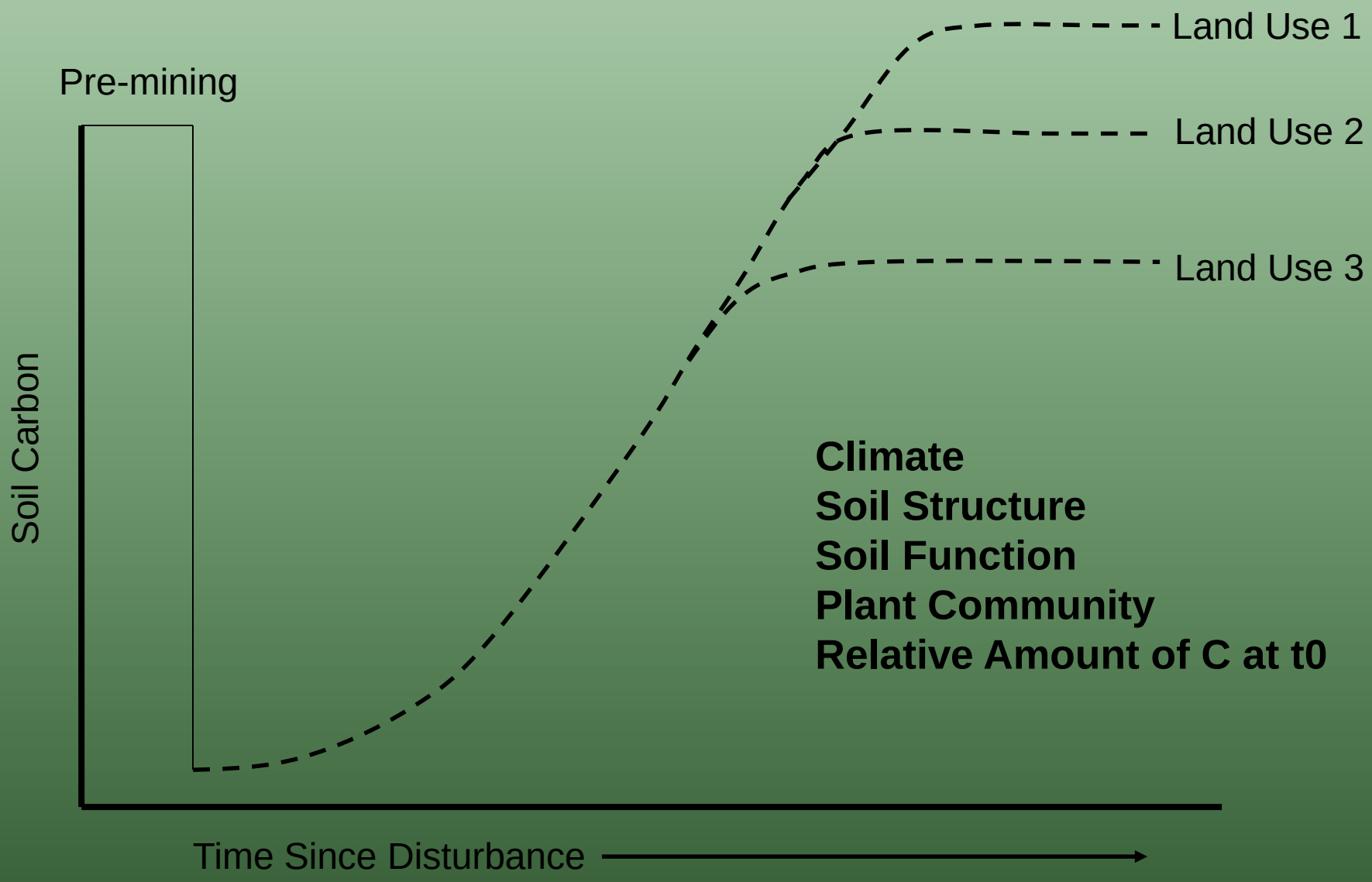
- **West**
  - Topsoil salvaged (stockpile or direct haul)
  - Low precipitation (<55 cm)
  - Shrub and grass establishment
  - 10 yr bond release

Though mining and reclamation practices are very different in each region, there is still the potential to accumulate and store C in reclaimed soils

What are the accumulation rates?

Carbon Accumulation Rates

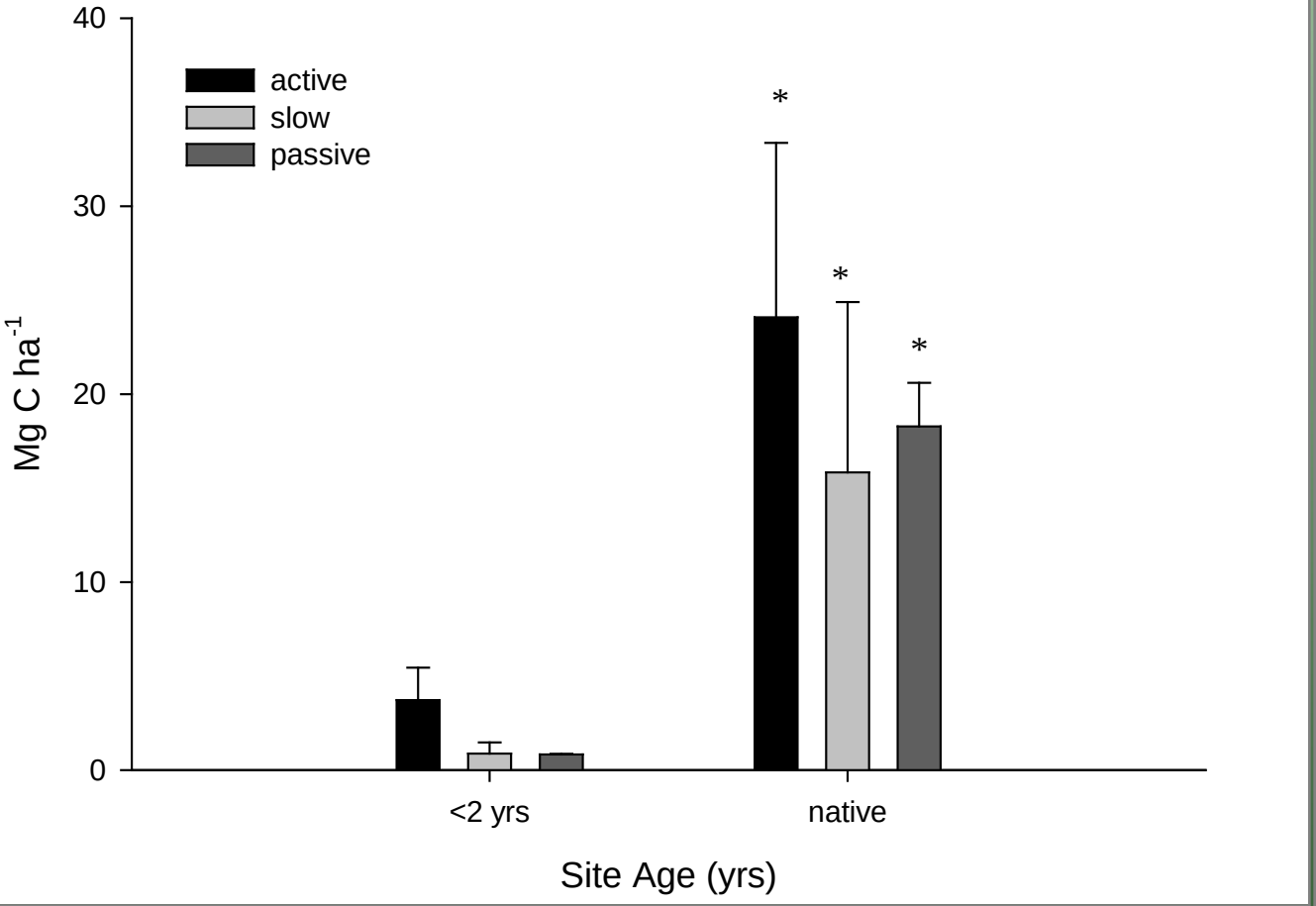
- Shrestha and Lal, 2006
  - 0.31 – 3.1 Mg ha^{-1} yr^{-1} (0-30 cm) in grasslands (OH)
  - 0.58 – 4.0 Mg ha^{-1} yr^{-1} (0-30 cm) in forest
- Benfeldt et al., 2001
  - 0.43 Mg ha^{-1} yr^{-1} (0-10 cm) in grasslands (VA)
- Schafer et al., 1980
  - 1.33 Mg ha^{-1} yr^{-1} (0-200 cm) in soils <10 yr old (MT)
  - 0.45 Mg ha^{-1} yr^{-1} (0-200 cm) in soils >10 yr old
- Anderson et al., 2008
  - 1.17 Mg ha^{-1} yr^{-1} (0-30 cm) in grass/shrub mix (WY)


Land Use 1
Land Use 2
Land Use 3
Pre-mining
Soil Carbon
Climate
Soil Structure
Soil Function
Plant Community
Relative Amount of C at t0
Time Since Disturbance

East: <2 yr

East: Native

Loss of C with Disturbance-East

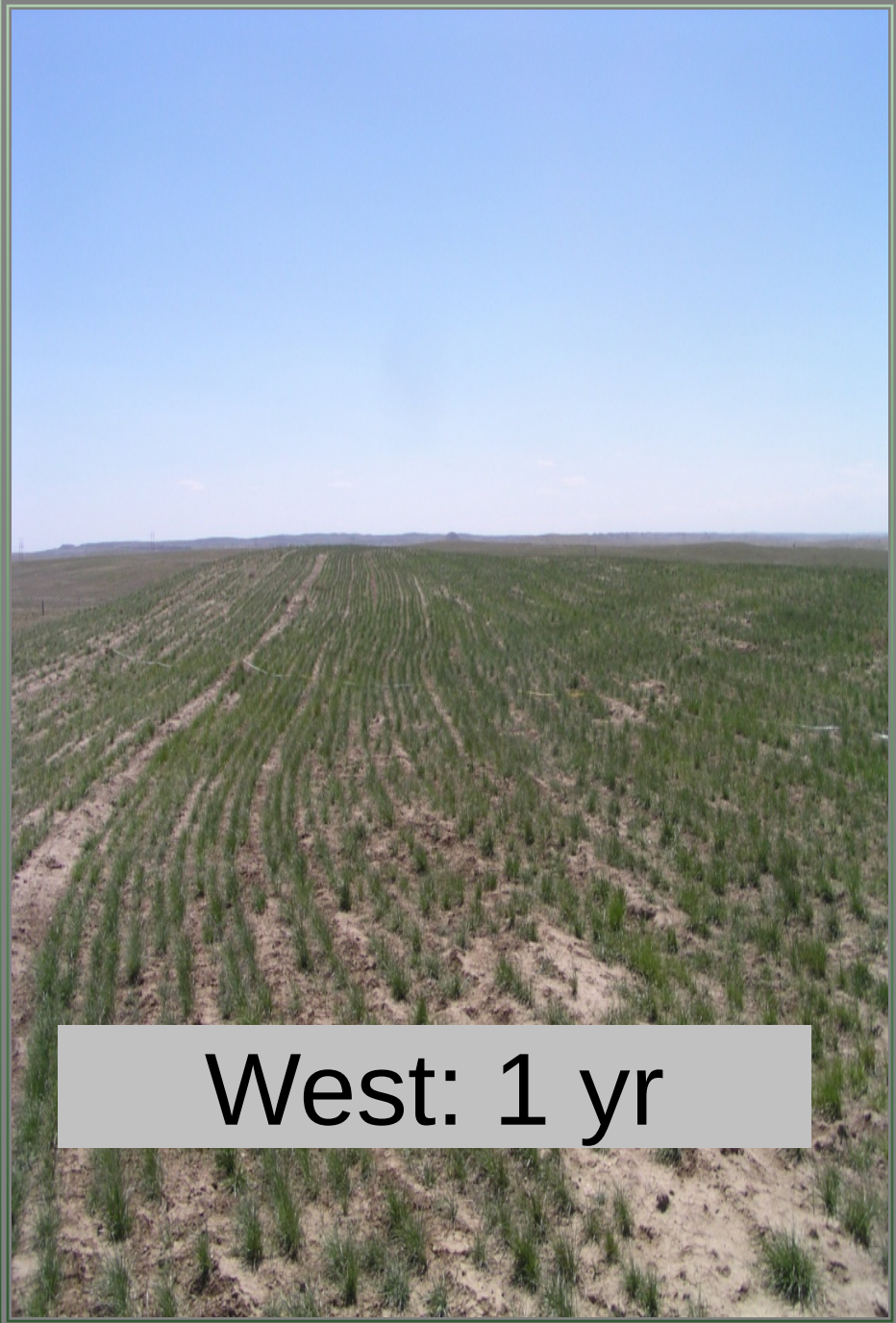


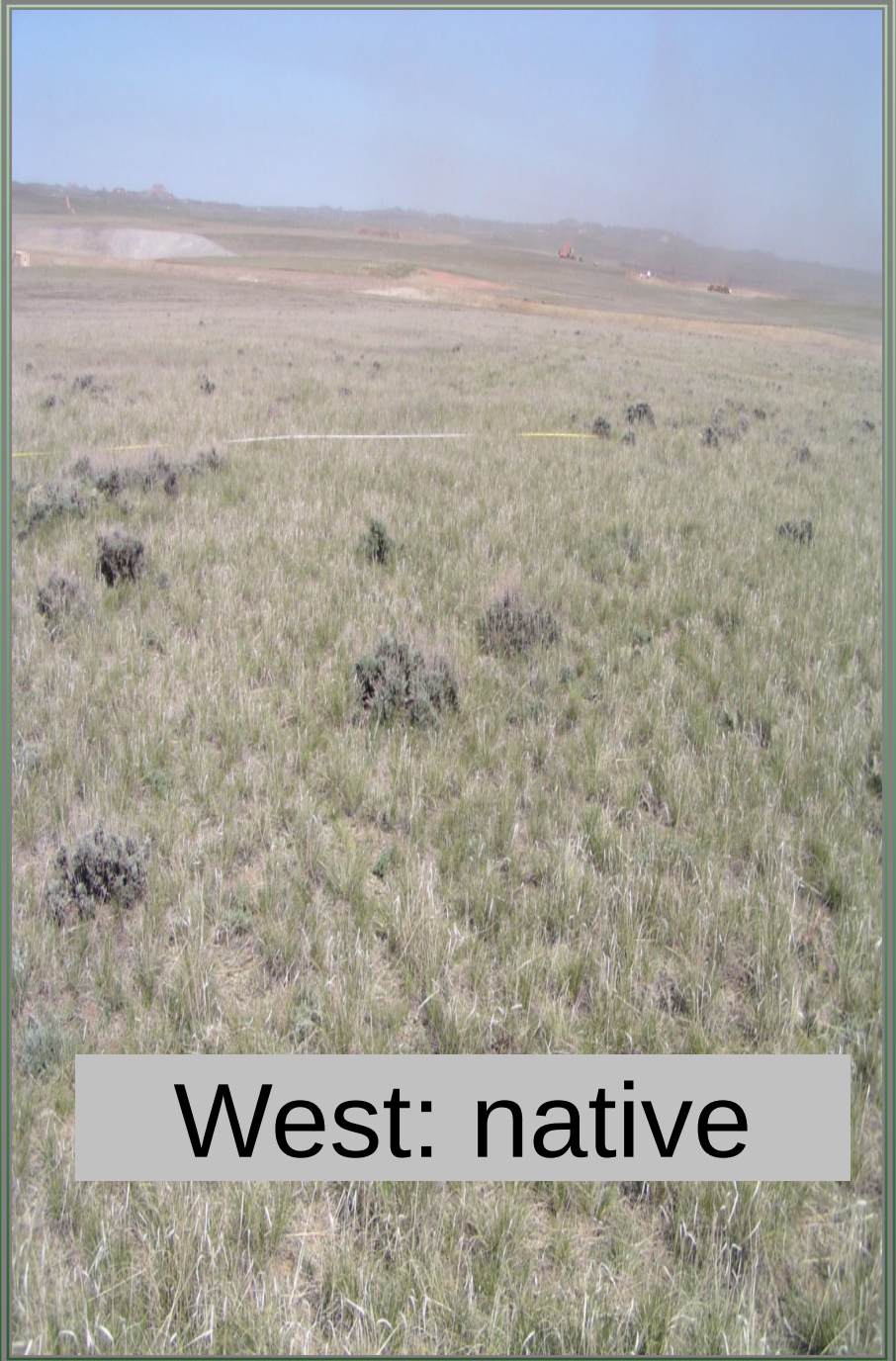
This loss is for the 0-5 cm depth

0.31 Mg ha^{-1} yr^{-1}: **170 yrs**

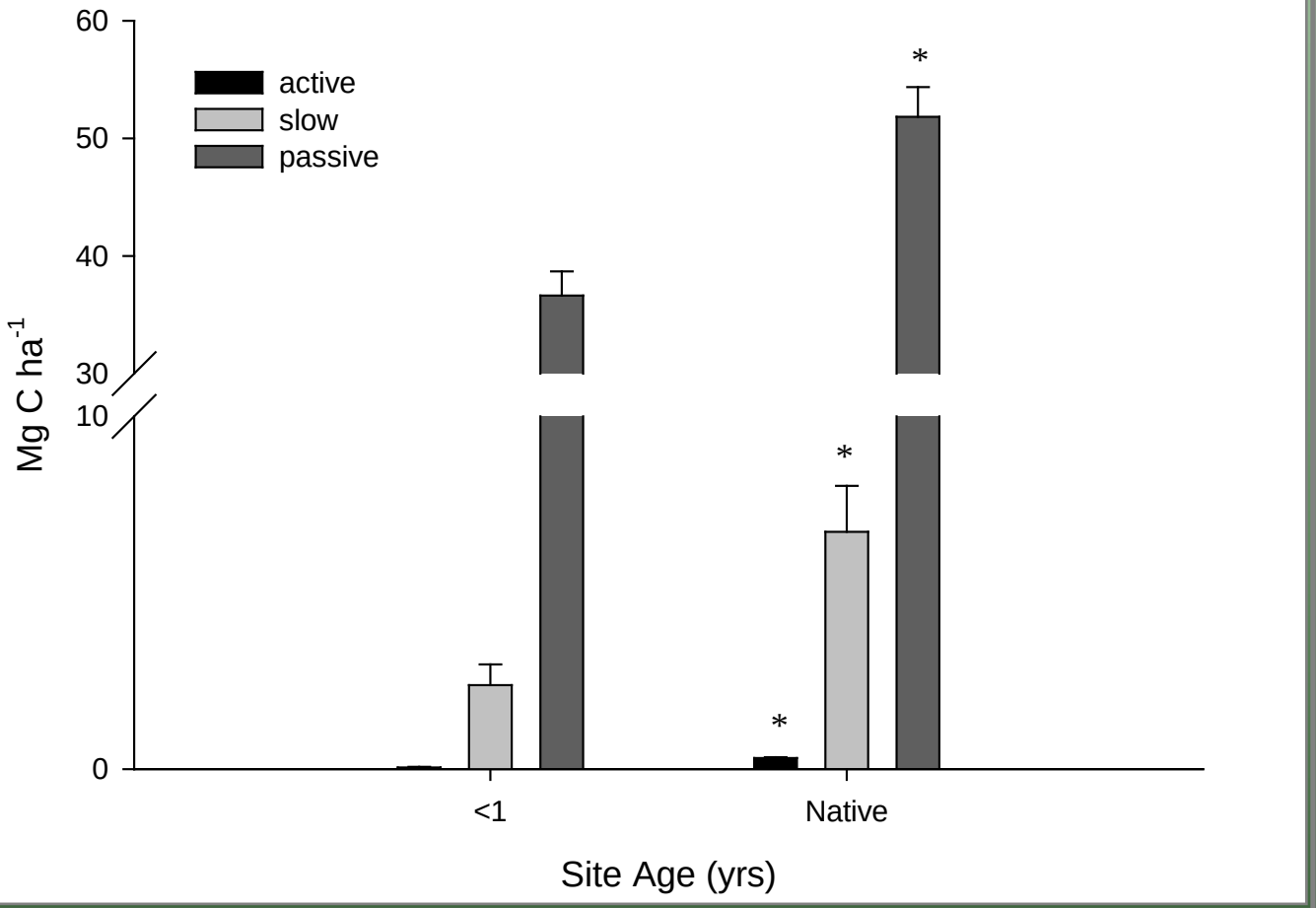
3.1 Mg ha^{-1} yr^{-1}: **17 yrs**

(Wick and Daniels, 2009, BLRS proceedings)


West: 1 yr


West: native

Loss of C with Disturbance-West



This loss is for the 0-5 cm depth

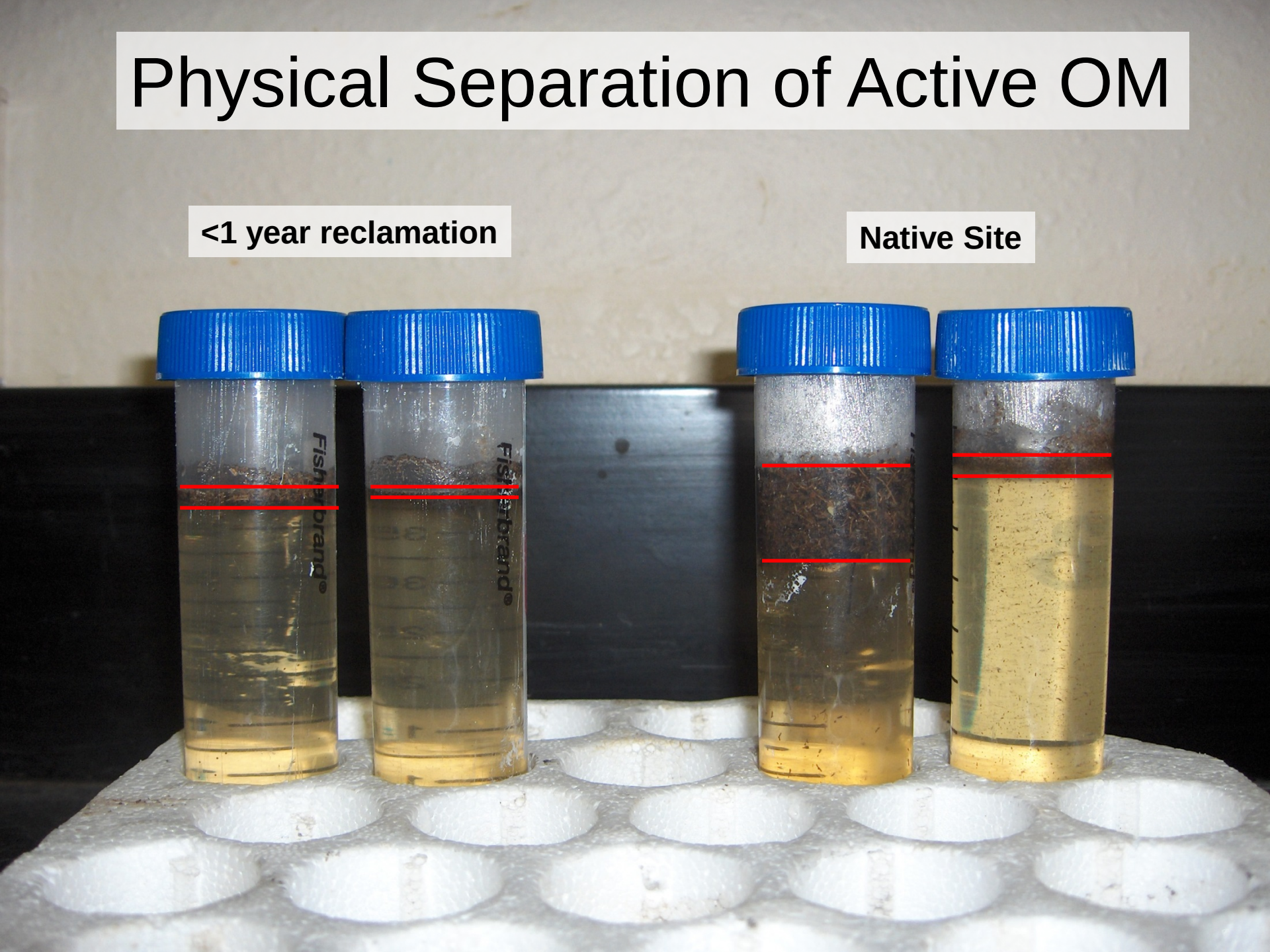
0.31 Mg ha^{-1} yr^{-1}: **147 yrs**

3.1 Mg ha^{-1} yr^{-1}: **15 yrs**

1.17 Mg ha^{-1} yr^{-1}: **39 yrs**

(Wick et al., 2009, Soil Use Mgt 25: 311-319)

Physical Separation of Active OM



Location of OM

- ***Active***
  - Living or newly added biomass
  - <10-20% of total OM
  - 10's of years
- ***Slow***
  - Physically protected (aggregates)
  - Important source for nitrogen
  - 100's of years
- ***Passive***
  - Very stable, chemically altered and bound (humus)
  - 60-90% of total OM
  - 1000's of years

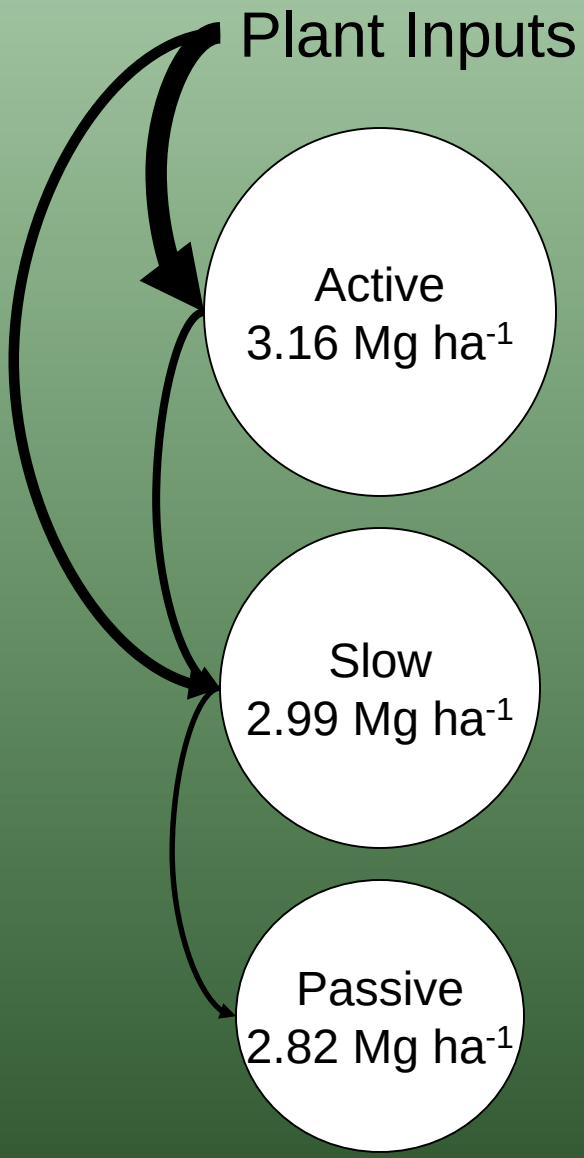
Eastern Soil Carbon Accumulation Rates

Whole soil: 0.30 Mg ha^{-1} yr^{-1}

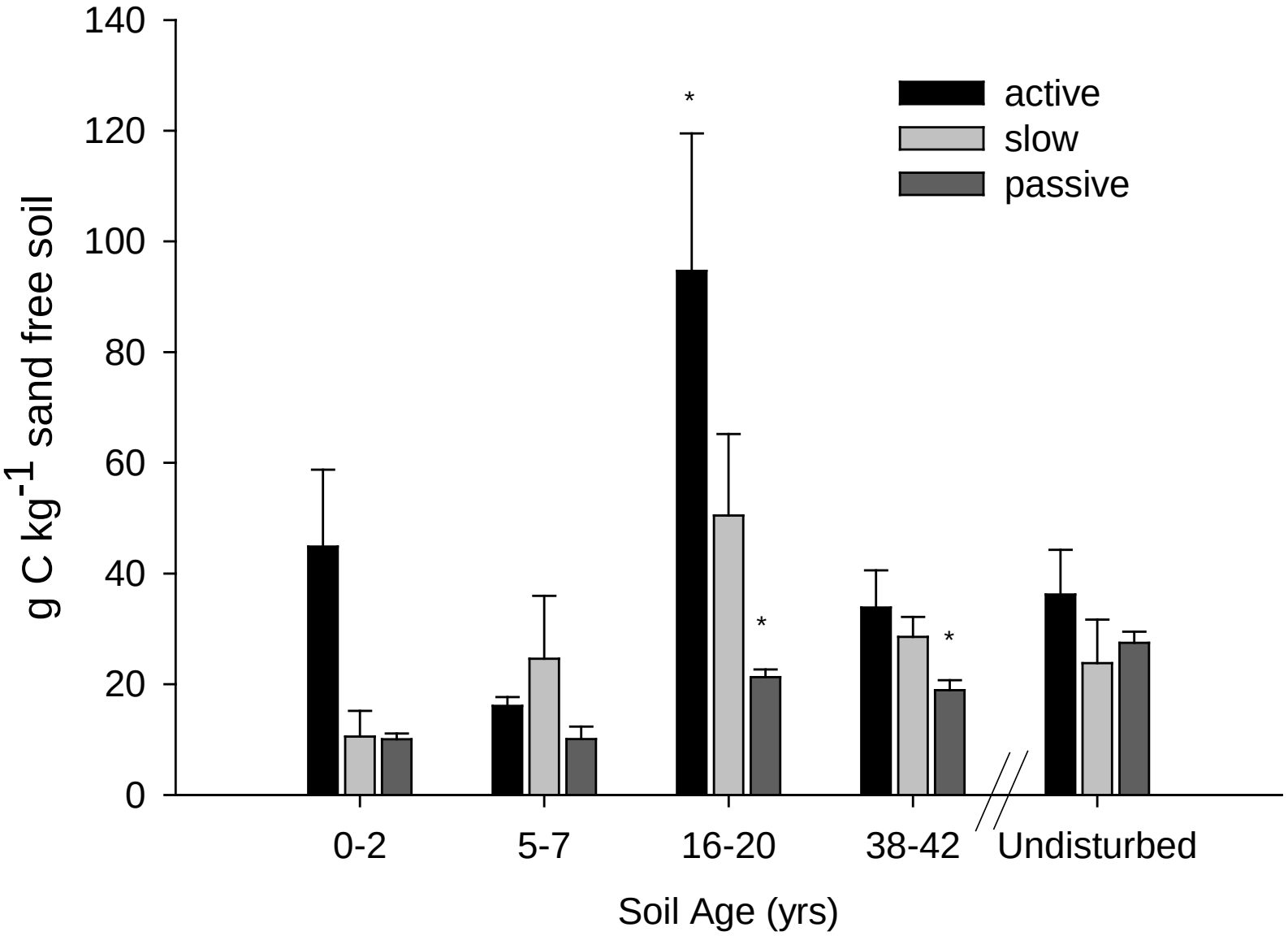
- Active: 0.11
- Slow: 0.10
- Passive: 0.09

194 yrs to reach “native” in 0-5 cm

Coarse Textured, 27 yr reclaimed site



Eastern Carbon Concentrations



Bars represent one standard error from the mean
Asterisks indicate significantly higher values among soil ages (P<0.05)

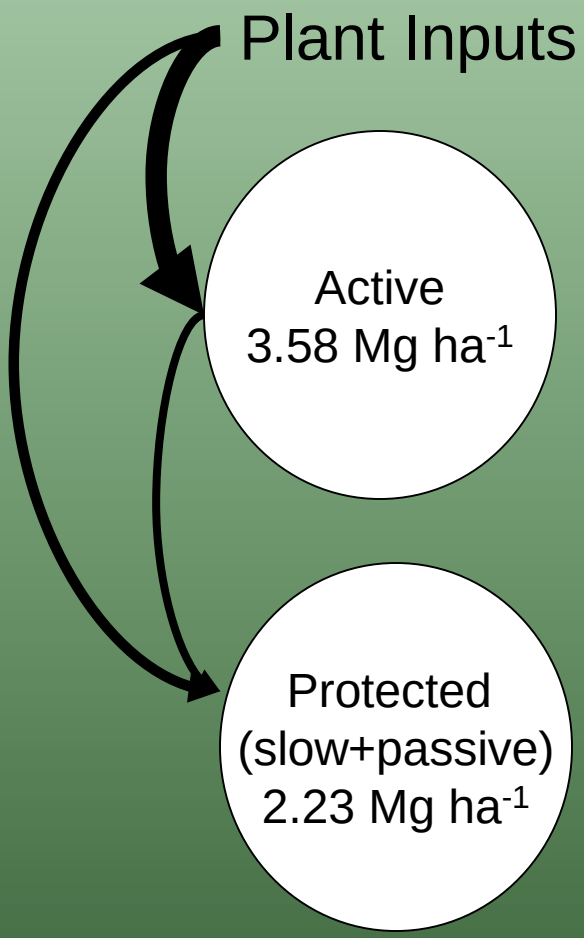
Western Soil Carbon Accumulation Rates

Whole soil: 0.17 Mg ha^{-1} yr^{-1}

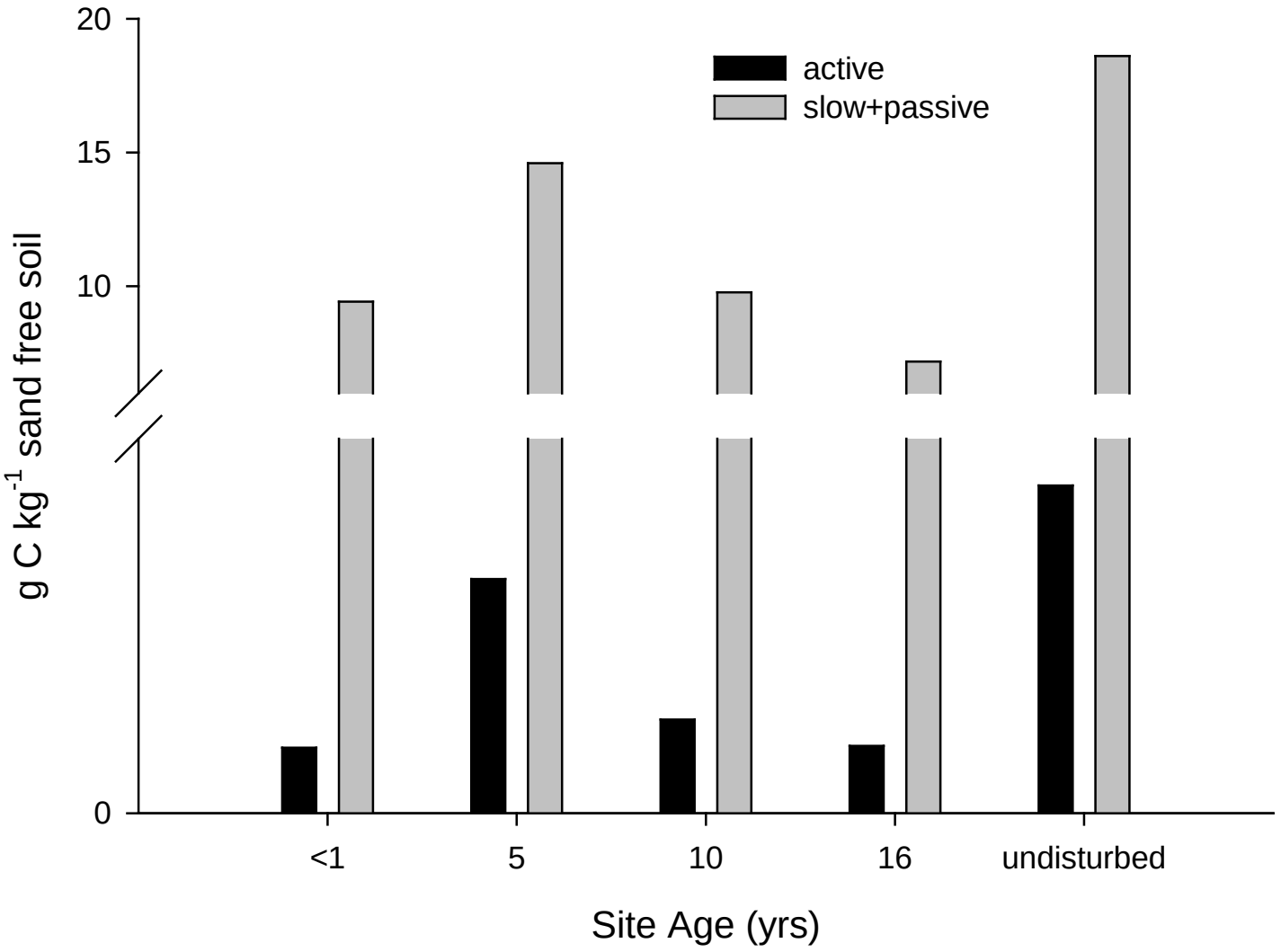
- Active: 0.03
- Protected: 0.14

462 yrs to reach “native” in 0-5 cm

Coarse Textured Soil, 16 yr reclaimed site



Western C Concentrations-Coarse



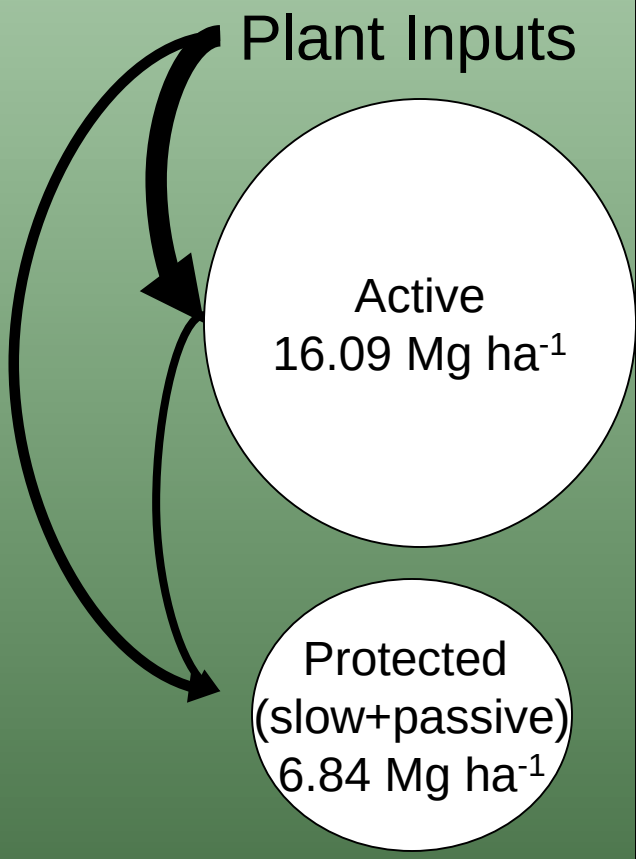
Western Soil Carbon Accumulation Rates

Whole soil: 0.71 Mg ha^{-1} yr^{-1}

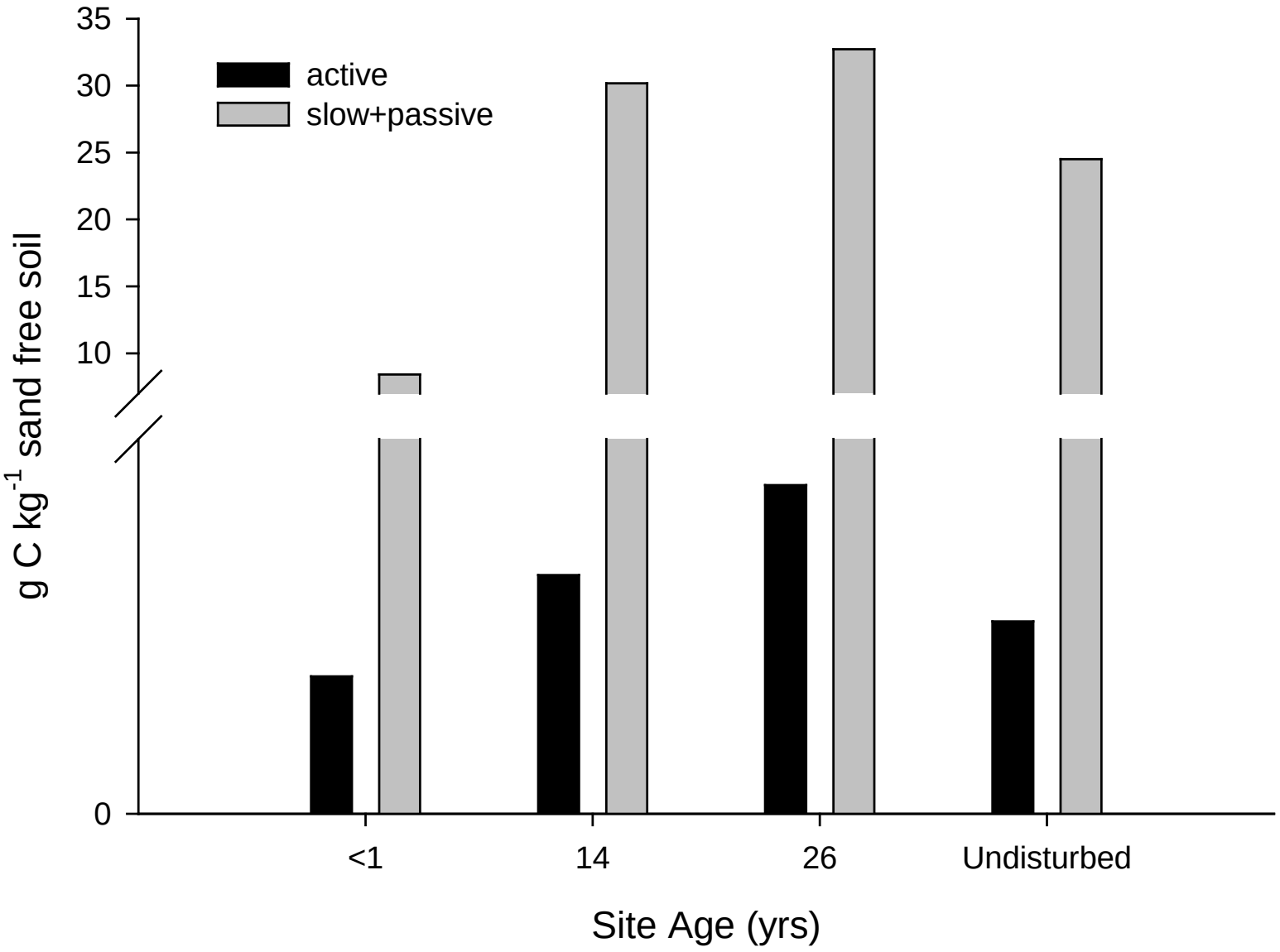
- Active: 0.55
- Protected: 0.16

86 yrs to reach “native” in 0-5 cm

Fine Textured Soil, 26 yr reclaimed site



Western C Concentrations-Fine

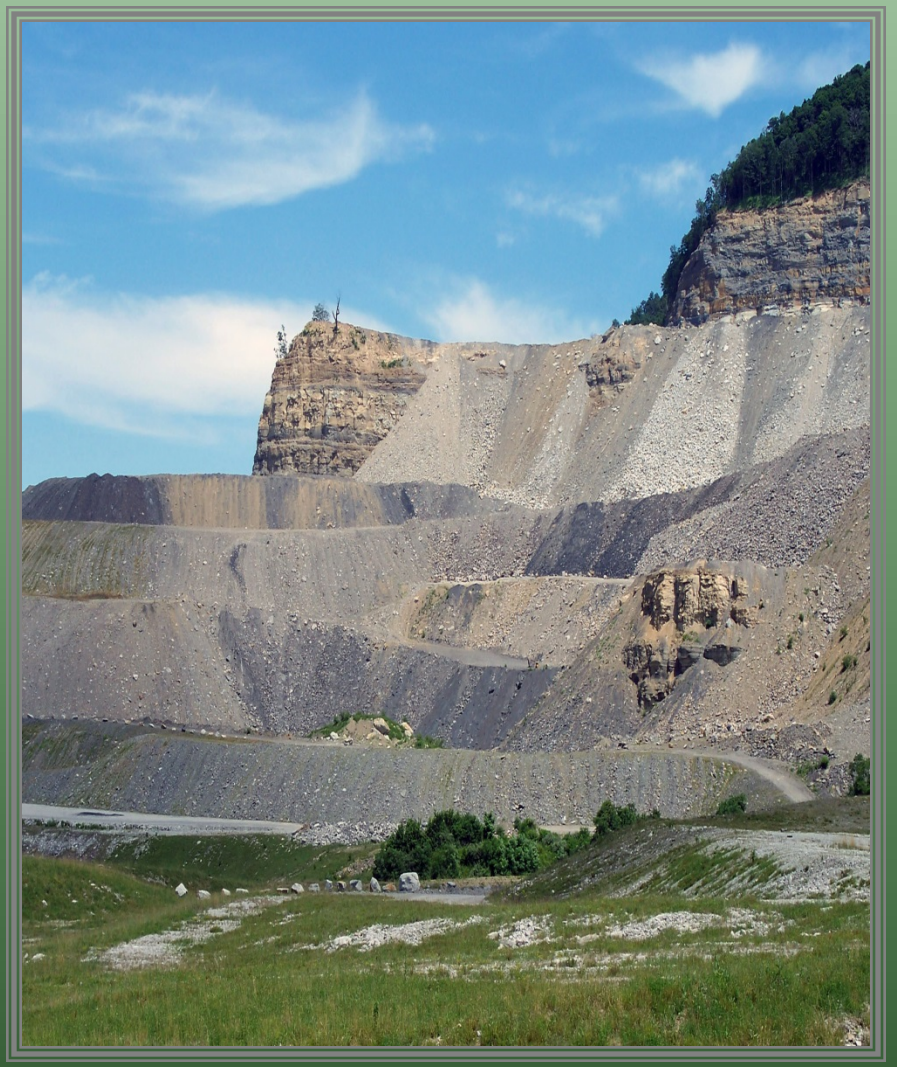


Conclusions

- **EAST:** active pool contained 35% total C
- **WEST:** active pool contained 60-70% total C

Conclusions

- **EAST:** Physical protection by aggregates and chemical binding of C to soil particles
- **WEST:** Climatic conditions and soil texture



Questions

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