

# Soil Properties That Distinguish Ecological Sites

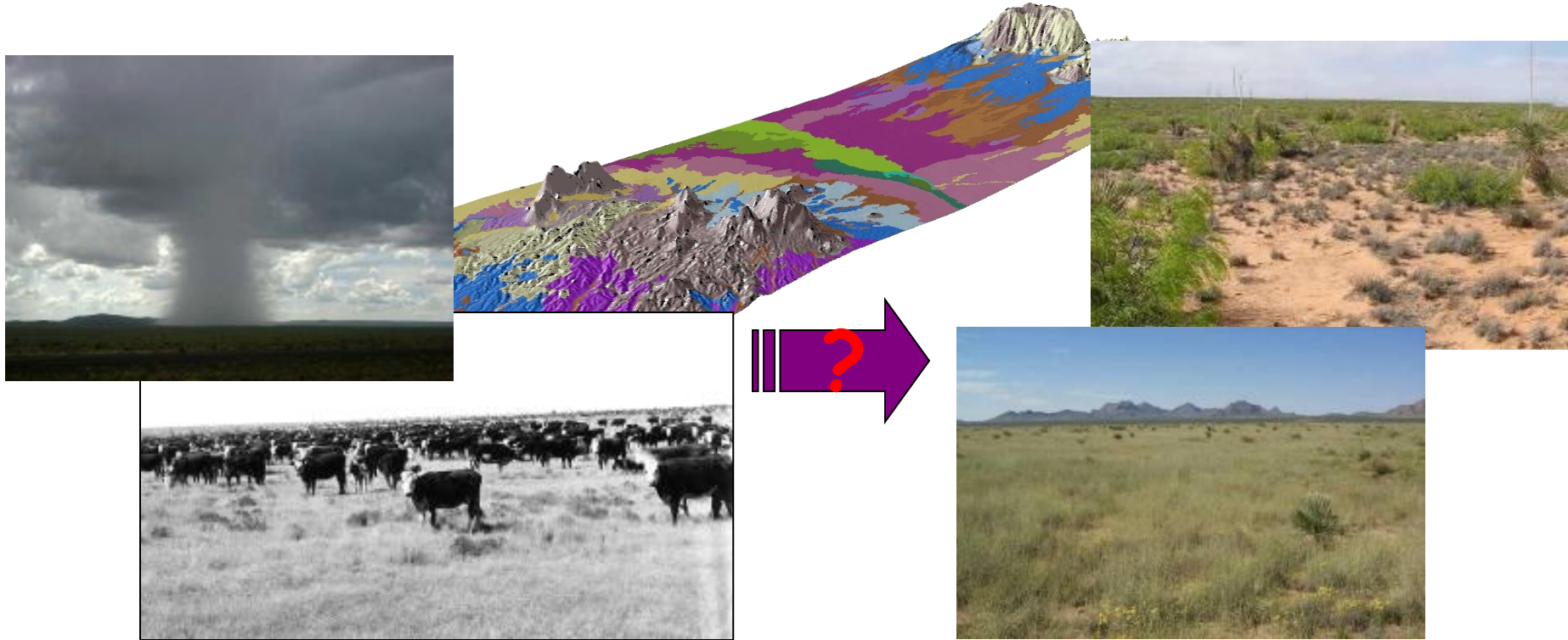
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# Ecological Sites

Answer the questions: *Why* do sites across a landscape vary in kinds and amounts of vegetation? *Why* do sites differ in response to disturbance & management?

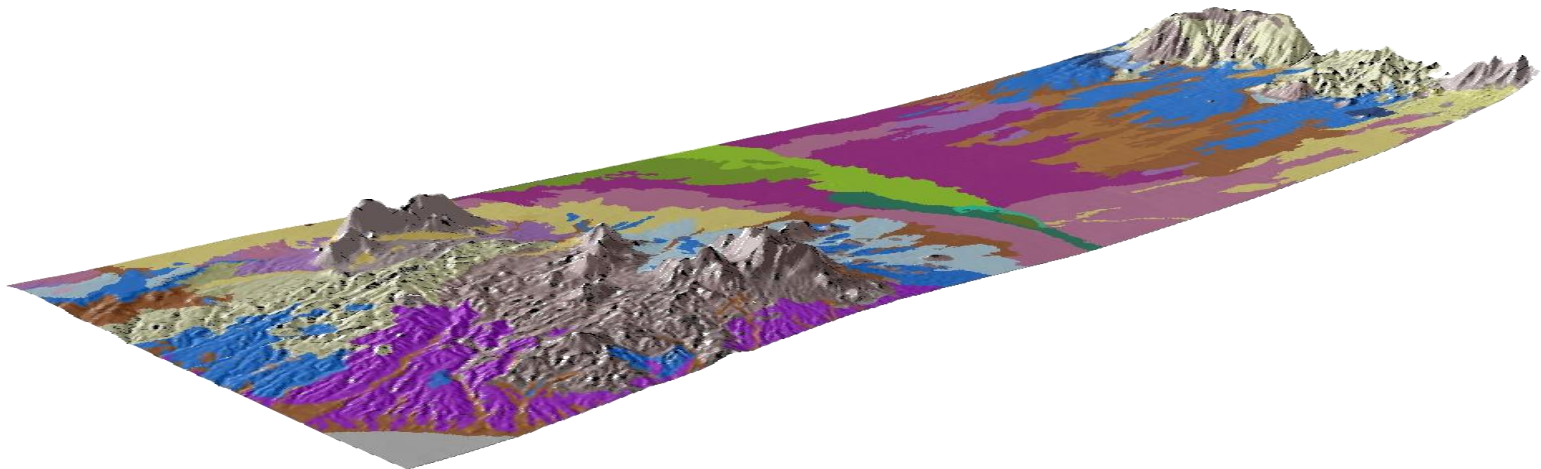


# Ecological Sites & Soil Properties

- Within a climatic zone (e.g. MLRA), differentiation of ecological sites based on soil and landscape properties (not current vegetation)
  - Two areas that have same vegetation, not necessarily same site
  - Two areas that have different vegetation, not necessarily different sites

# Ecological Sites & Soil Properties

- When dividing landscapes into ecological site units, we focus on those landscape and soil properties that control the inherent ecological potential
- Properties that are relatively insensitive to common management & disturbance scenarios



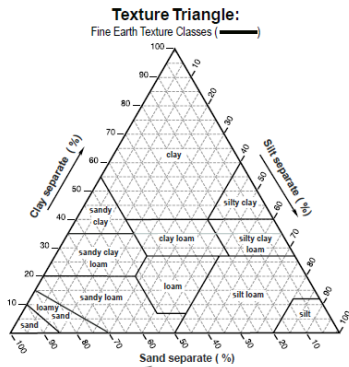
# Soil Properties & Processes

Soil properties are features of a soil:

- e.g. soil texture, depth

Soil processes are a series of actions in the soil that bring about a result

- e.g. water percolating into the soil that determines soil water amounts.



# Ecological Sites, Soil Properties & Soil Processes

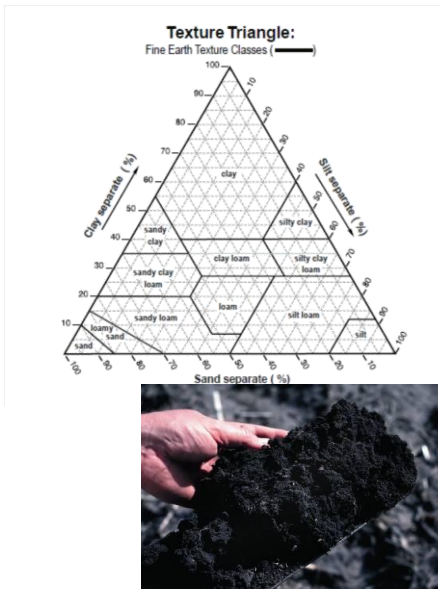
- Although we use properties, it is the soil processes that are controlled by the properties that actually cause differences between ecological sites.
- Soil processes explain why ecological sites (and sometimes states) differ.

# Soil Properties & Processes

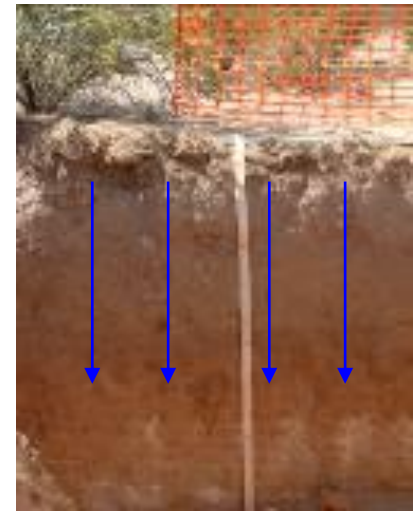
- Measured relationships between soil properties and soil processes allow us to estimate soil processes given information on a set of soil properties and other variables.



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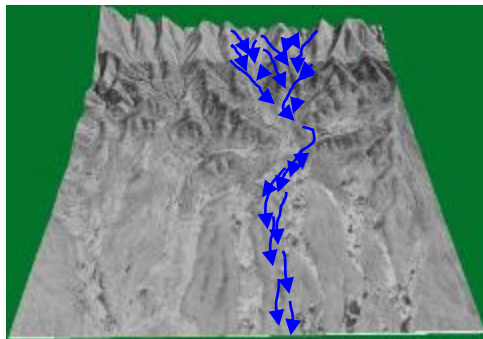
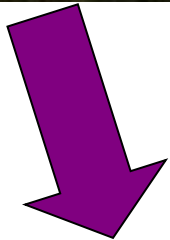
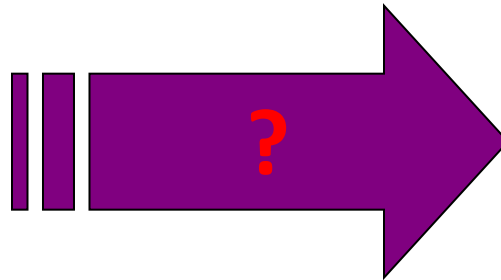


# Soil Properties That Distinguish Ecological Sites

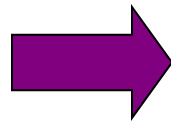
- Primarily considering properties that have substantial control over four processes:
  - Soil water availability\*
  - Soil nutrient availability
  - Plant rooting
  - Soil stability and redistribution
- These are the primary ecological mechanisms leading to differences in ecological potential



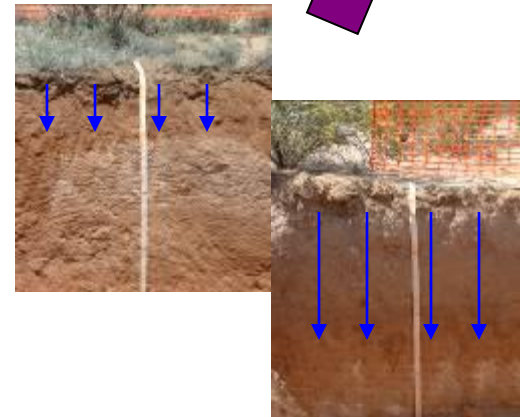
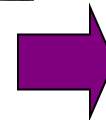
# Soil Water Availability



Landscape Position



Surface Soil Characteristics



Soil Profile



# Soil Water Availability

## Landform and Landscape position

- Increased production where water and sediment collects, up to a point.....



**Flooding 2 hours  
(2200 kg/ha of  
perennial grass)**



**Flooding 2 days  
(3900 kg/ha of  
perennial grass)**



**Flooding 2 weeks  
(0 kg/ha of perennial  
grass)**

# Soil Water Availability

## Aspect:

South-facing aspects produce warmer conditions at the soil surface and increased rates of transpiration and evaporation compared with north-facing aspects



South-facing



North-facing

# Soil Water Availability

## Surface texture:

Sandy surface textures typically allow more rapid infiltration and less evaporation than clayey textures. Important in dry environments.

**Sub-surface texture:** Medium-textured (loamy) soils have greater plant-available holding water compared to very sandy and clayey soils

\*A sandy soil surface over a finer-textured horizon can improve water retention and productivity



# Soil Water Availability



**Abrupt increase in sub-  
surface clay**



# Soil Water Availability

## Surface coarse fragments

- Reduce infiltration capacity
- Can increase water capture



Sub-surface coarse fragments reduce water holding capacity.



# Soil Water Availability

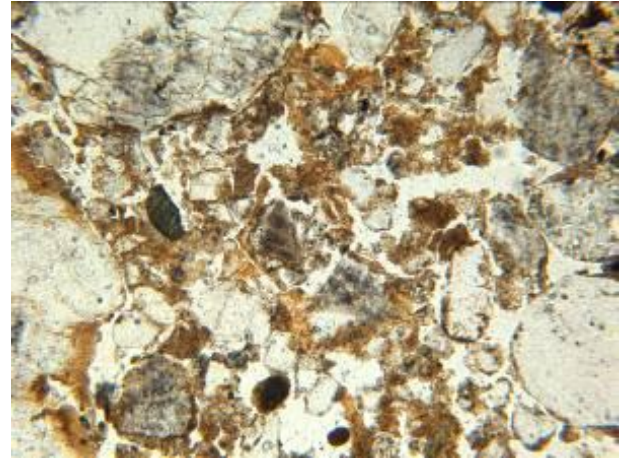
Water table depth  
• Shallow water,  
woodland in the  
desert!



# Soil Nutrient Availability

Differences in soil texture and mineralogy can cause important differences in plant nutrient availability.

- E.g. high amounts of gypsum in the soil profile tend to have imitations in mineral nutrients such as nitrogen, phosphorus, and potassium
- Few sites in west specifically related to nutrients availability





# Plant Rooting

Depth to a root-limiting layer can determine the ability of different plant species to access water and other resources.



**Restrictive horizons include**

- petrocalcic (caliche)
- petrogypsic
- duripans
- fragipans
- bedrock

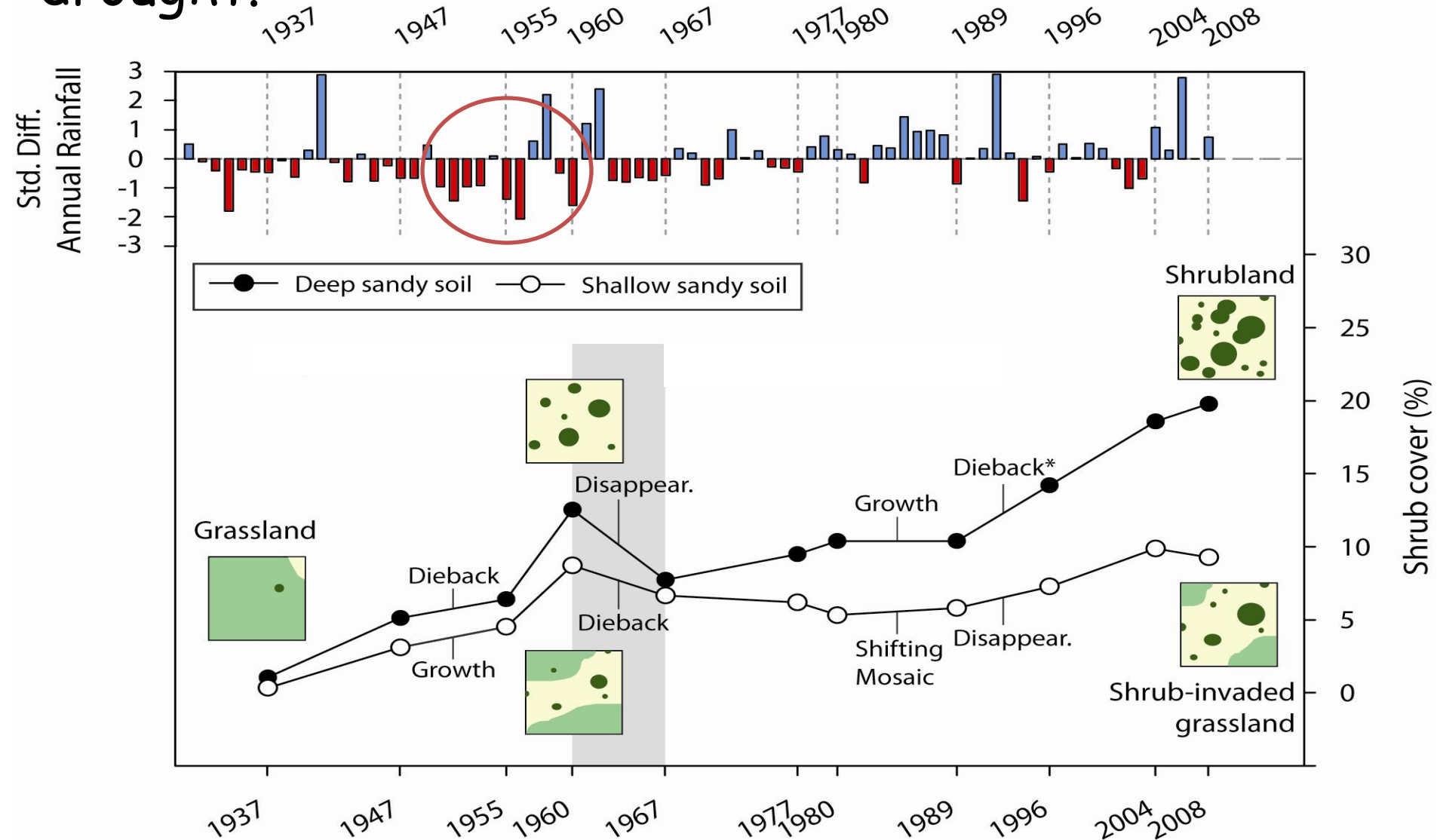


# Plant Rooting

- Restrictive horizons stop or slow the elongation of roots and reduce the available rooting volume in the soil (i.e., "shallow" sites)
- Does not always correspond to reduced plant-available water
  - Several studies have illustrated the availability and utilization of water within rocks and rock-like soil
- Weathered granites (Jones and Graham, 1993)
- Limestones (Querejeta, J. I., et al. 2007. )
- Petrocalcics (Duniway et al. 2007)



# Example from MLRA 42.2. Deep versus Shallow Sandy ecological sites, differing resilience to drought.



# Plant Rooting

- The continuity of such horizons is also important.
  - Cracks and fissures can both trap water and facilitate access to water contained within the matrix of the restrictive horizon.
- Depth to the water table
  - Meadow sites
  - Florida



# Soil Stability & Redistribution

- Erosion interrupts a plant's ability to access resources
  - e.g. exposing roots or burying plants.
- Surface soils that form stable aggregates (clumps of soil particles glued together by organic matter or clay) are less erodible than non-aggregated soils.



# Soil Stability & Redistribution

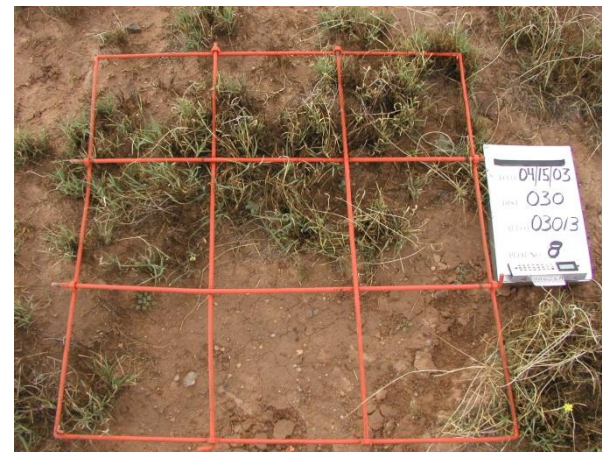
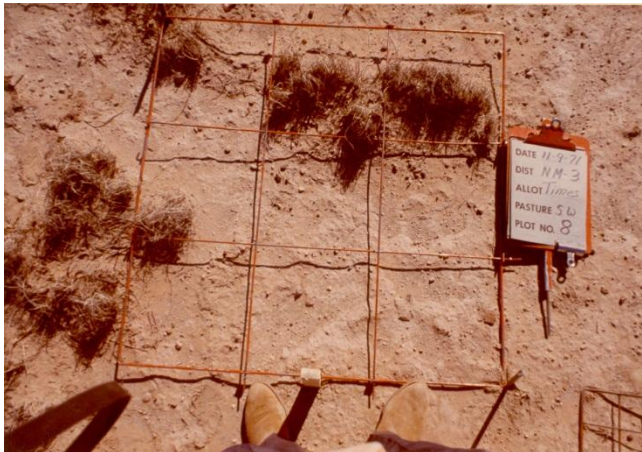
1970s-80s



2003



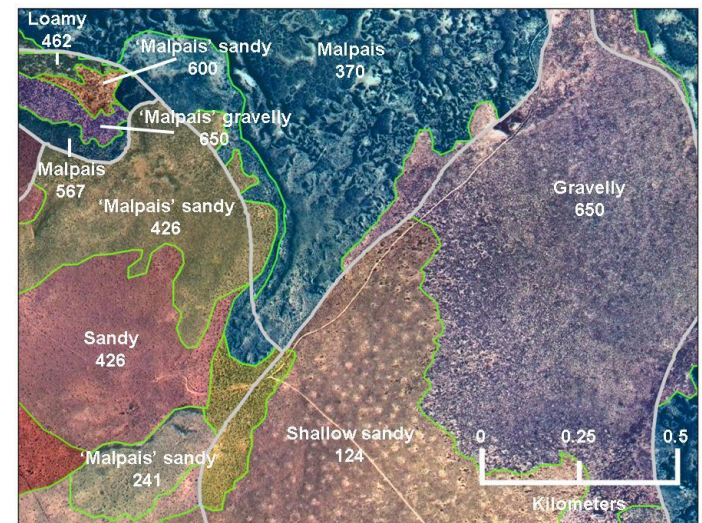
Sandy soils  
(high  
erodibility)



Clayey soils  
(low  
erodibility)

# Soil Properties & Ecological Sites

- How do we go from a multivariate, continuum of soil properties to ecological site classes?
- How do we determine which soil properties and processes differ among ecological sites?



# Soil Properties & Ecological Sites

- We observe relationships between soils and the plant communities occurring on them.
  - Inventory plant communities and soil properties within a climatic zone and look for statistical relationships among them.
  - Draw on research to infer the soil processes that occur and develop hypotheses about how those processes explain plant community patterns



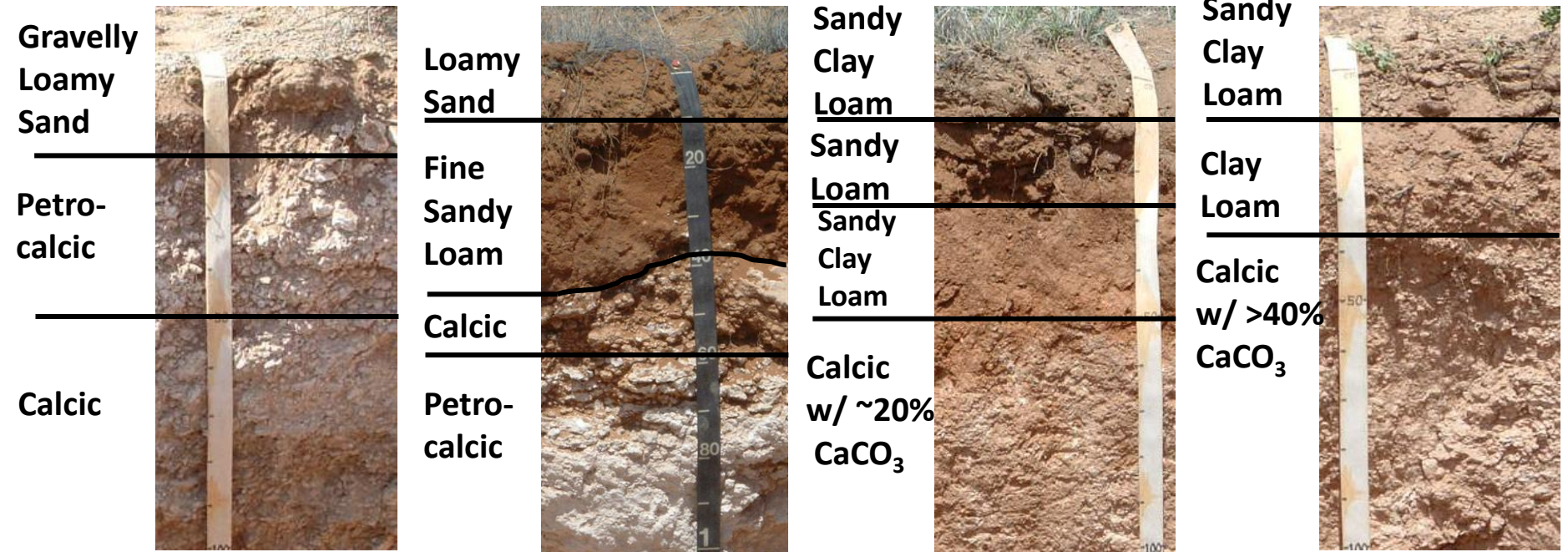
# Soil Properties & Ecological Sites

**Gravelly**

**Sandy**

**Loamy**

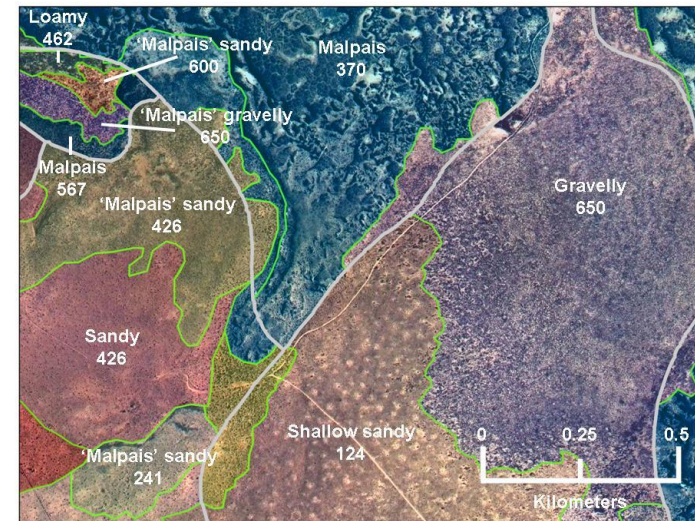
**Limy**



Four example from MLRA 42.2.

# Ecological Site Data Needs

- Where ES defined:
  - Refinement of soil surveys in areas with low precision mapping
- Where ES still in development (or refinement)
  - Soil property-plant community data sets (digital soil mapping)



**Thanks!**  
**Questions?**  
**Comments?**

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