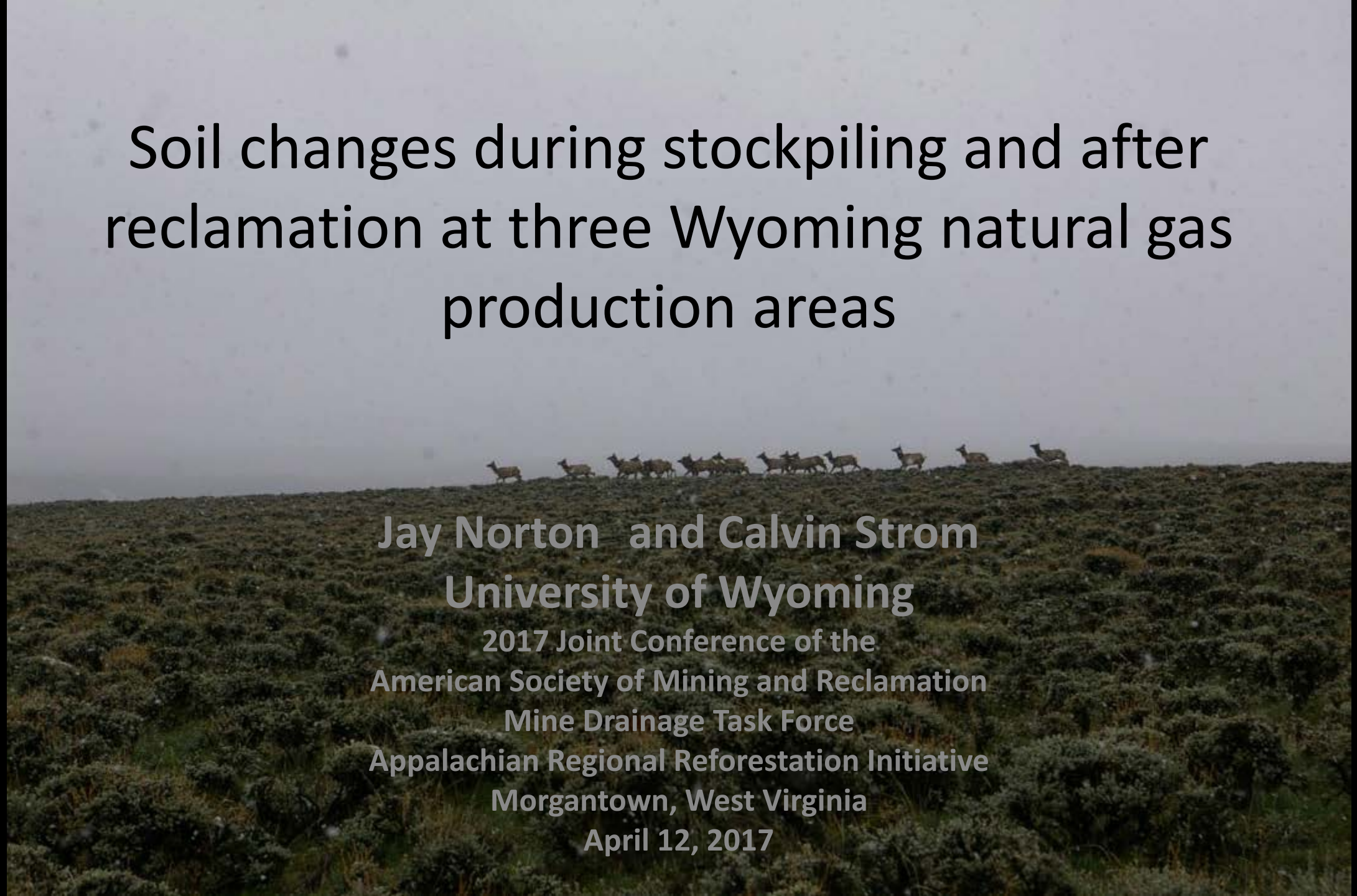
# Soil changes during stockpiling and after reclamation at three Wyoming natural gas production areas



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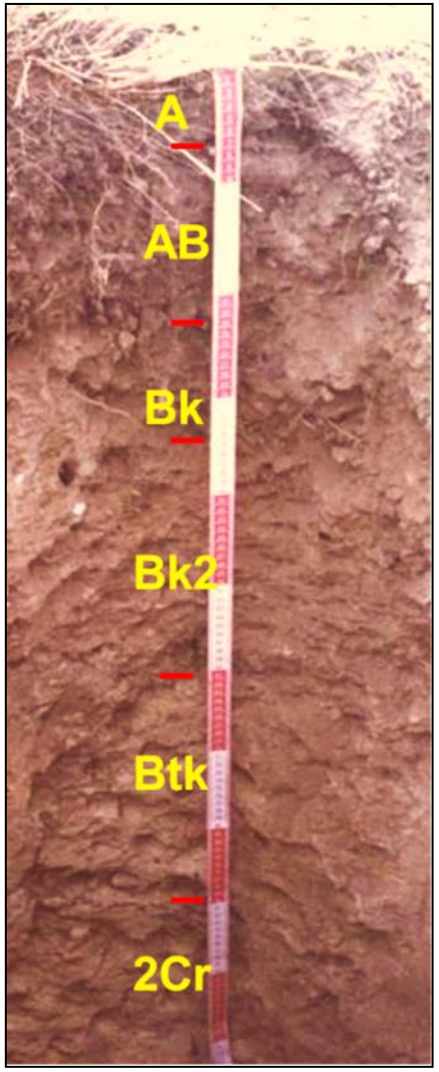
**University of Wyoming**

**2017 Joint Conference of the**
**American Society of Mining and Reclamation**
**Mine Drainage Task Force**
**Appalachian Regional Reforestation Initiative**
**Morgantown, West Virginia**
**April 12, 2017**

# Soil Function in aridisols and aridic alfisols

- A horizon: interface with atmosphere:
  - OM accumulation and ELUVIATION;
  - loss of clays, solutes;
  - More OM, coarser texture, lower EC & pH than other horizons;
  - Water infiltration & holding; nutrient cycling (microbes)
  - **Germination/establishment**;
- B horizon: zone of accumulation of clays and solutes: ILLUVIATION
  - Less OM, finer texture, higher EC & pH
  - Water holding in finer texture



# Salvage & reclamation procedures



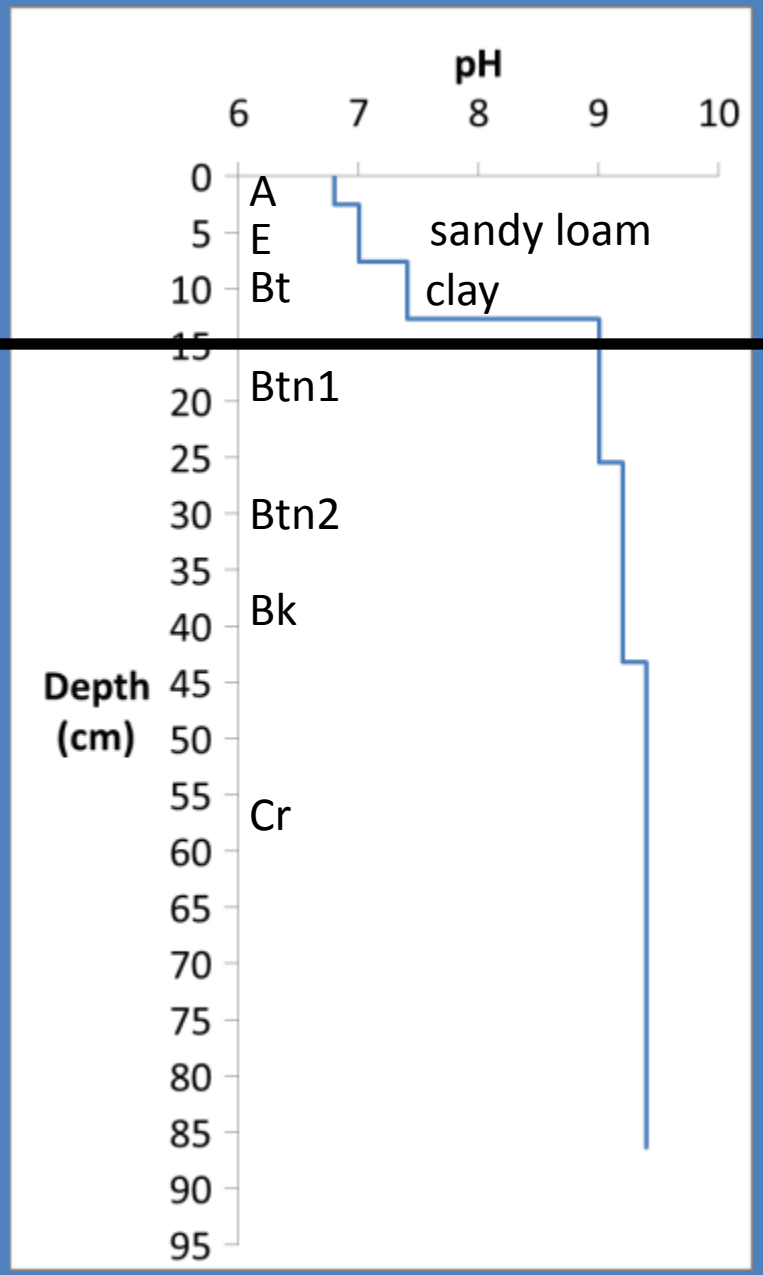


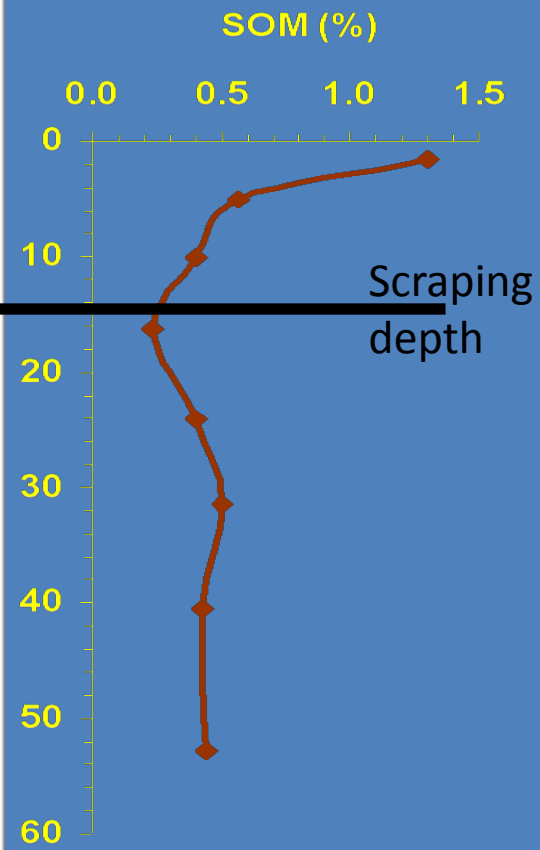





One size fits all

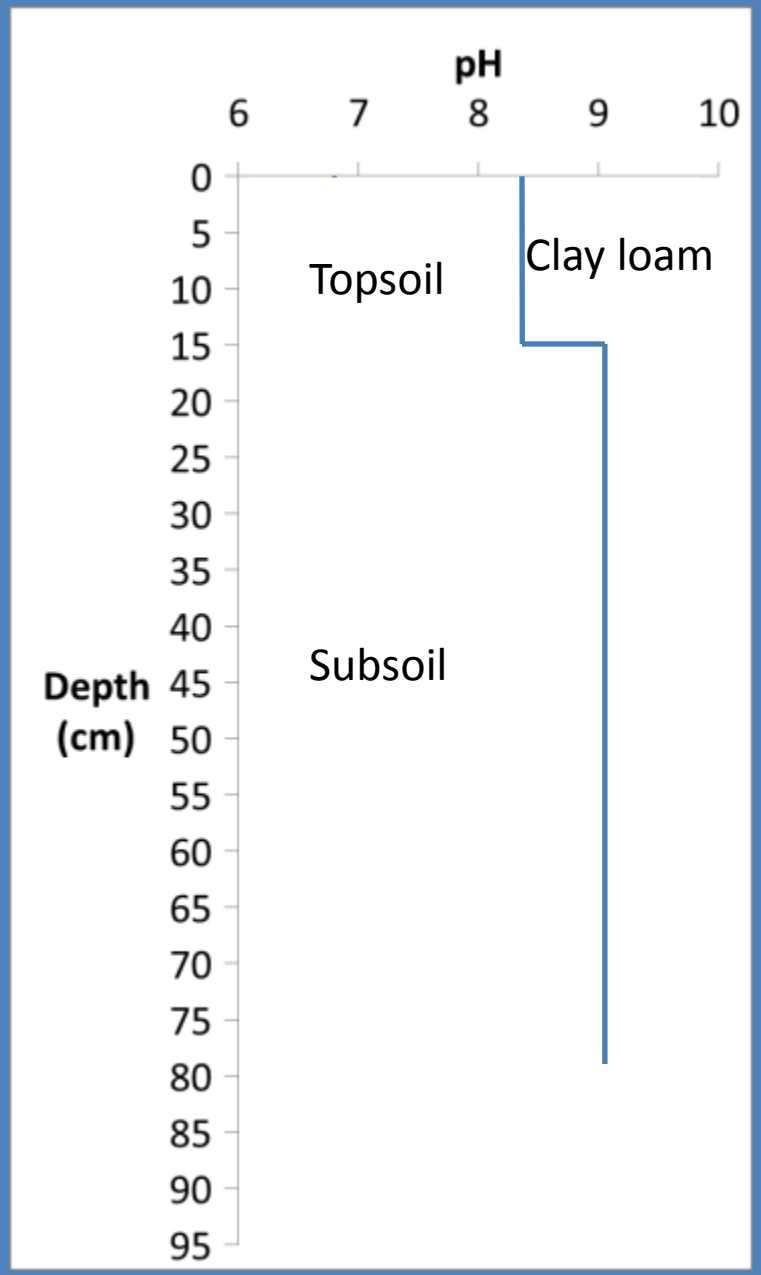
Pre disturbance: ABSTON FINE, SMECTITIC, FRIGID USTIC NATRARGIDS

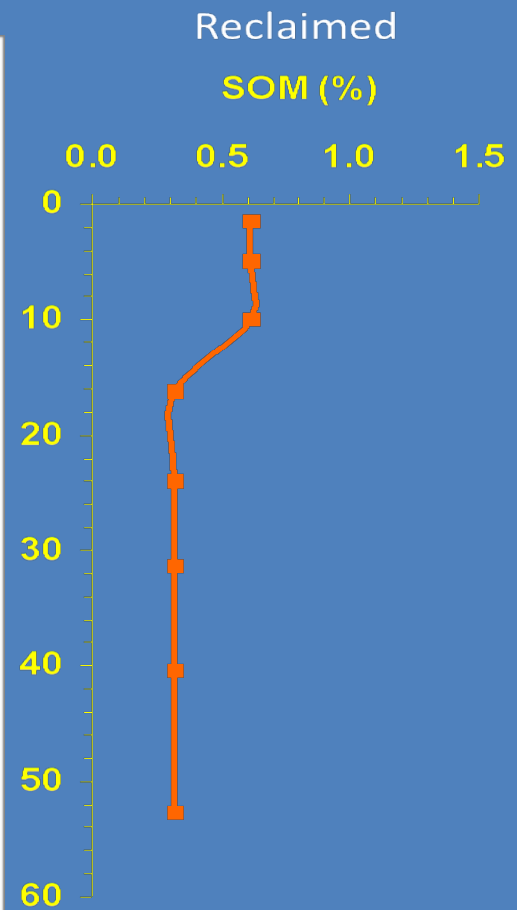



Scraping depth

## After reclamation: ENTISOL



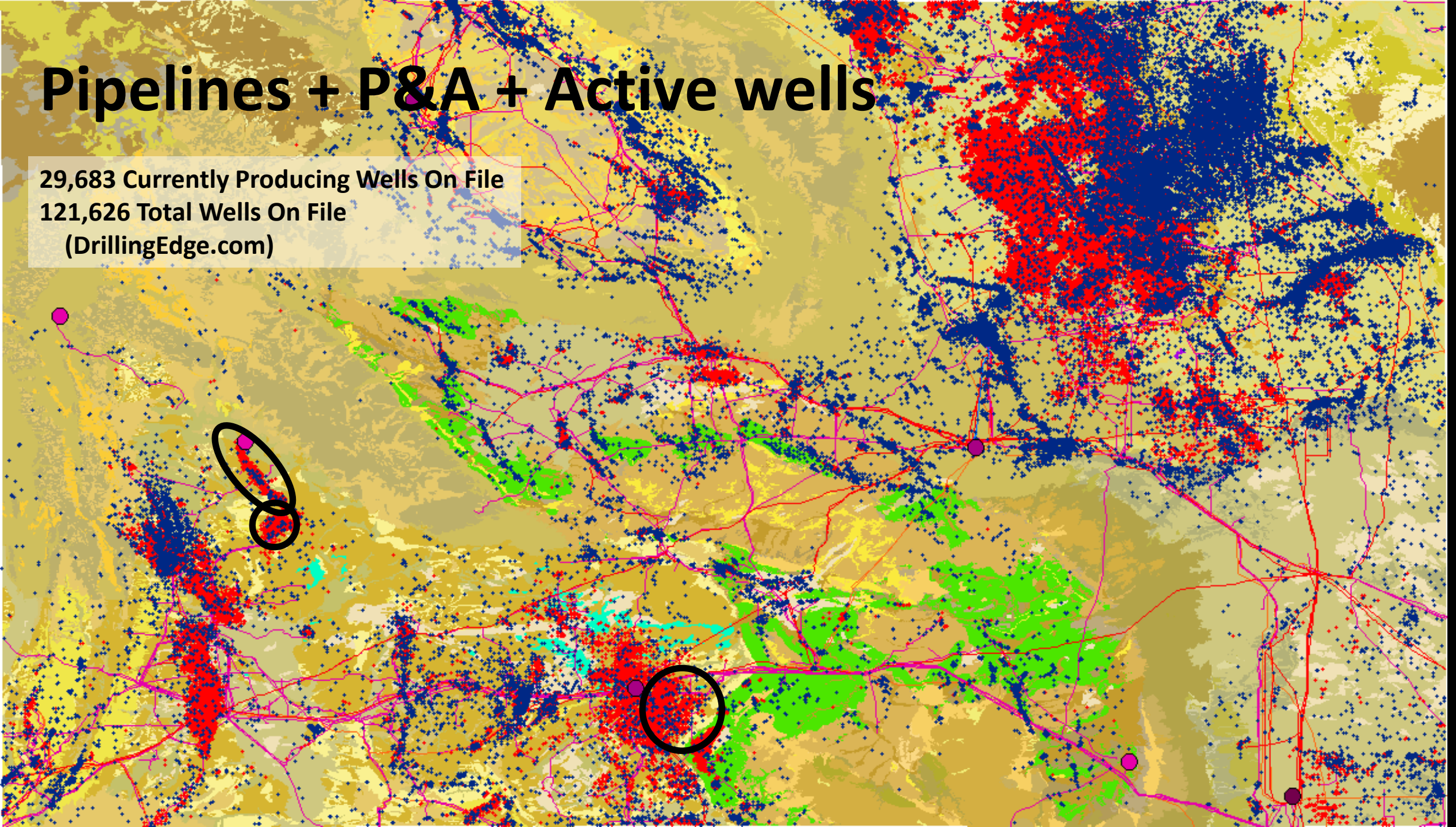



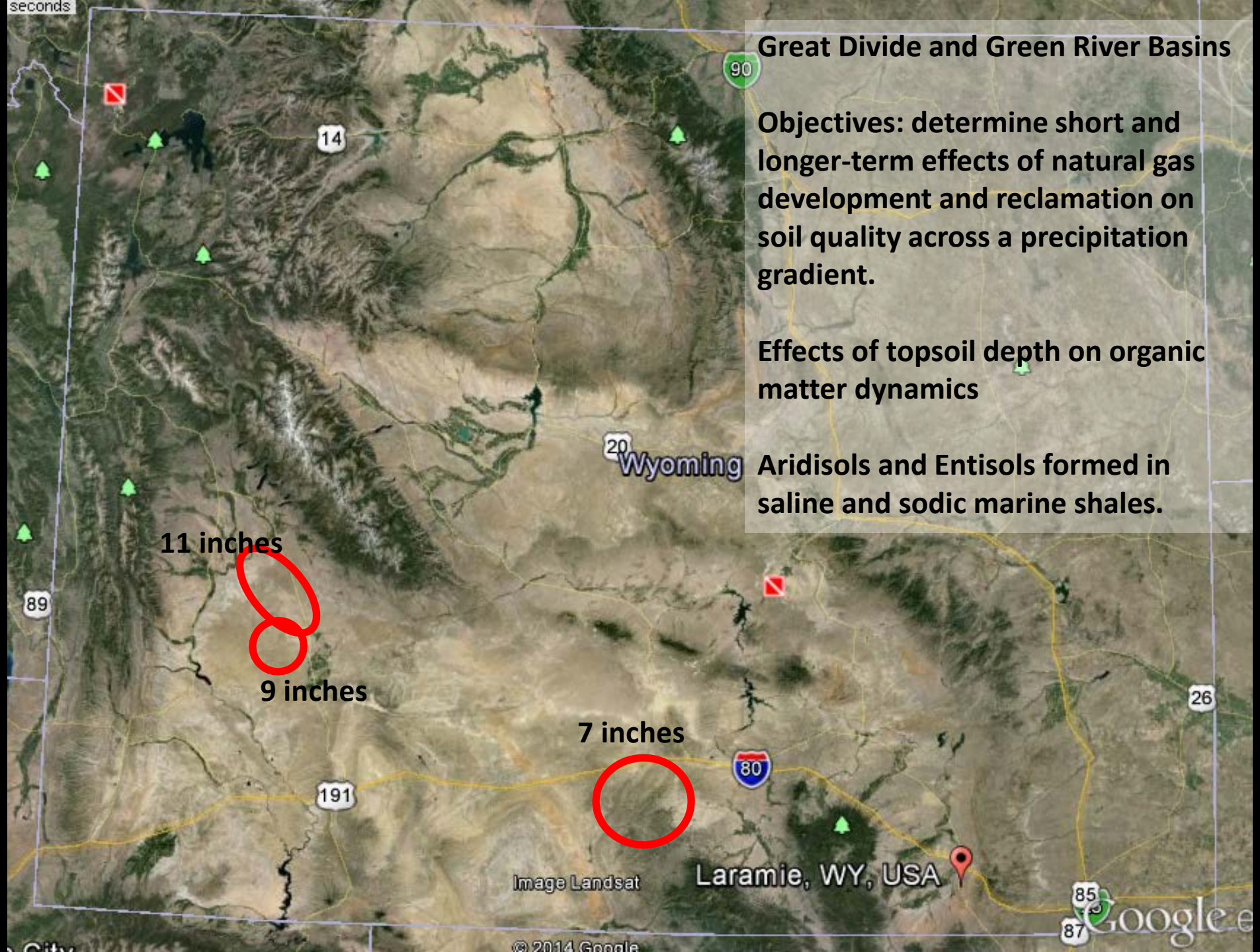
# Loss of A horizon reduces already slim chances for germination & establishment

- Lifeless: little SOM to support microbial activity and nutrient cycling;
- Finer: inhibits water infiltration and facilitates evaporation;
- Drier: less OM and fine texture decrease plant-available water;
- Saline: EC > 4; osmotic potential and ion toxicity slow germination;
- Sodic: ESP > 15 disperses aggregates, exacerbating the above.

# Pipelines + P&A + Active wells

**29,683 Currently Producing Wells On File**
**121,626 Total Wells On File**
**(DrillingEdge.com)**





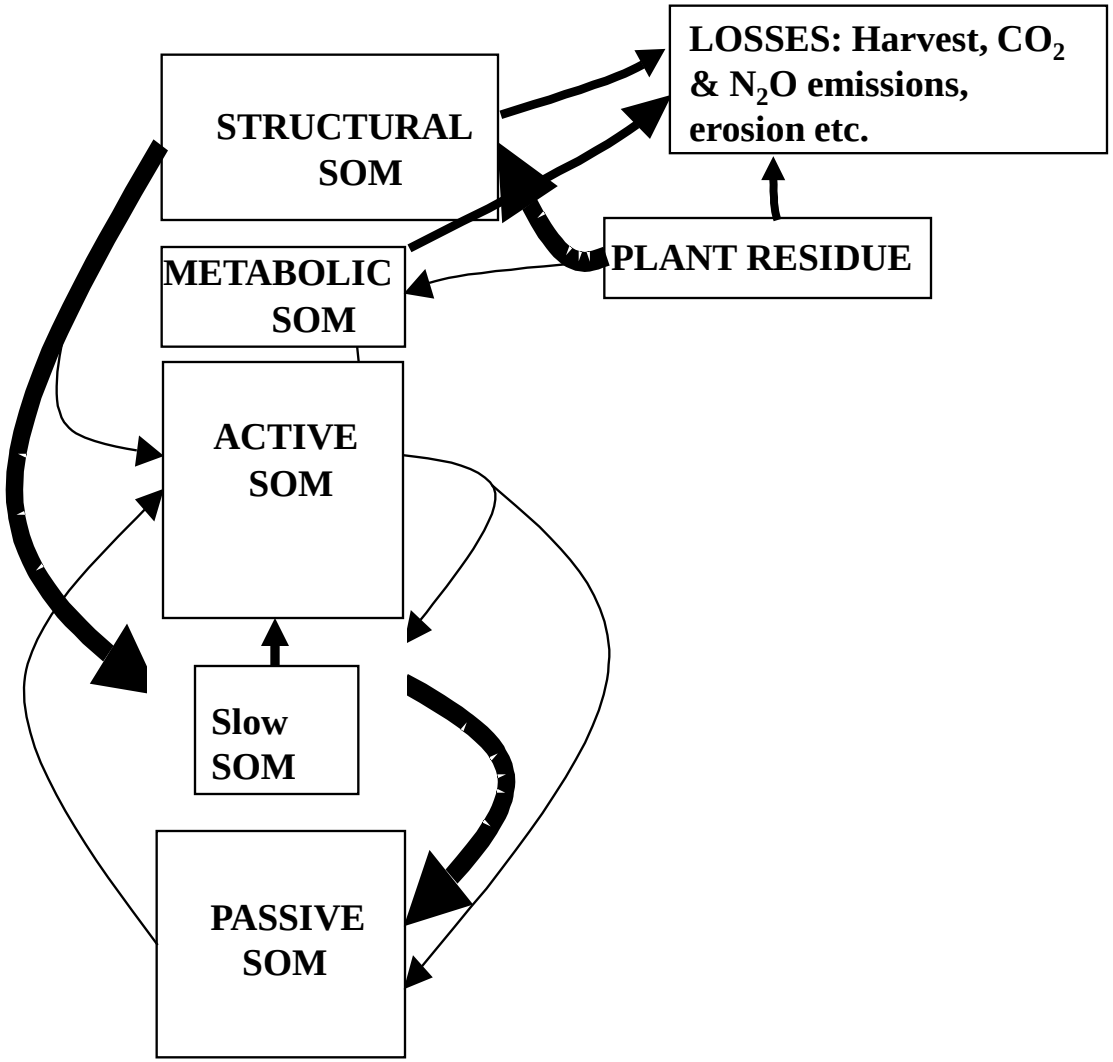

**Great Divide and Green River Basins**

**Objectives: determine short and longer-term effects of natural gas development and reclamation on soil quality across a precipitation gradient.**

**Effects of topsoil depth on organic matter dynamics**

**Aridisols and Entisols formed in saline and sodic marine shales.**

# Soil Organic Matter Pools




**Active, or labile, SOM:**

**Annual turnover**

**Mineral N**

**Mineralizable C& N**

**dissolved organic C & N;**

**Microbial C & N;**

**light fraction C & N.**

**Slow, or protected, SOM:**

**Decades;**

**Same as labile, but protected from mineralization within soil structure.**

**Passive, or stabile, SOM:**

**Centuries to millennia;**

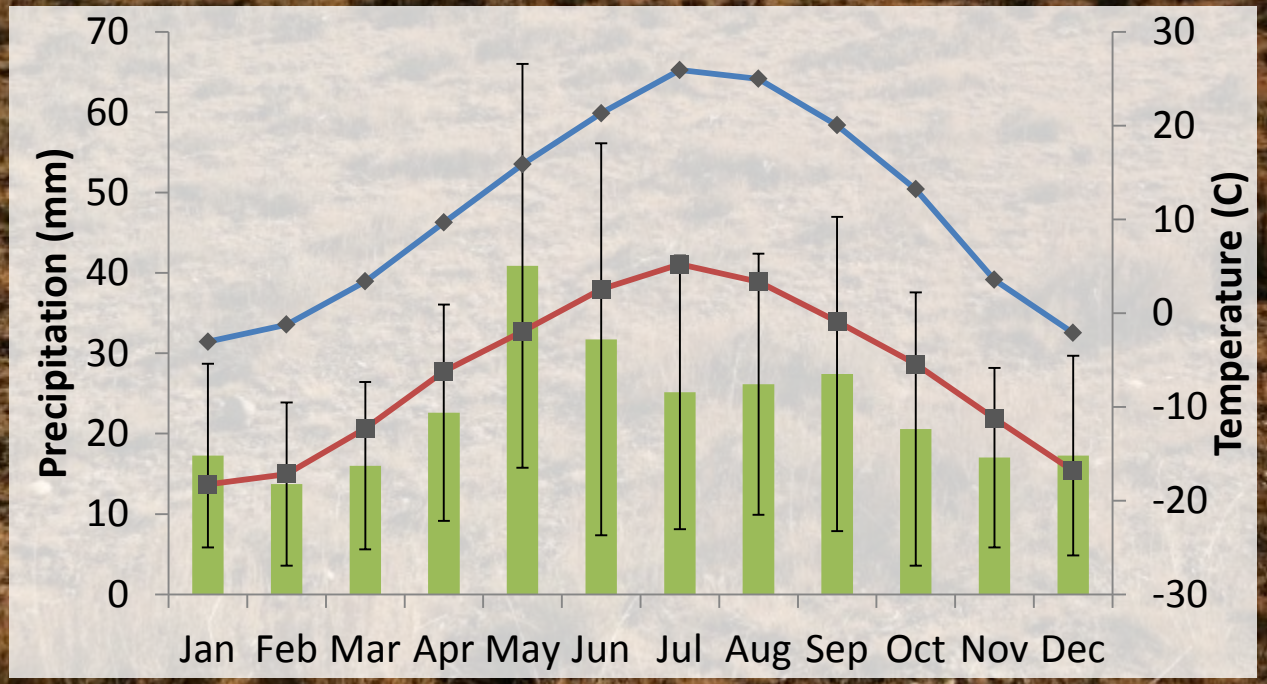
**Humus;**

**Mineral-associated C & N;**

# Pinedale Anticline

**Elevation: 2440 meters**
**MATmax: 11°C**
**MATmin: -6.6°C**
**MAP: 276 mm**
**Annual CV: 26.5%**

**Fine-loamy, mixed, superactive, frigid Calcidic Haplustalfs**



# Jonah Field

**Elevation: 2140 meters**

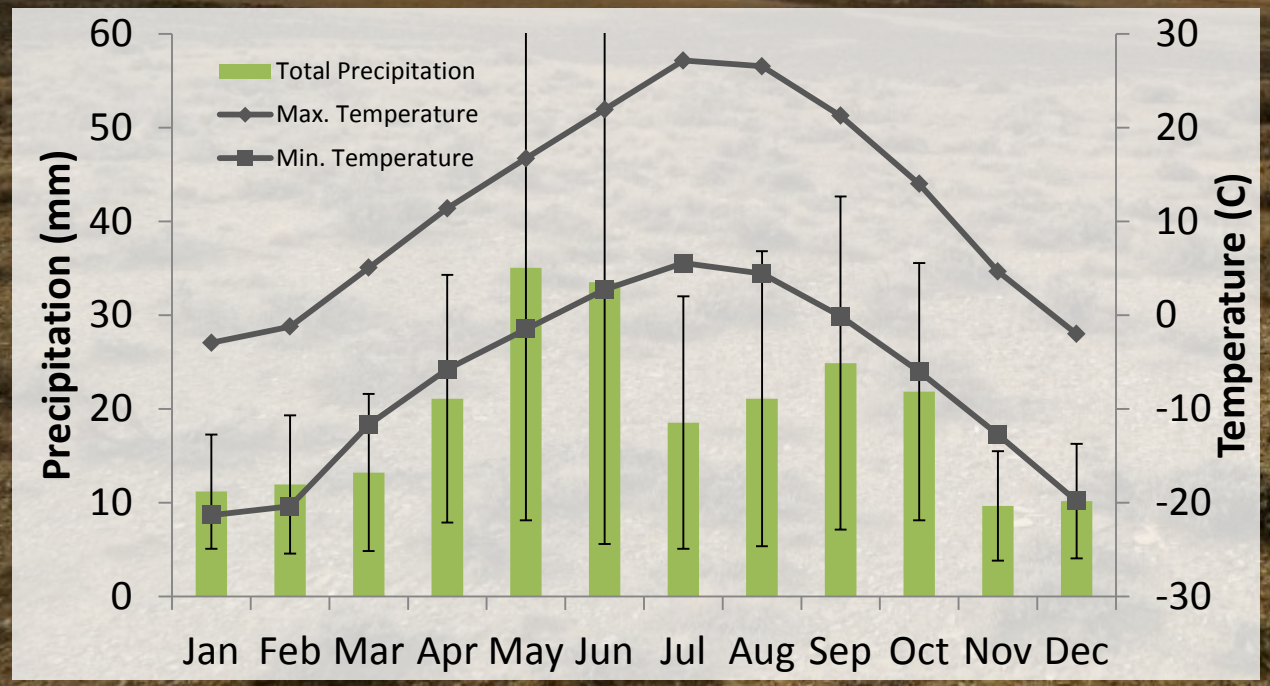
**MATmax: 11.9°C**

**MATmin: -7.2°C**

**MAP: 232 mm**

**Ann CV: 27%**

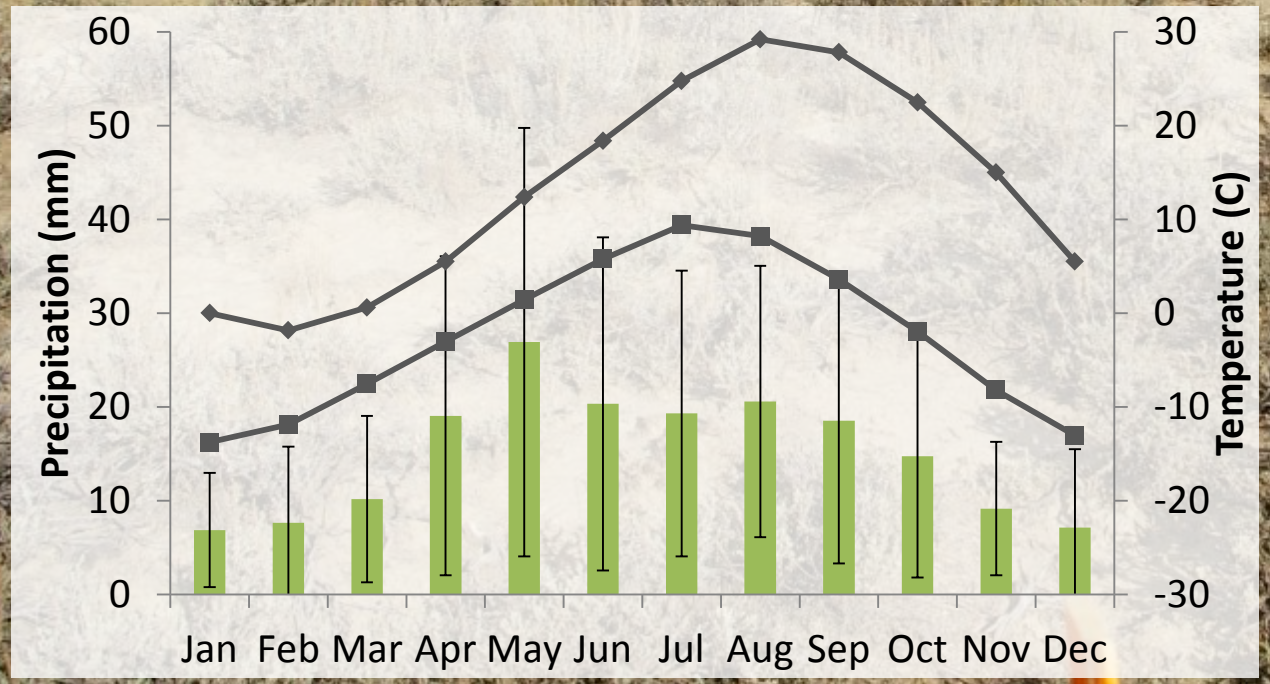
**Fine-loamy, mixed, superactive, frigid Calcidic Haplustalfs**



# Wamsutter/Great Divide Basin

**Elevation: 2065 meters**
**MATmax: 13.2°C**
**MATmin: -2.6°C**
**MAP: 180 mm**
**Ann CV: 32%**

**Fine-loamy, mixed, superactive, frigid Typic Haplargids**




**Three new well pads sampled at each field starting in 2009 (9 points composited)**

1. **Predisturbance;**
2. **Stockpile;**
3. **Respread;**
4. **1 year later;**
5. **7 years later.**

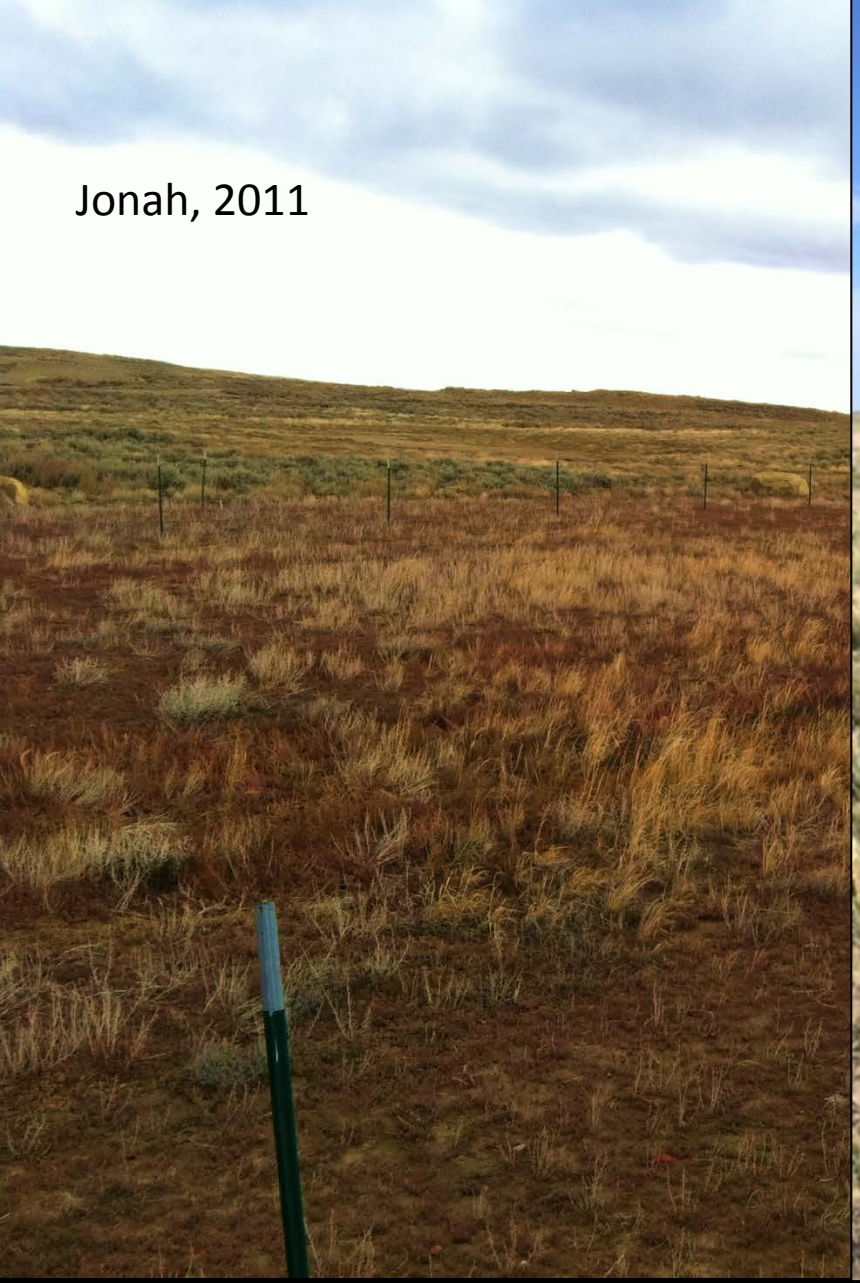
**Soil samples from 0-5, 5-20, and 20-30 cm**

Stockpiles:
Three points sampled to 250 cm

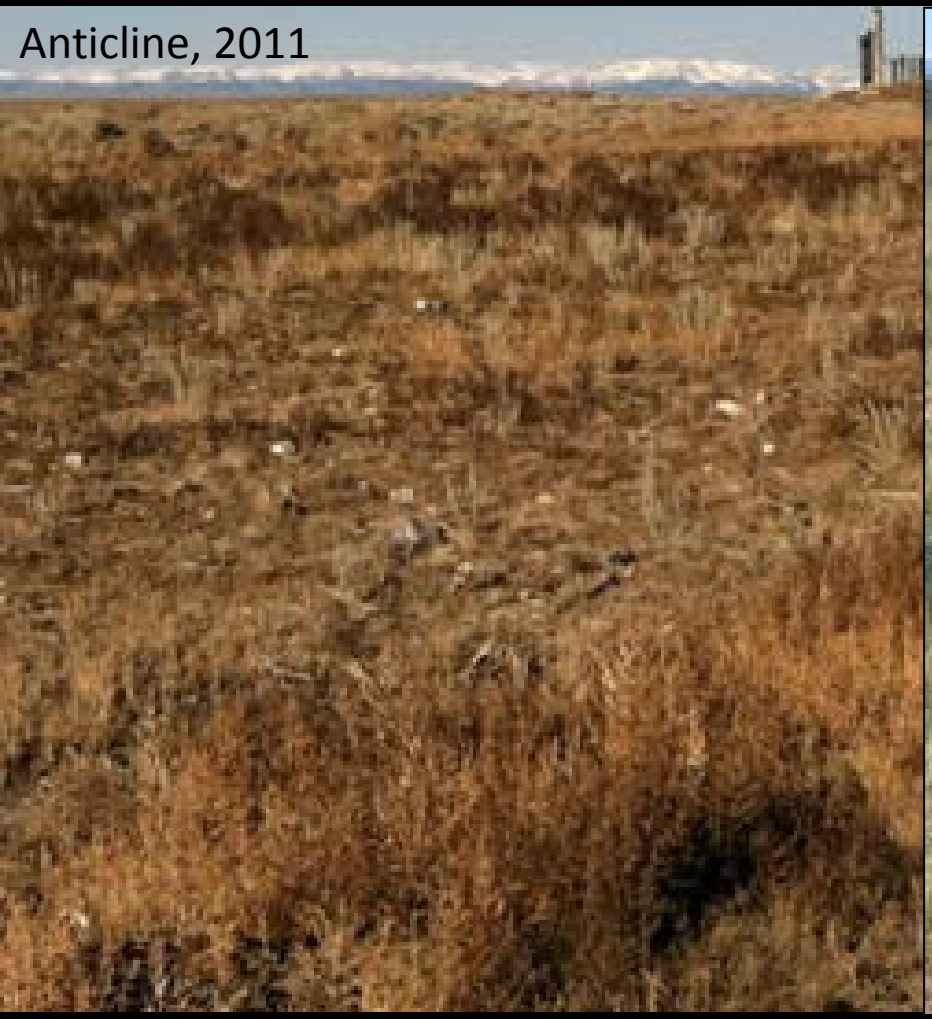
# Data Collection

- Vegetation cover
- Physical properties: bulk density, texture
- Chemical properties: pH, EC
- Biological properties (total and labile soil organic matter):
  - Total soil organic carbon and nitrogen;
  - Mineral nitrogen;
  - Dissolved organic carbon and nitrogen;
  - Mineralizable organic carbon and nitrogen.


05/17/2009

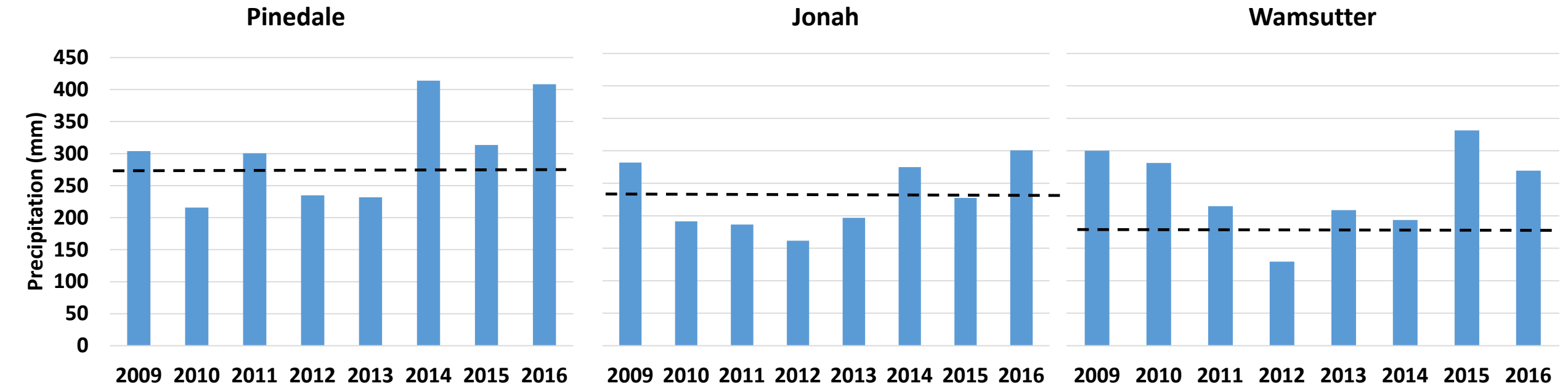

Jonah, 2011

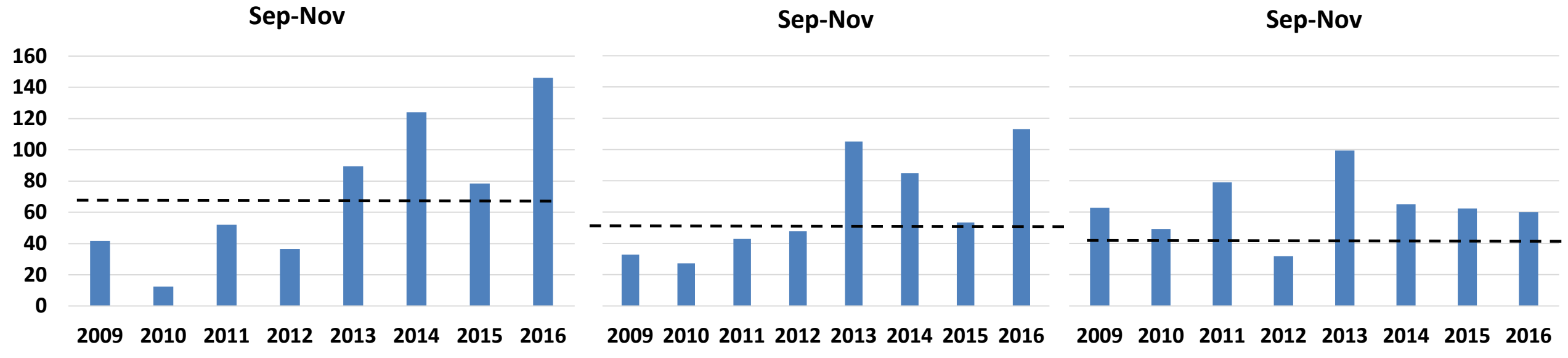

Jonah, 2016


Anticline, 2011

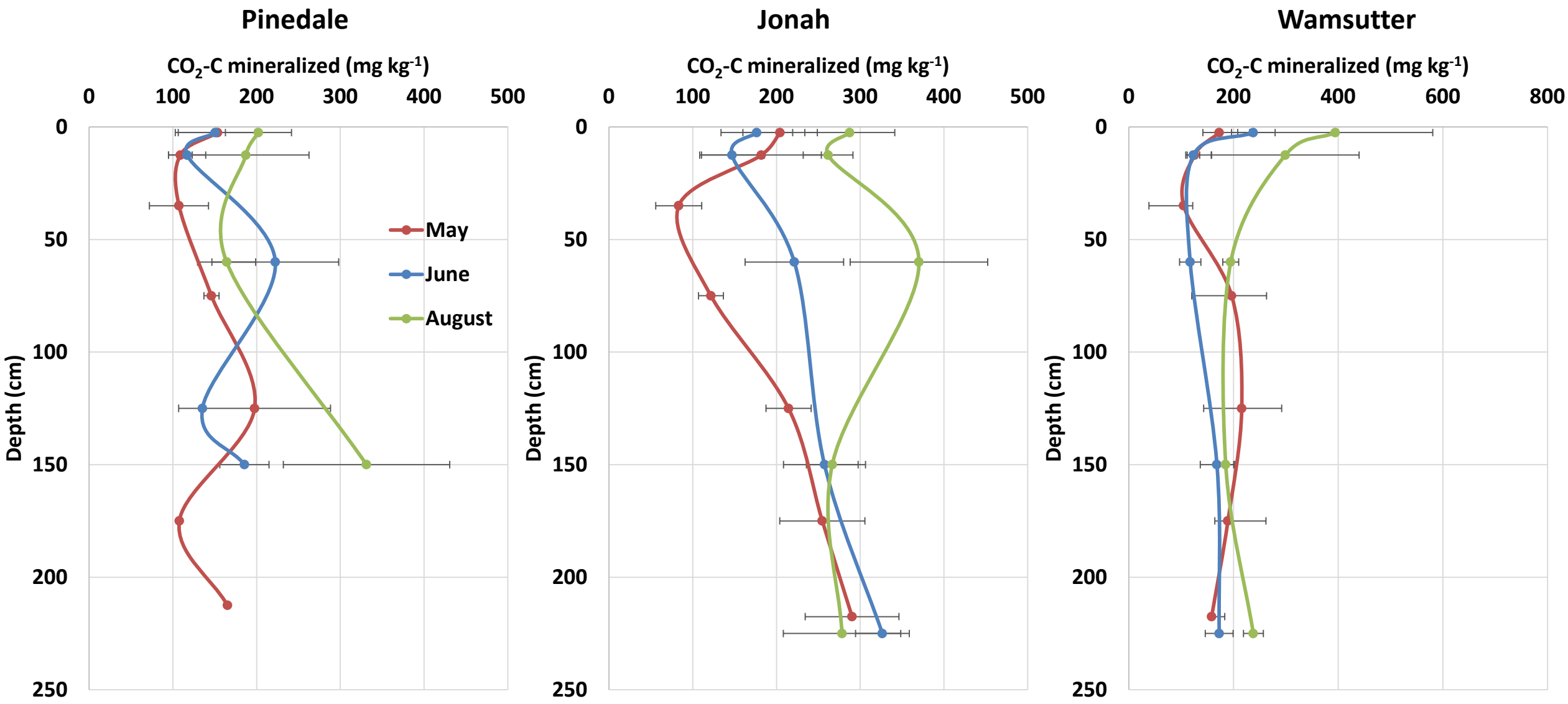

Anticline, 2016

# Study Period Precipitation

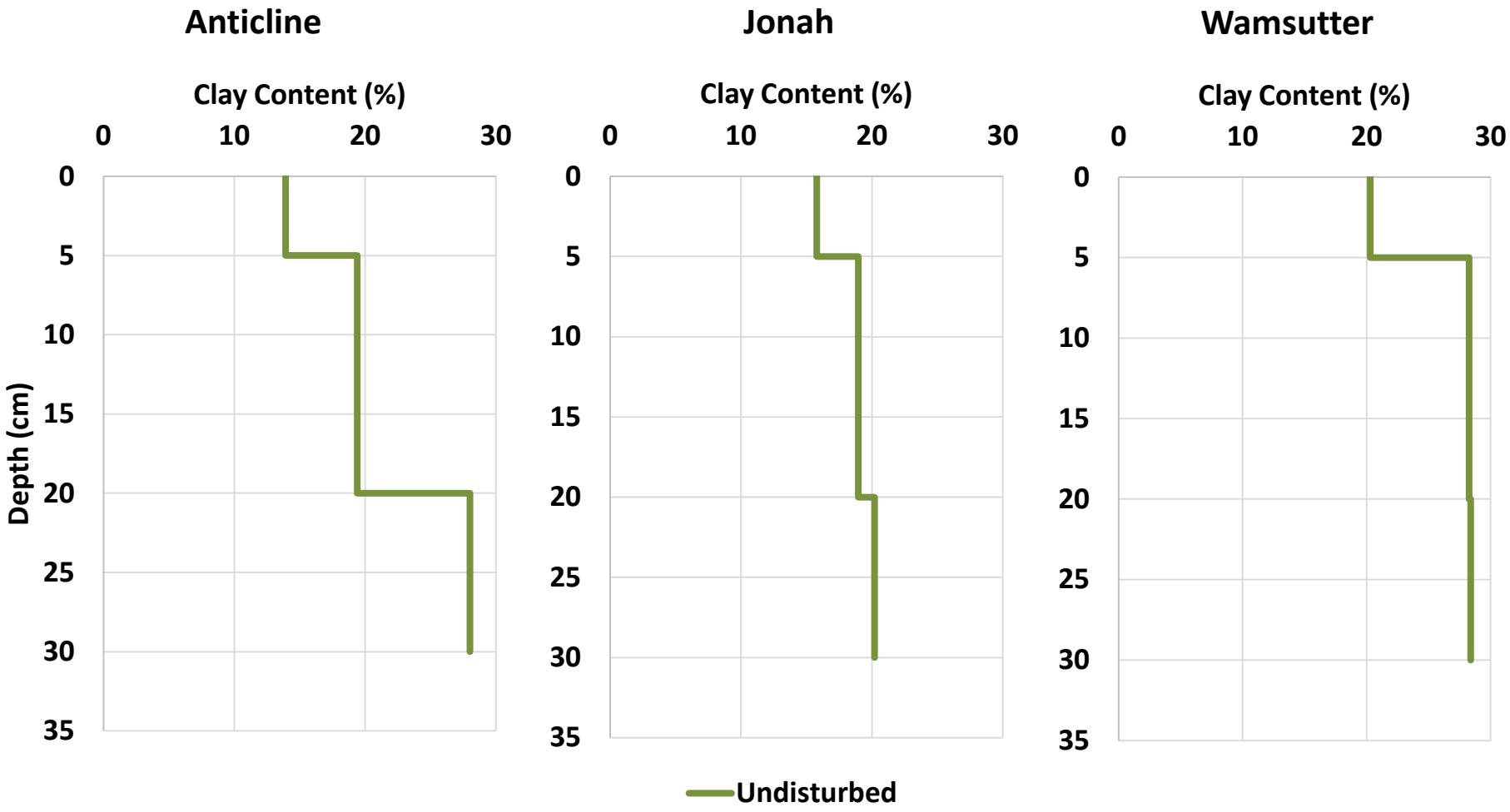


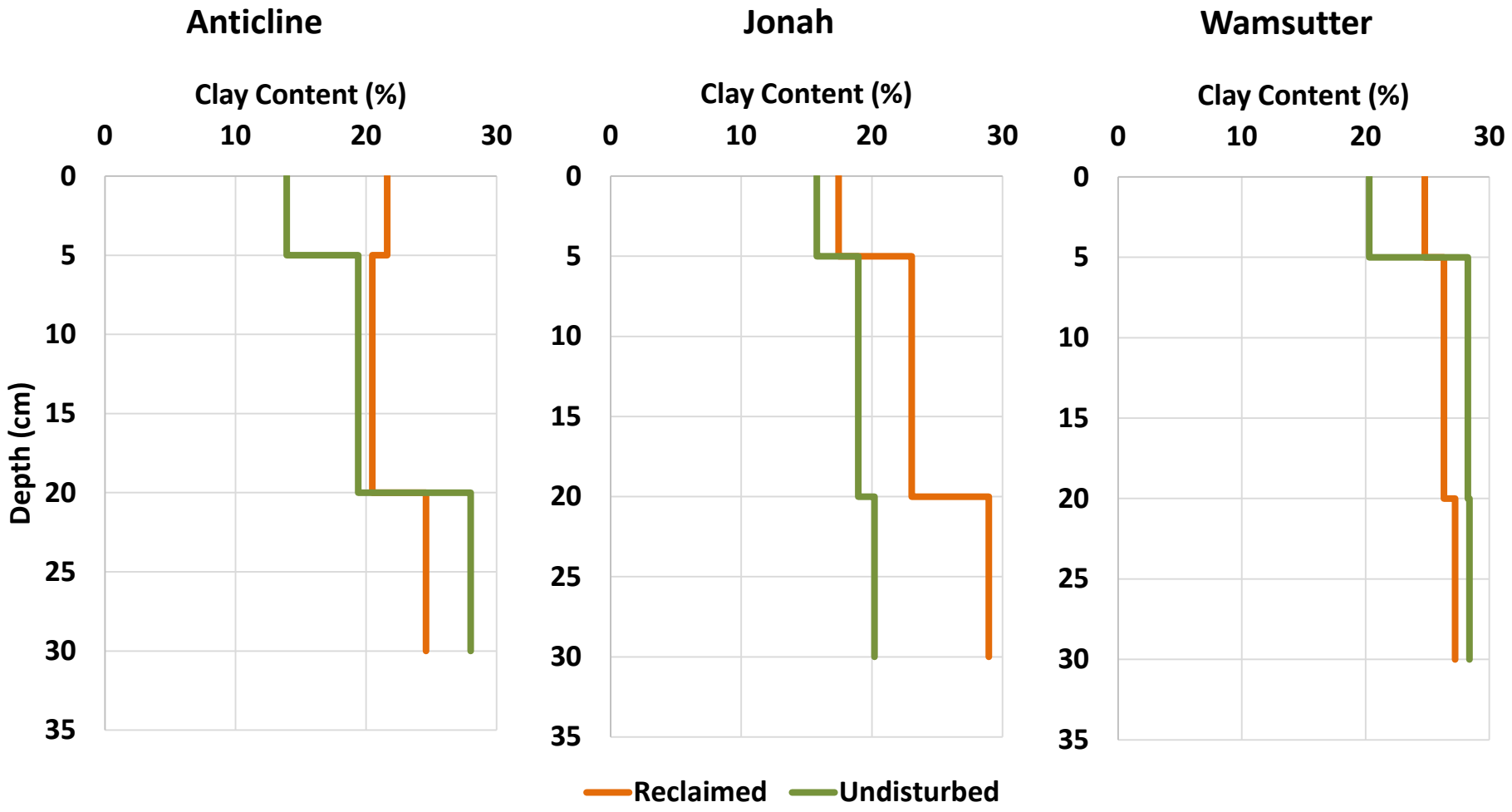
# Mineralizable C in stockpiles, 2009



# Reclaimed: Soil texture

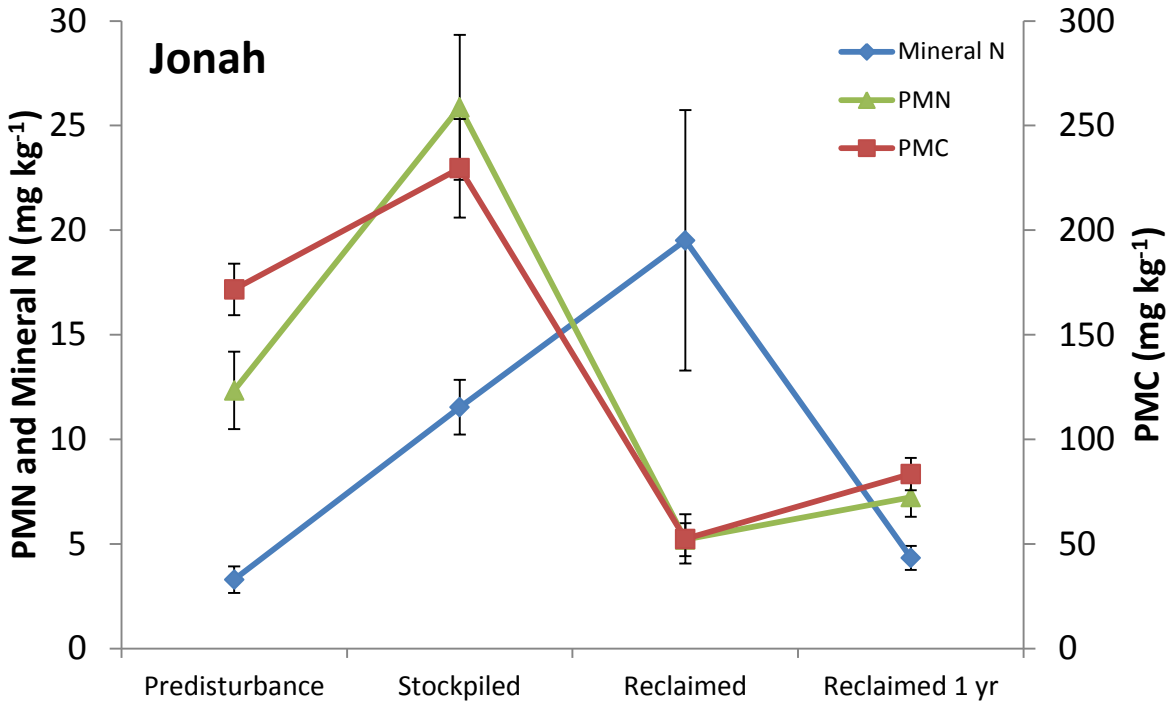


# Reclaimed: Soil texture

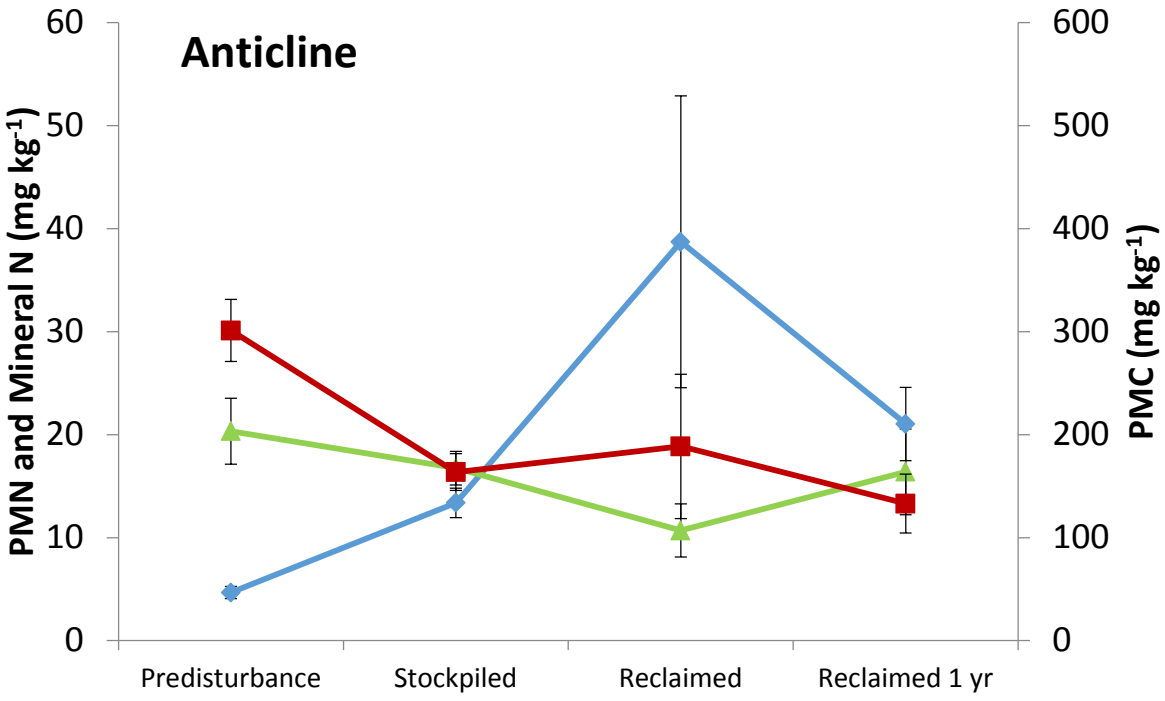


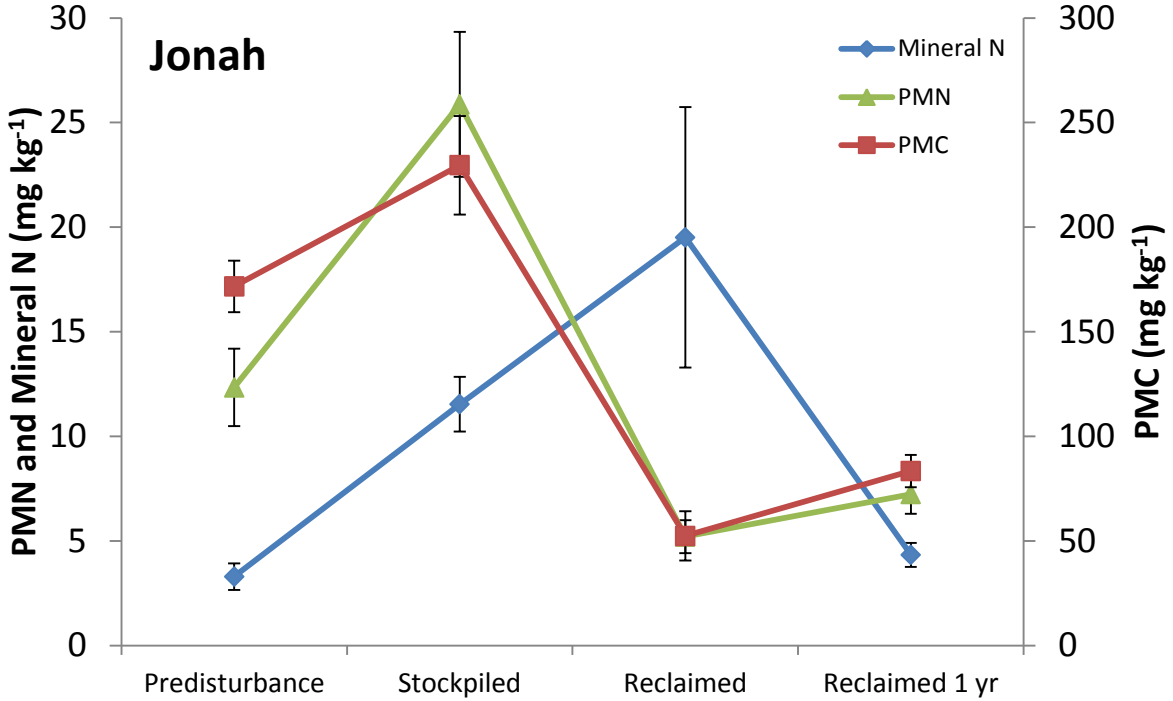
**Disturbance Effects**

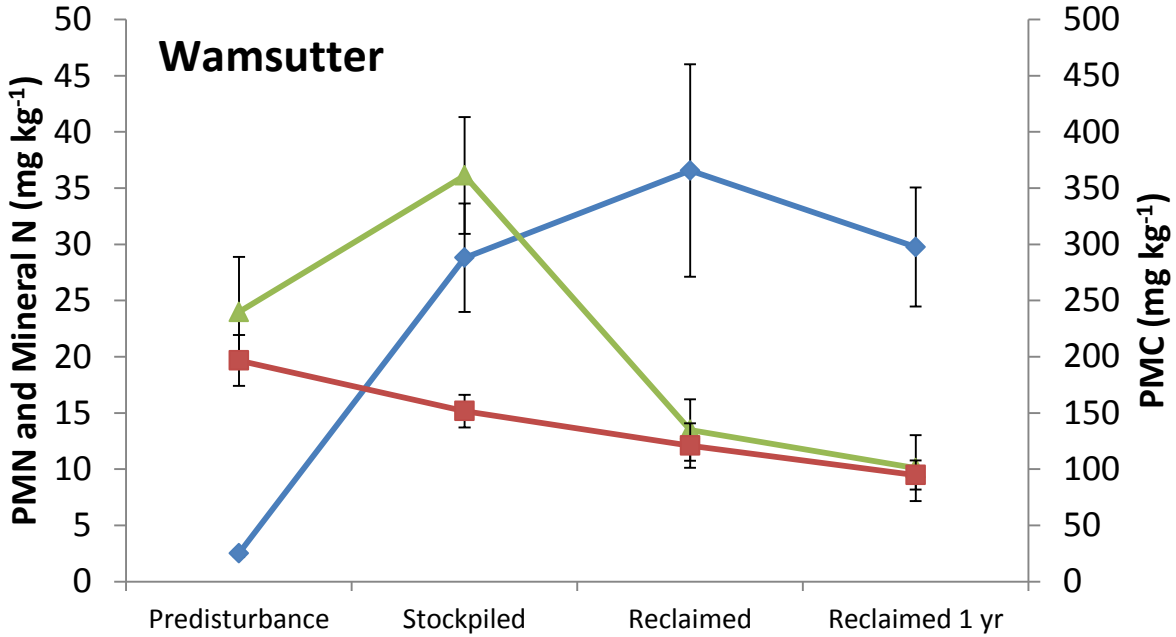
1. **Undisturbed: high labile SOM concentrations, low mineral N concentrations (low net mineralization);**
2. **Pulse of labile and mineral nutrients after disturbance truncated in cold storage in stockpile;**
3. **Pulse of mineralization at expense of PMC and N;**
4. **Loss of mineral N, labile OM begins to rebound.**




**0-30 cm weighted averages**



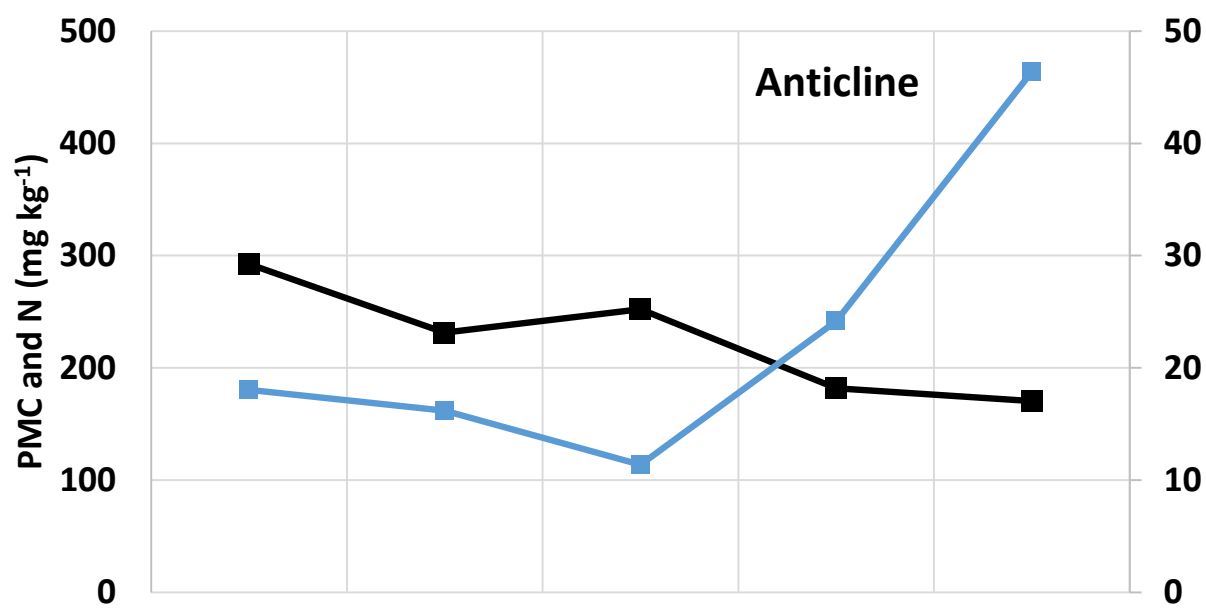



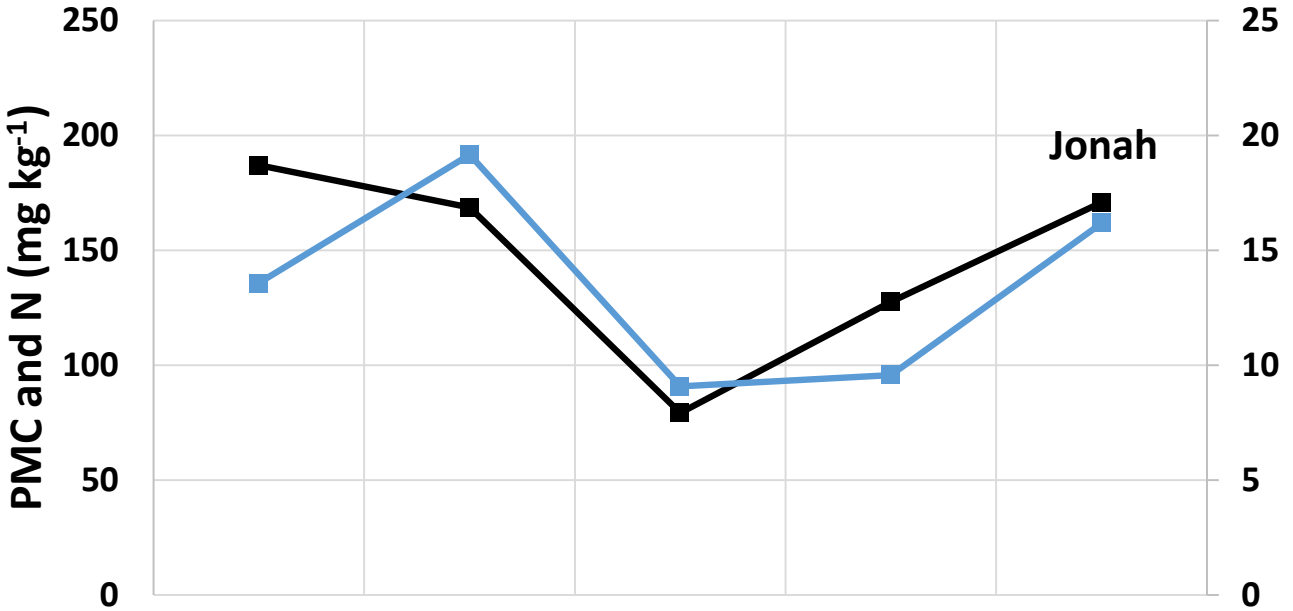

# Disturbance Effects

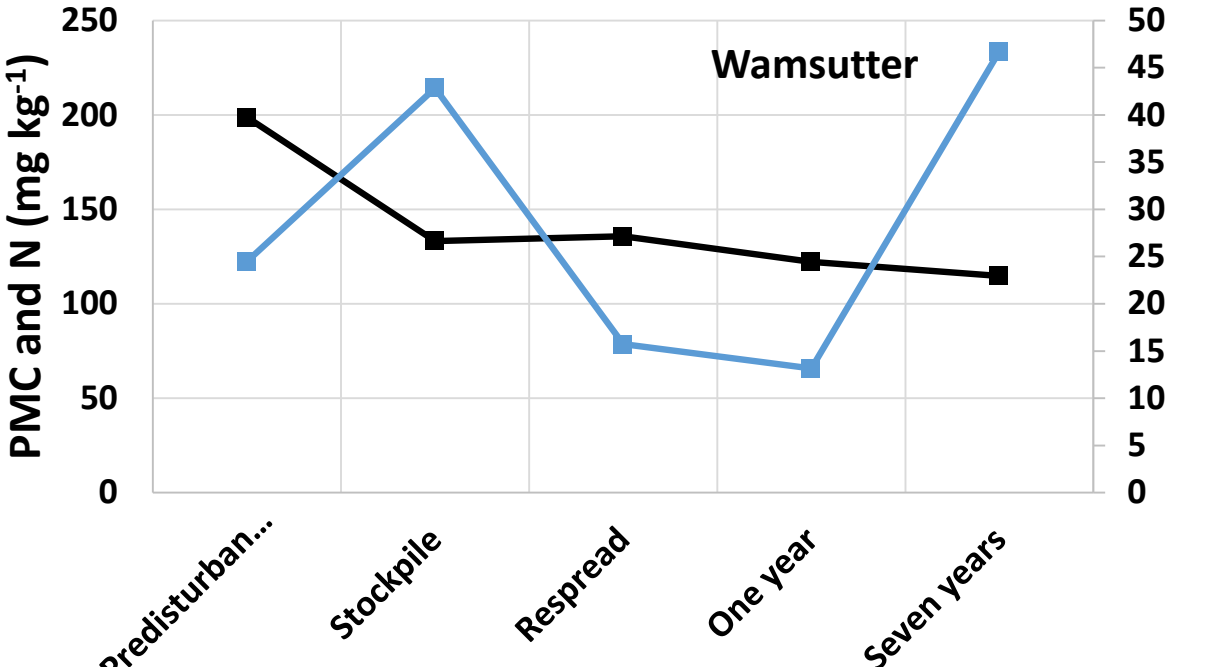
## 0-30 cm weighted averages

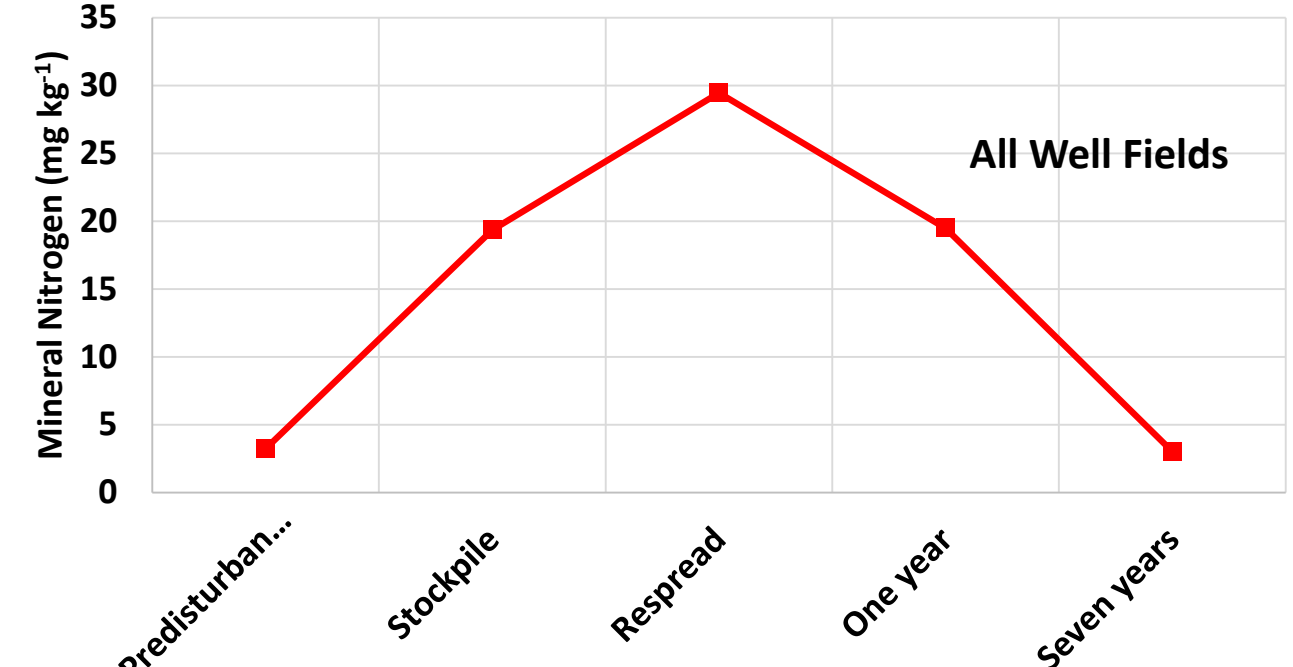
Anticline: complicated by stockpile being moved at least twice.

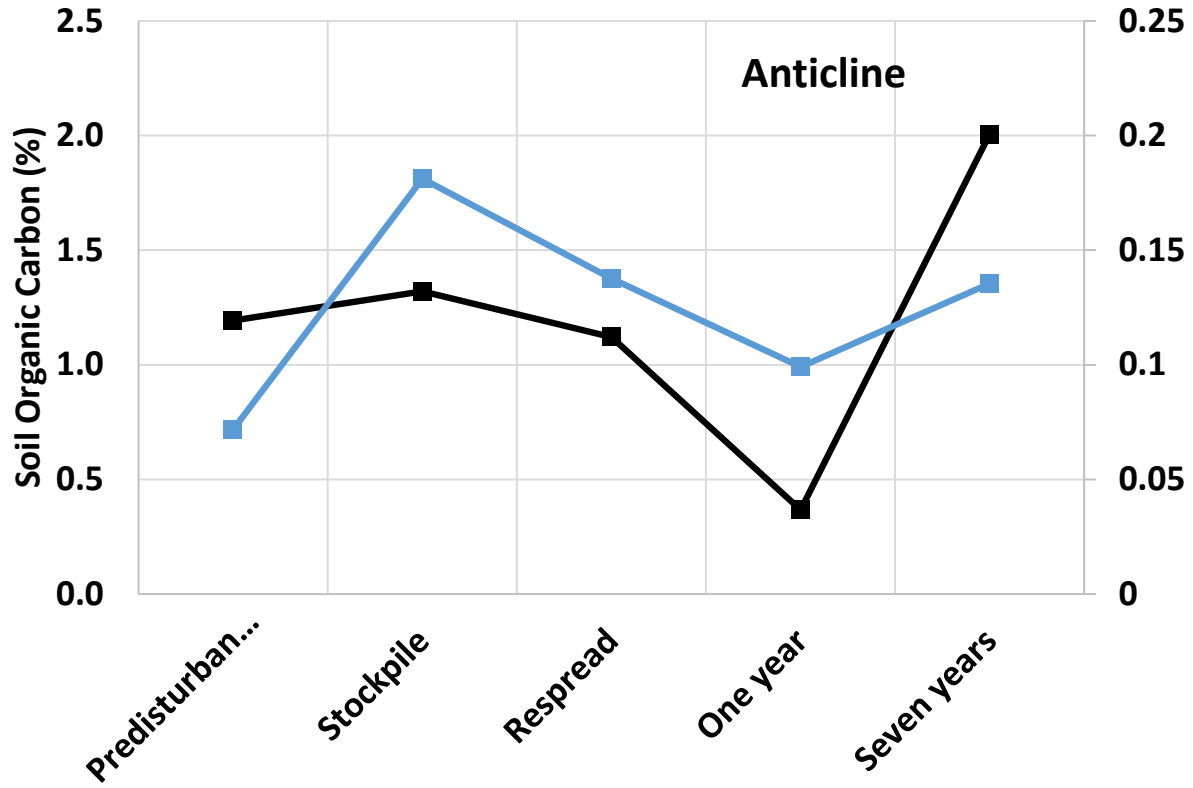
# Loss of labile C and N

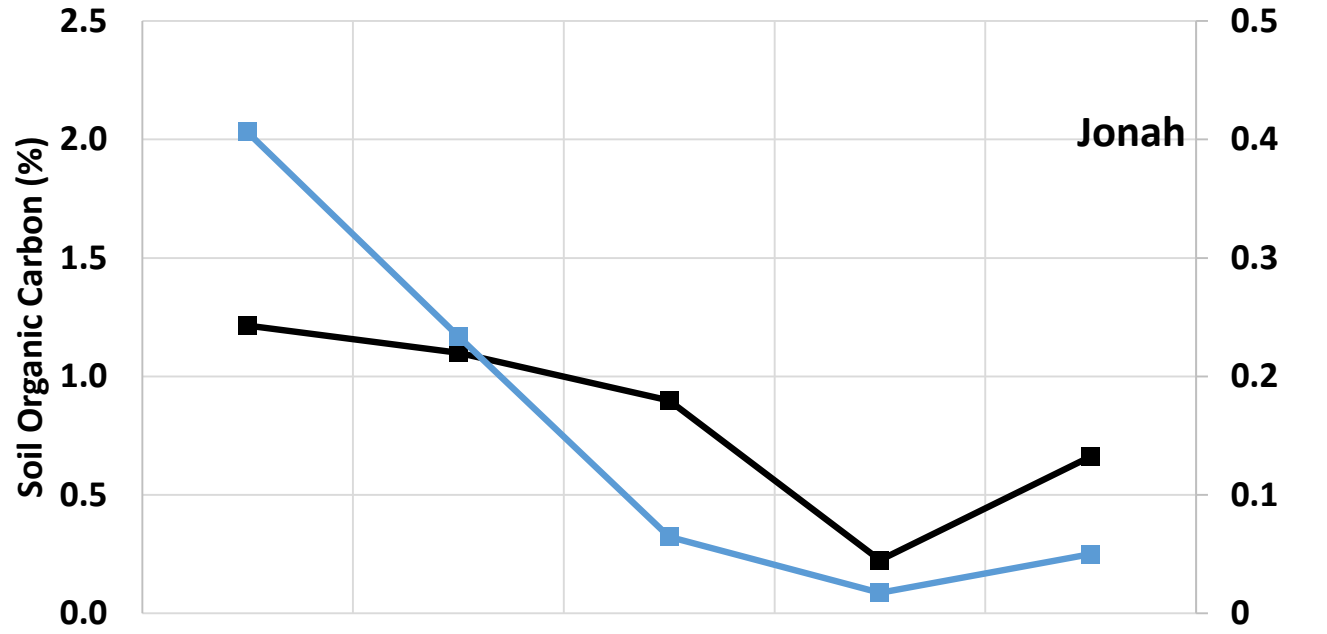


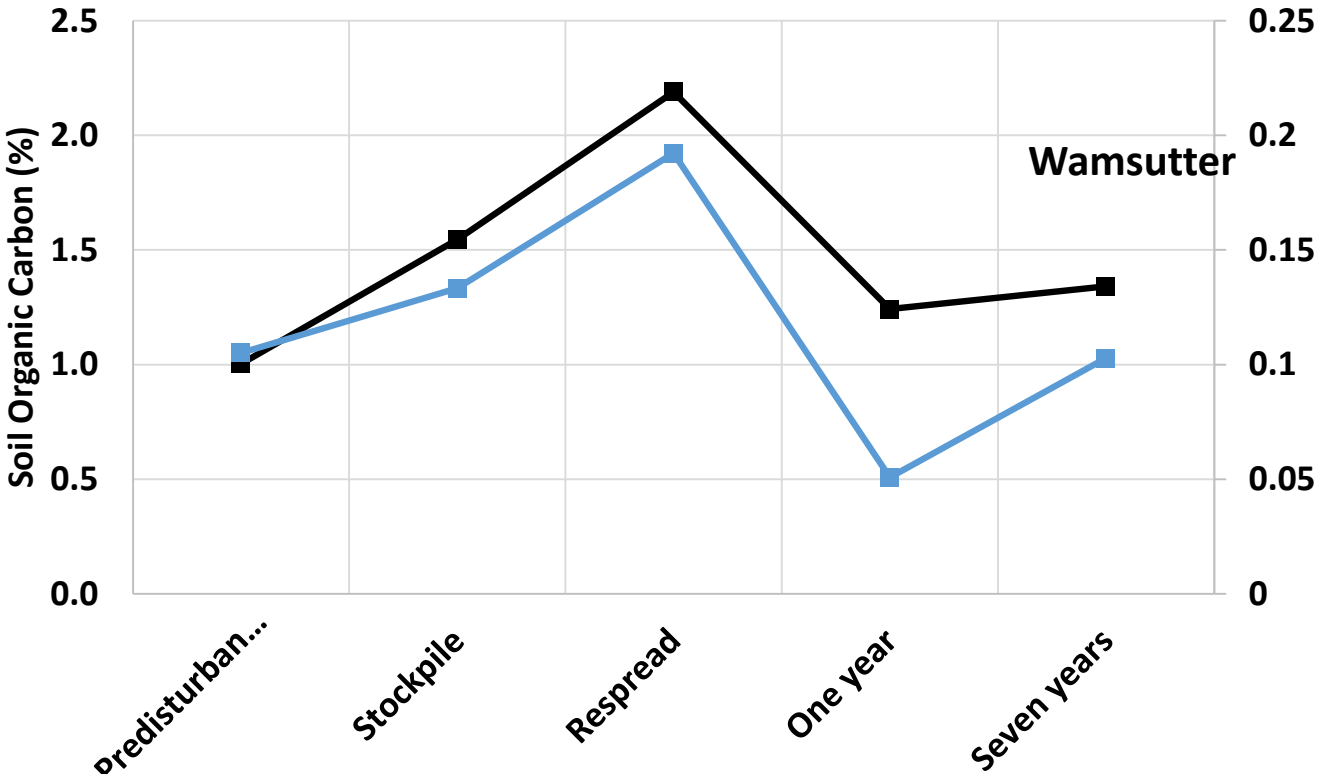






# Recovery of SOM

**Change: predisturbance to seven years after reclamation.**

| | TOC | TN |
|---|---|---|
| | *% change* | |
| **Anticline** | **72** | **88** |
| **Jonah** | **-45** | **-197** |
| **Wamsutter** | **3.7** | **-1.7** |

# Conclusions

- Stockpiles in semiarid region may not be affected by depth, at least in the short-term;
  - What about age?

- Compared with degraded reference sites, reclaimed sites seem to recover or exceed original SOM levels within seven years;
  - Possibly due to increased herbaceous vegetation

- Potentially mineralizable carbon recovers more slowly;
  - Possibly due to loss of soil structure, which protects labile SOM from mineralization, and continued accelerated mineralization, lack of woody species…

- Interest in reclamation research is as variable as annual rainfall.


**Thanks to**

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