Soil Structure

What is soil structure and Why do we care?

Engineering Technologies Canada Ltd.


Soil Structure

The naturally occurring grouping of individual soil particles into a larger grouping.

(Also called an *aggregate* or "*ped*")

Soil Structure

The *peds* are separated from adjoining peds by natural planes of weakness.

Soil Structure

Soil that has structure *will break apart into predictable and characteristic shapes*

Structure relates to:

- Water Movement
- Aeration
- Water Retention
- Root Penetration

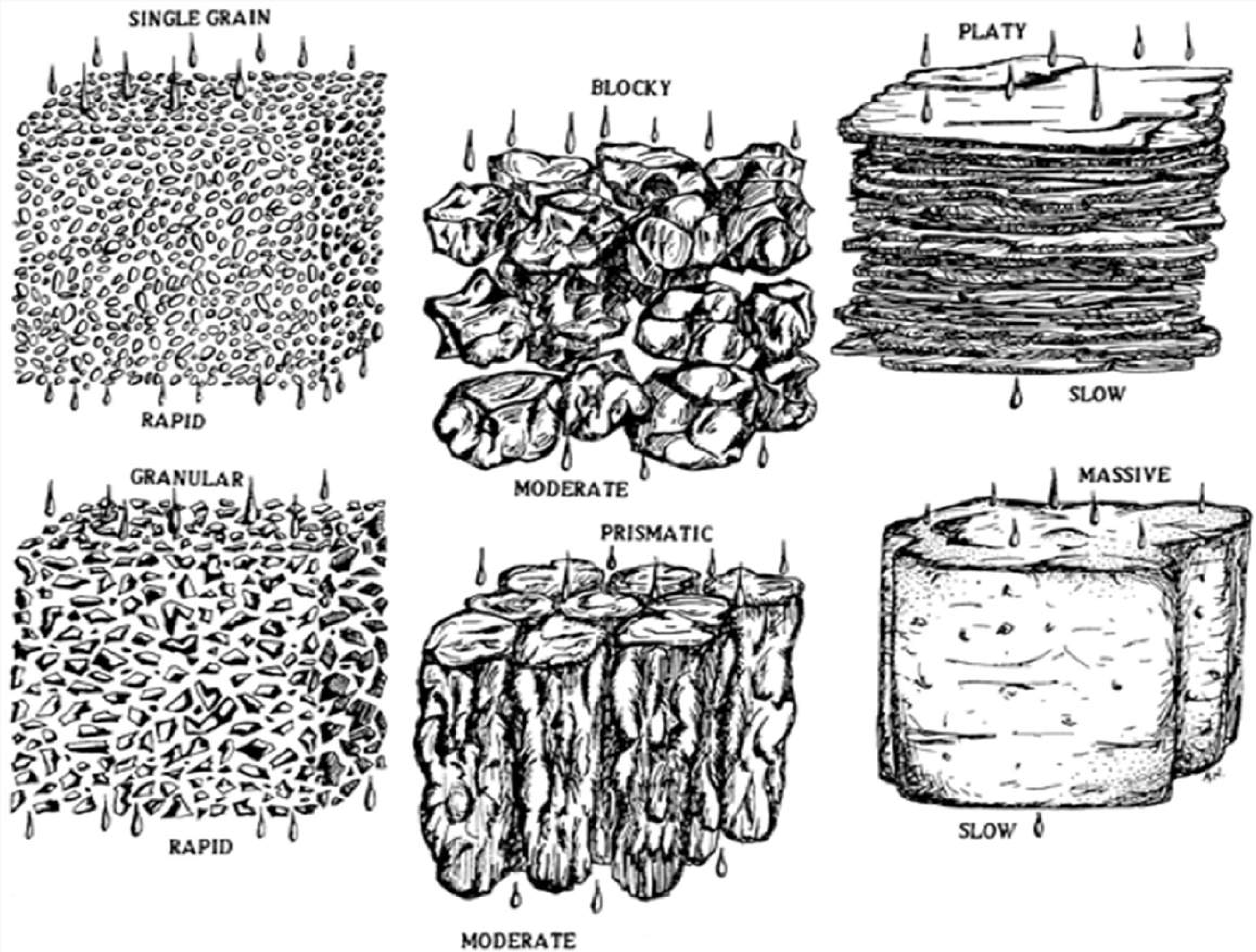
Soil Structure

- Type or Shape
- Grade
- Size (beyond the scope)

Natural Soil Structural Units Common in the Maritimes (Types)

- Granular
- Angular Blocky
- Subangular Blocky
- Platy

Structure Types or Shapes



Structure Types or Shapes

Type (shape)	Typical Permeability	Description	Comments
Structureless - Single grain	Rapid	No observable aggregation or joining of individual soil particles	Loose, incoherent mass of individual particles as in clean sands.
Granular	Rapid	Particles are joined into relatively small spherical units.	Peds look like “cookie crumbs”
Blocky	Moderate	Soils joined together to form larger units bounded by flat or rounded surfaces.	Observable sharp or rounded surfaces on peds.

Grade 0 – Structureless: Single Grain

Single Grain – No structural units; entirely non-coherent; e.g. loose sand

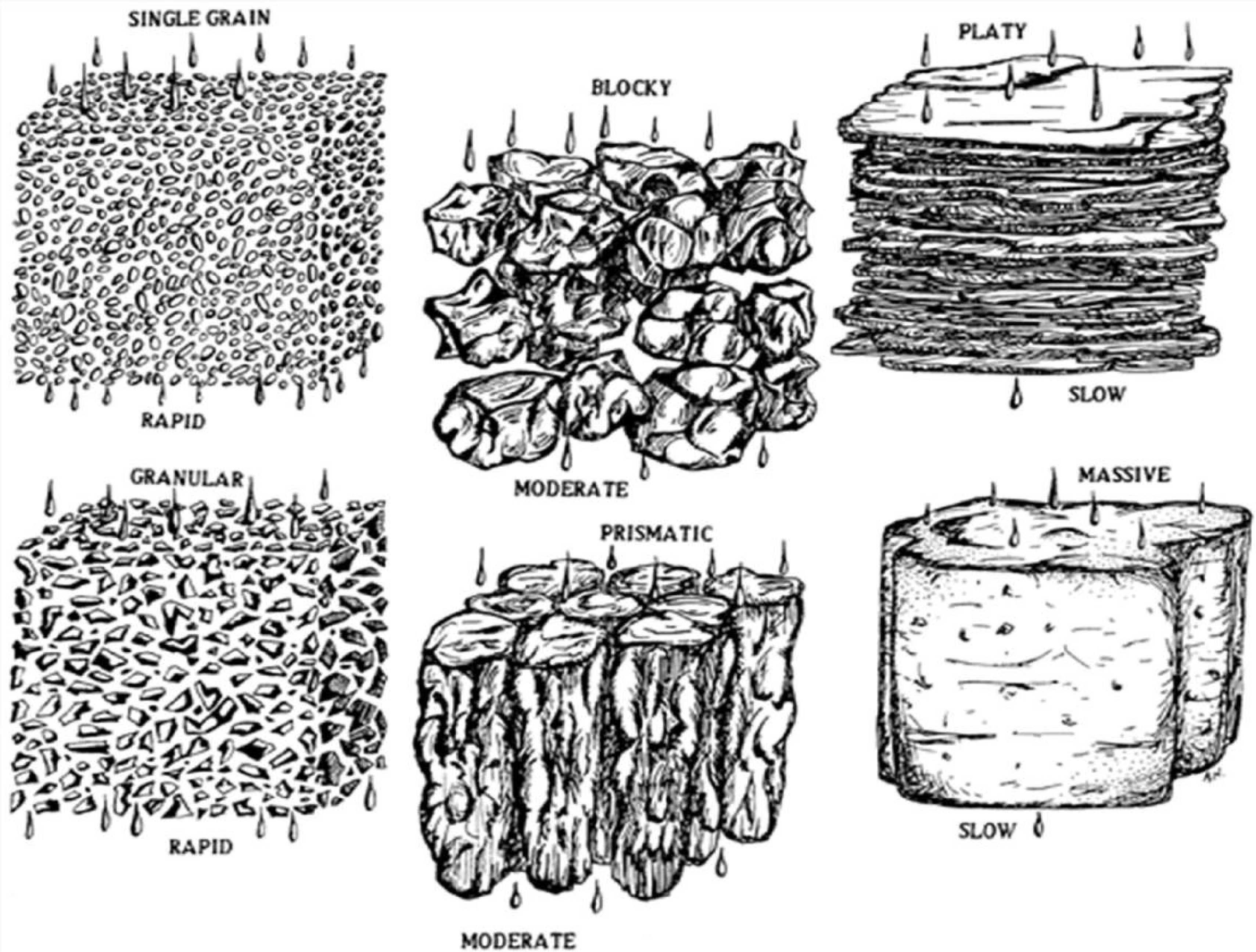
Structureless – Single Grain: No discrete structural units observable in place or in hand sample. Composed of individual particles. Material is noncoherent.


Granular – Small polyhedrals, with curved or very irregular faces

Blocky (angular) –
faces intersect at sharp angles (planes)

Subangular Blocky – Polyhedrals with sub-rounded and planar faces, lack sharp angles

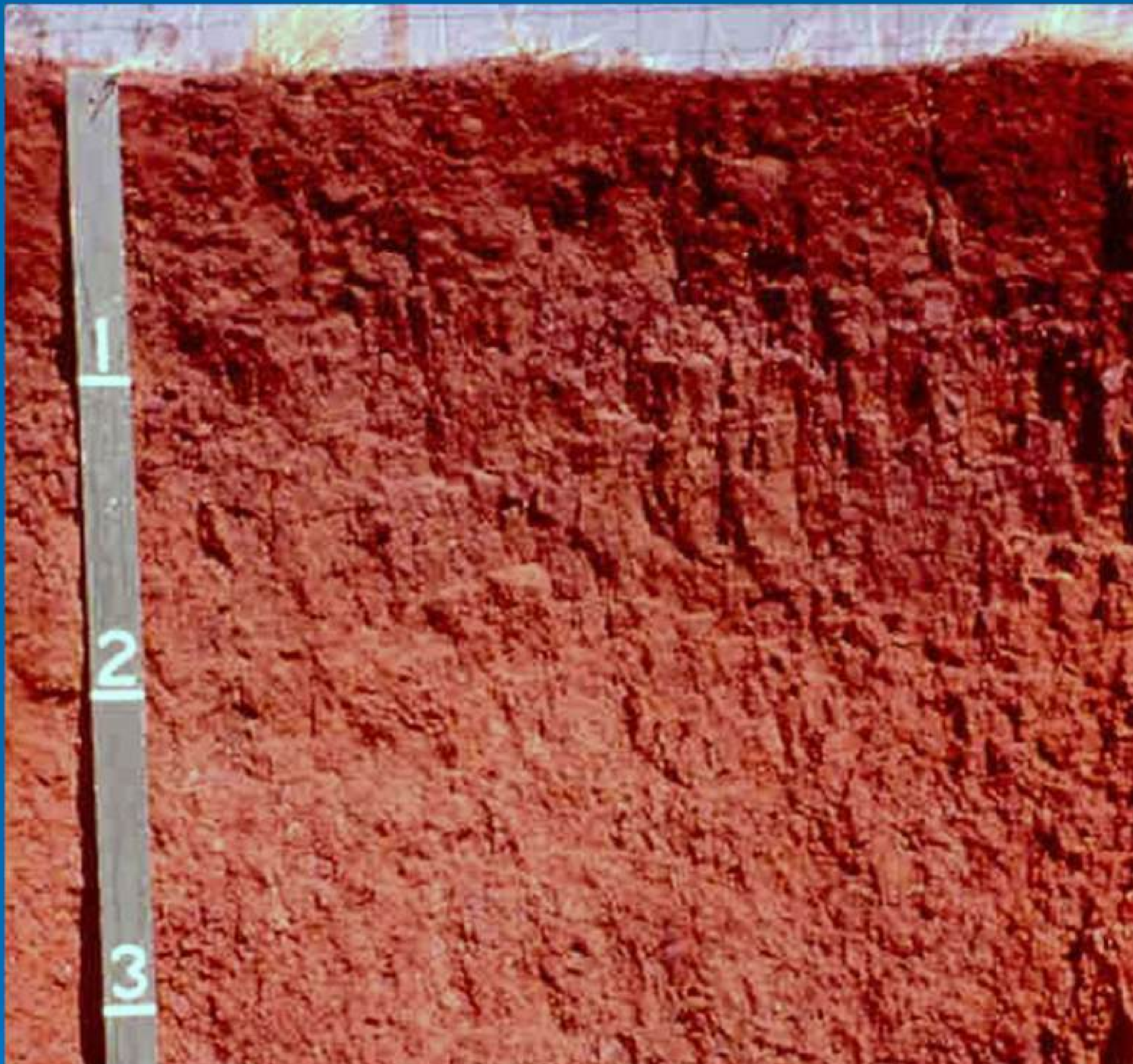
Structure Types or Shapes



Structure Types or Shapes

Type (shape)	Typical Permeability	Description	Comments
Prismatic or Columnar	Moderate	Structure is arranged in a vertical plane. Peds have relatively flat vertical surfaces.	Peds formed in a vertical arrangement. Less common.
Platy	Slow	Peds are arranged in layers on a horizontal plane.	Horizontal layering appearing as plates. Often associated with soils high in clay content.
Structureless - Massive	Slow	Solid structure. No evidence of any distinct arrangement of soil particles.	Appears as solid mass.

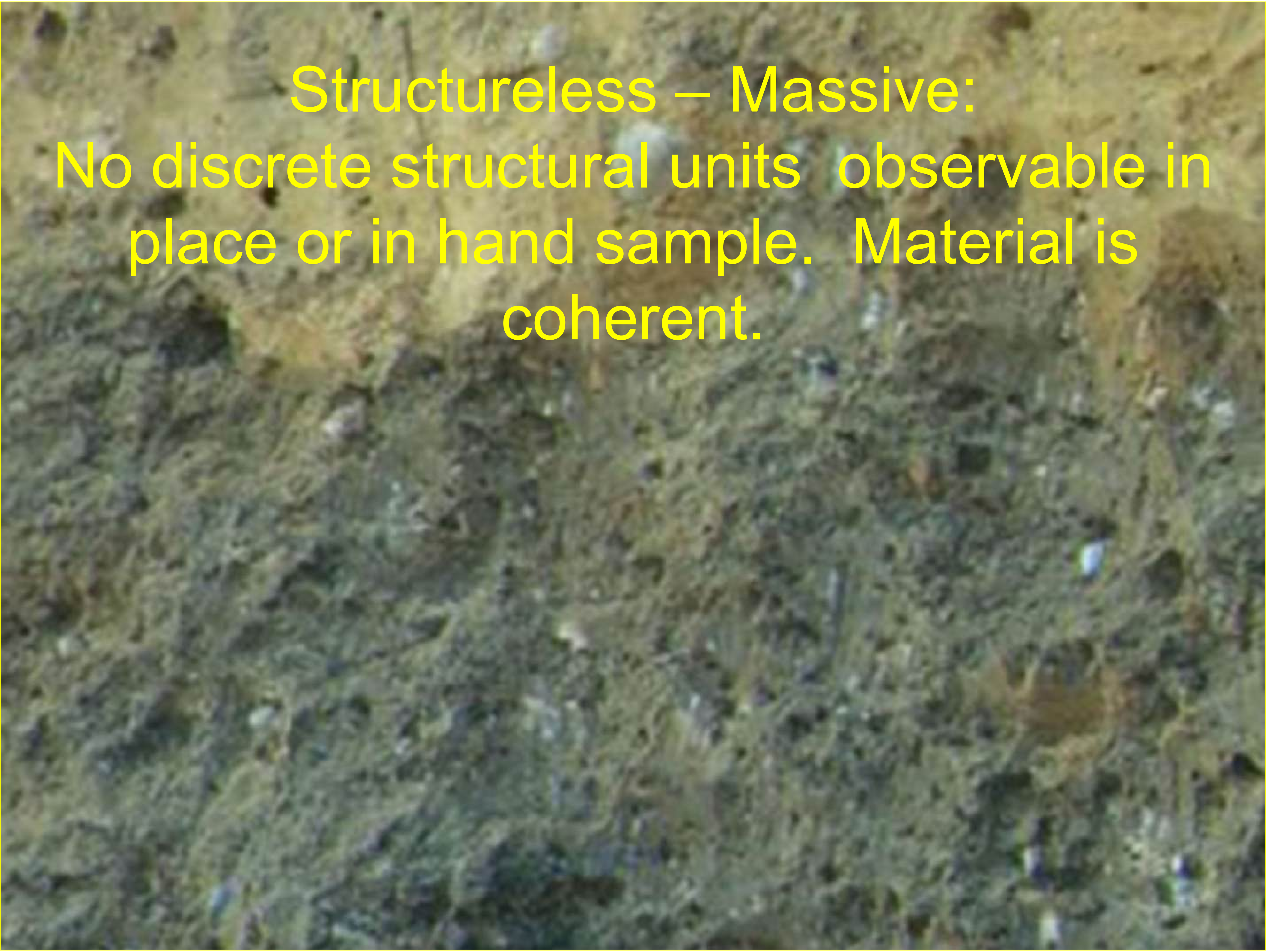
Prismatic/Columnar Structure



Prismatic/Columnar Structure

Platy – Flat and plate-like units

Platy – Horizontal layering effect


Structureless – Massive:
No discrete structural units observable in place or in hand sample. Material is coherent.

Texture Plays a Major Role with Micropores.

Structure Plays a Major Role with Macropores.

Structural Type and Porosity

Most Porous	Granular (crumb)
↓	Cube-Like
	•Subangular Blocky
	•Angular Blocky
	Prism-Like
	•Prismatic
	•Columnar
Least Porous	Platy

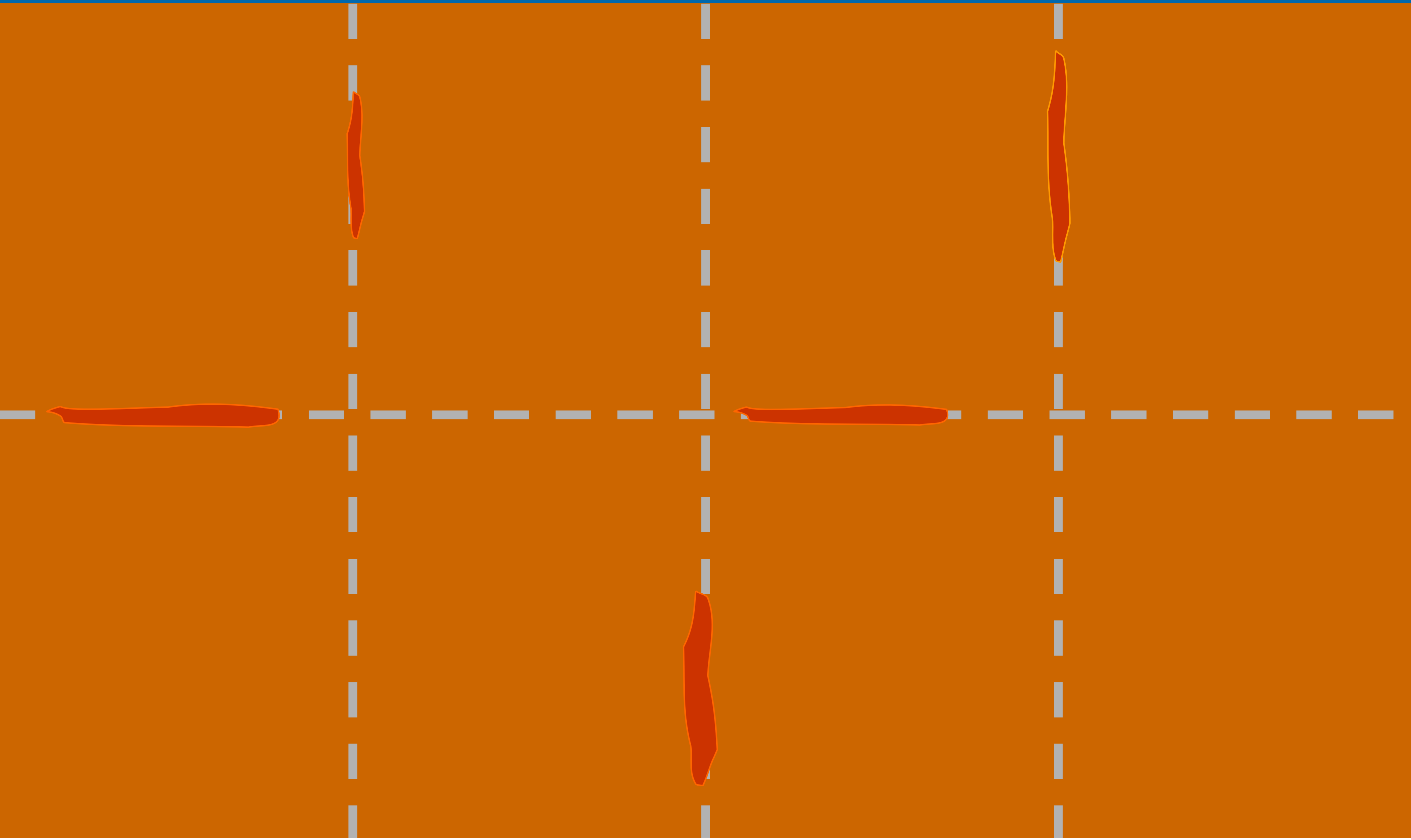
Structure and Water Movement

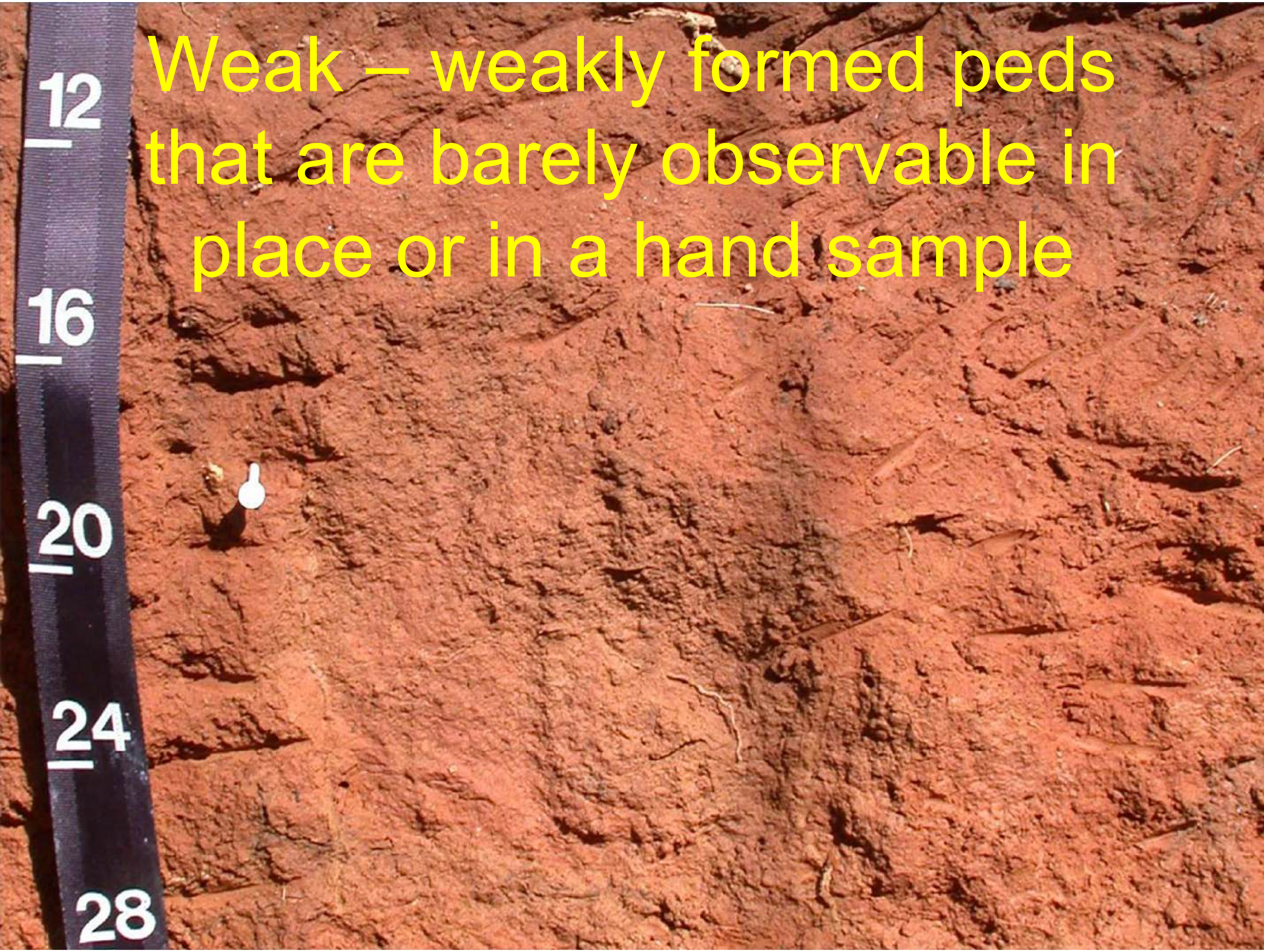
Soil Structure Grade

- Structureless - single grain
- Structureless - massive

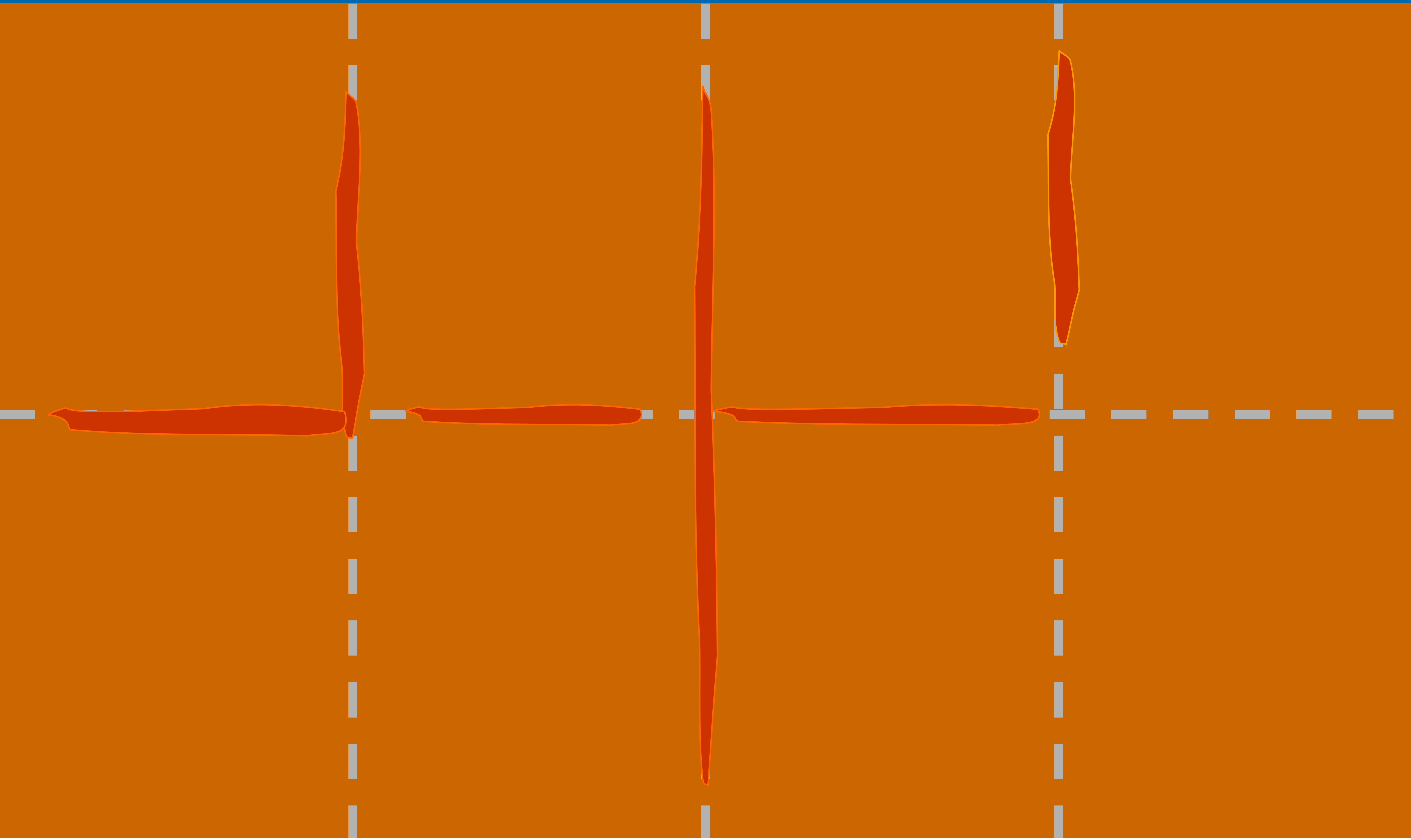
- Weak
- Moderate
- Strong

Grade 1 - Weak



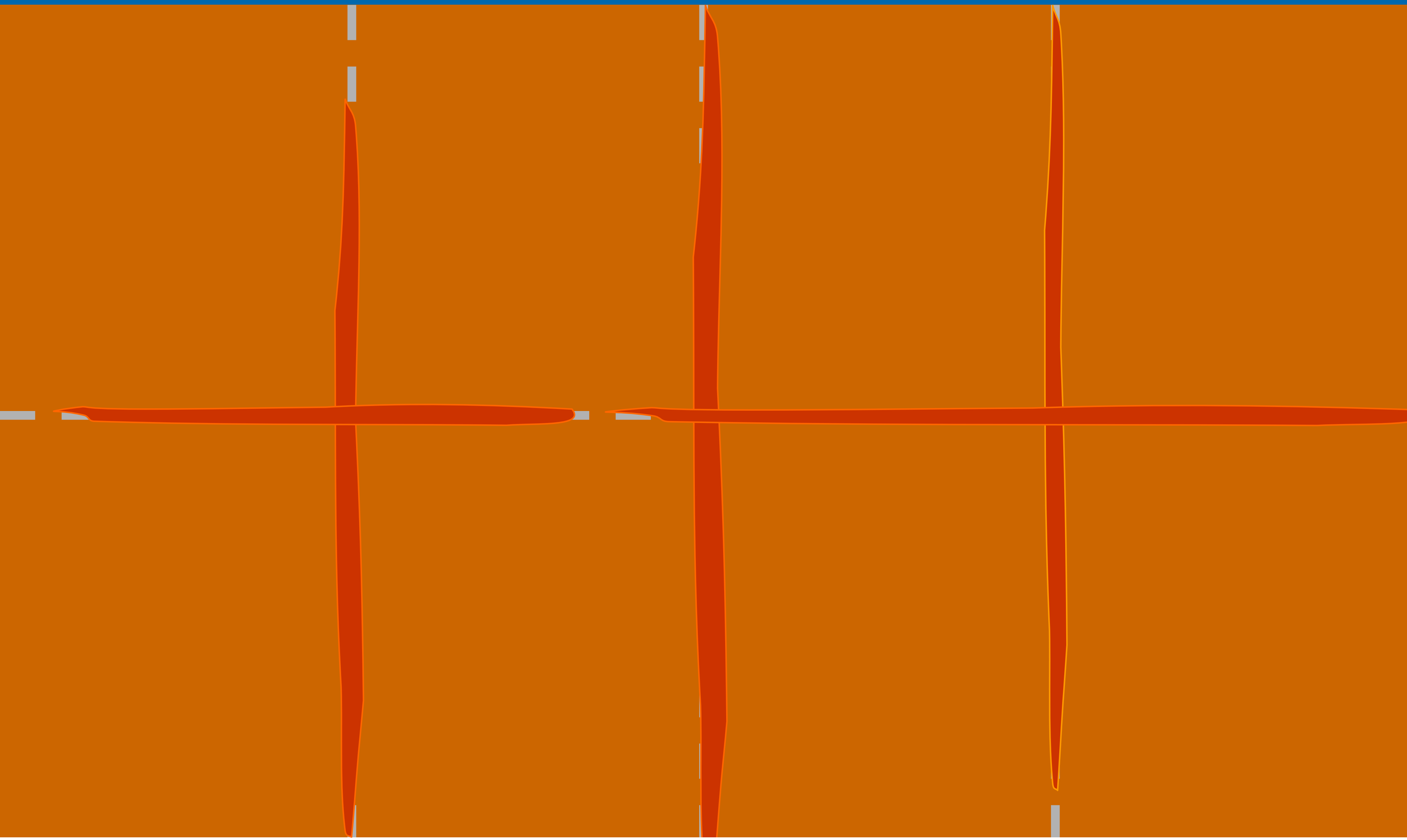

Weak – weakly formed peds
that are barely observable in
place or in a hand sample
12
16
20
24
28

Grade 2 - Moderate




Moderate – peds are moderately well-formed and moderately evident in place or in a hand sample

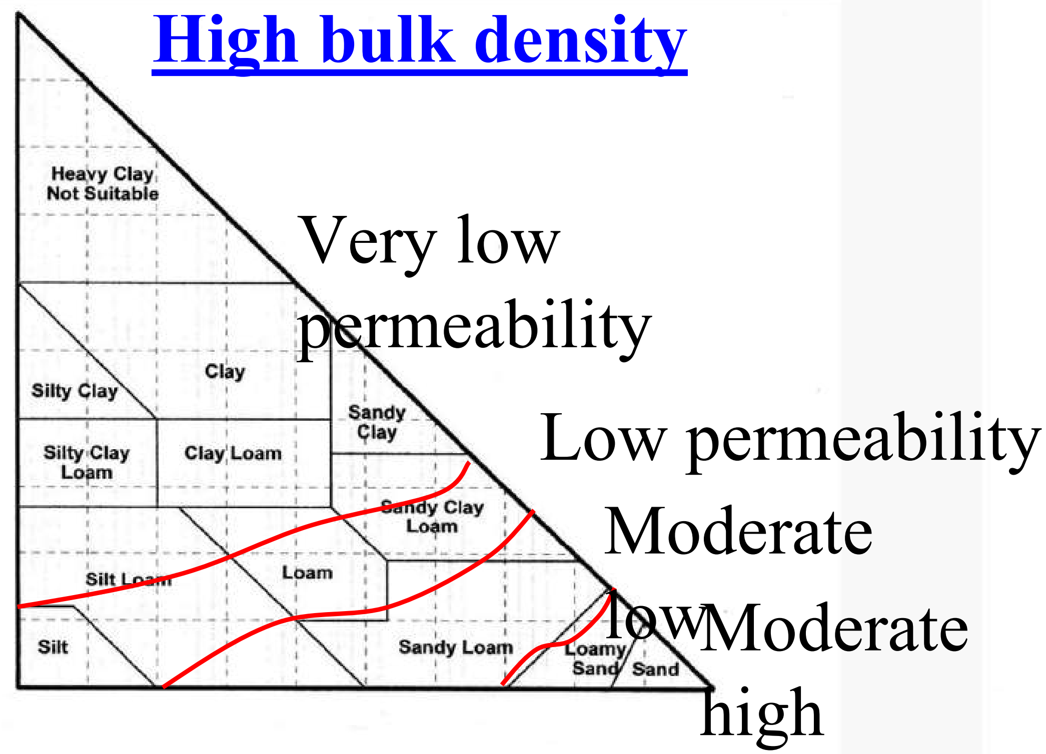
Grade 3-Strong



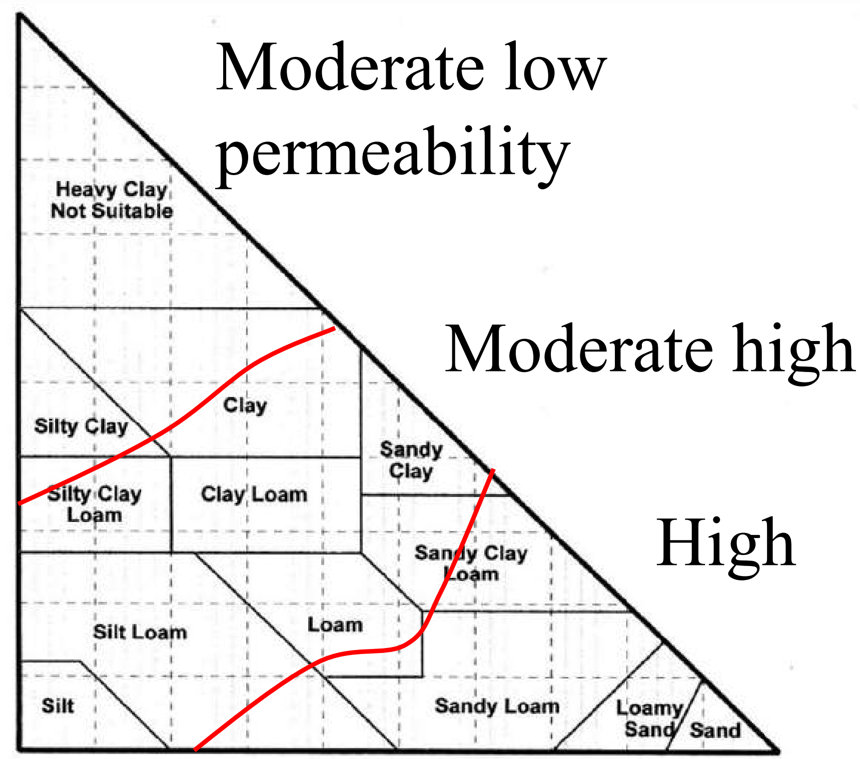
Strong –
Peds are distinct in place, separate cleanly, remain intact when disturbed

Soil structure affects density which can significantly affect permeability

Weak structure and/or High bulk density



Strong structure and/or Low bulk density



Assessing Soil Density

#	Density Classification	Typical Penetration Depth of Probe (cm)
1	Very Loose	> 10 Probe penetrates very easily
2	Loose	5 – 10 Probe penetrates easily, Easily excavated with shovel
3	Compact	2.5 – 5 Two-handed effort required to push probe into soil, Can excavate with effort
4	Dense	1 - 2.5 Difficult to push probe into soil, Difficult to excavate with shovel
5	Very Dense	< 1 Very difficult to push probe into soil, Very difficult to excavate with shovel

Glacial Geology Affects Soil Density

- *Ground Moraine Glacial Till* – lodged under the ice, wide assortment of particles, angular shapes, **often dense**
- *Ablation Moraine Till* – let down from upper surface of ice during melting of glacier, **non-compact**

Glacial Geology Affects Soil Density

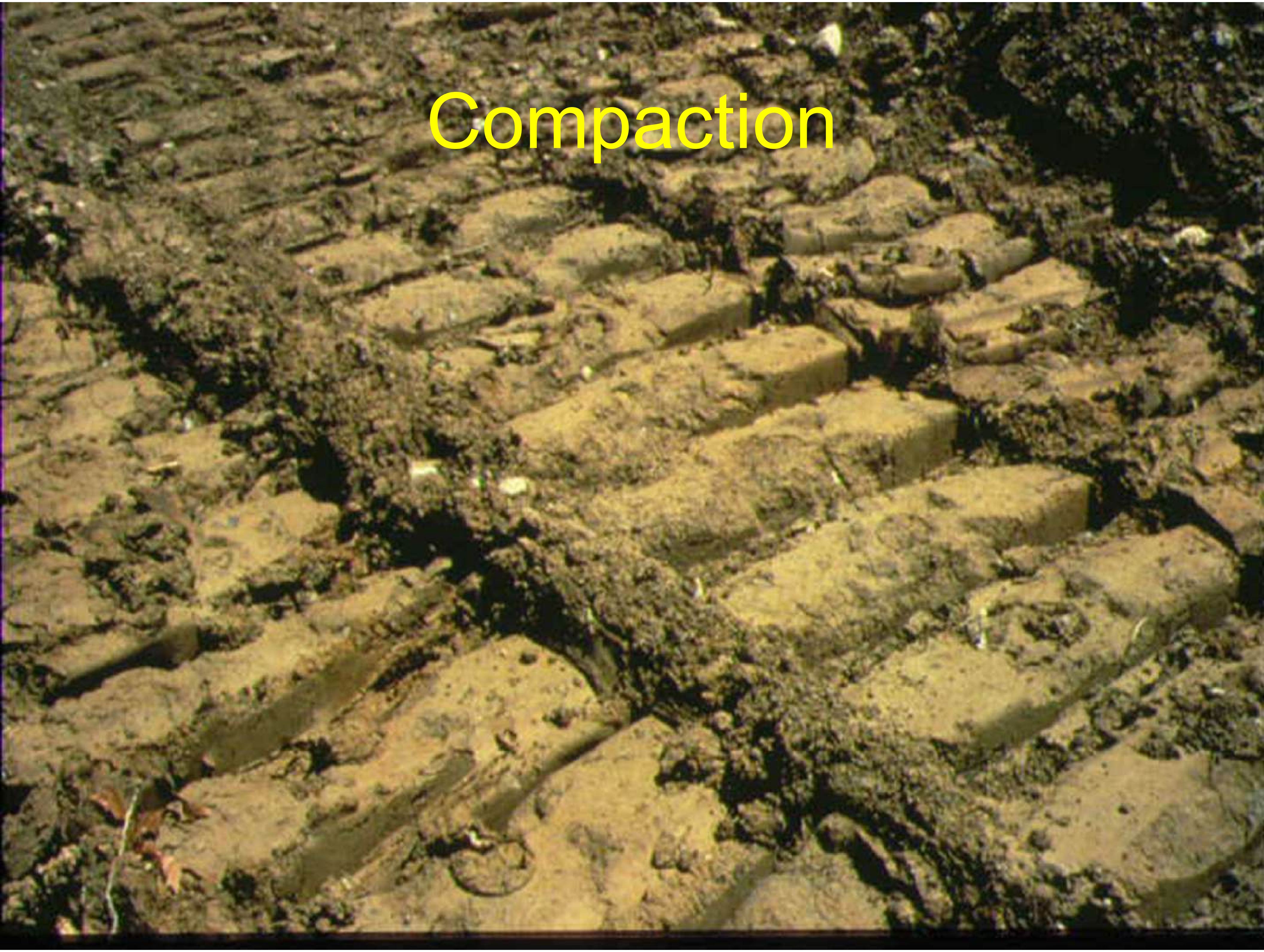
- *Glaciomarine Deposits* - deposited by glacial meltwater in the ocean – **not dense**, unstratified, smaller range of particles
- *Glaciofluvial Deposits* – Carried, sorted, deposited by streams from melting glaciers – **loose**, stratified.

Glacial Geology Affects Soil Density

PEI Soil Survey, see:

- See Table 6 (p.20-21)
- Table 8 (p.32)

For a guide to the type of glacial deposit for each soil survey type.


Compaction

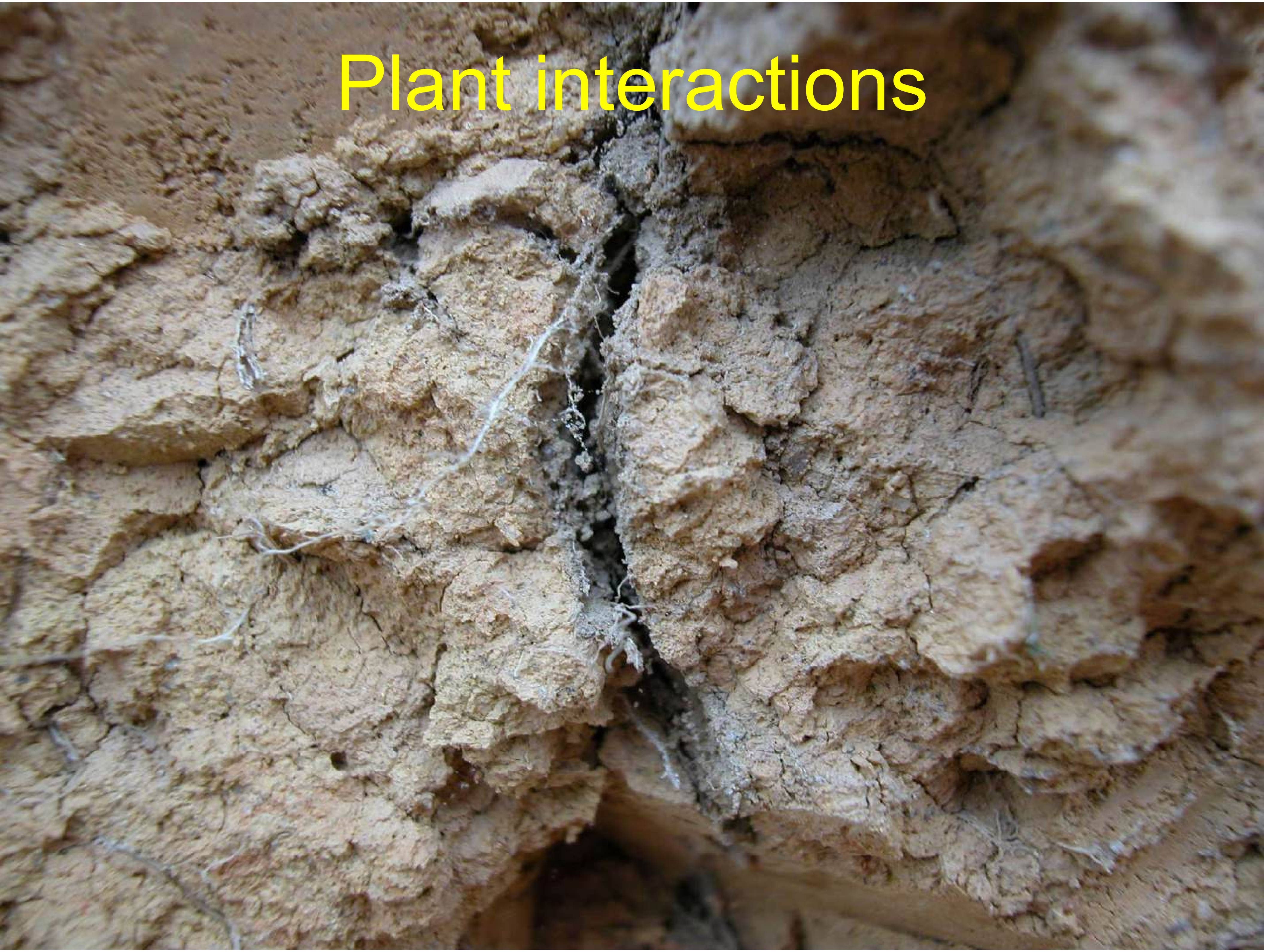

Mechanical disruption – tillage,
sub-soiling, plow pan


Mechanical disruption -
smearing

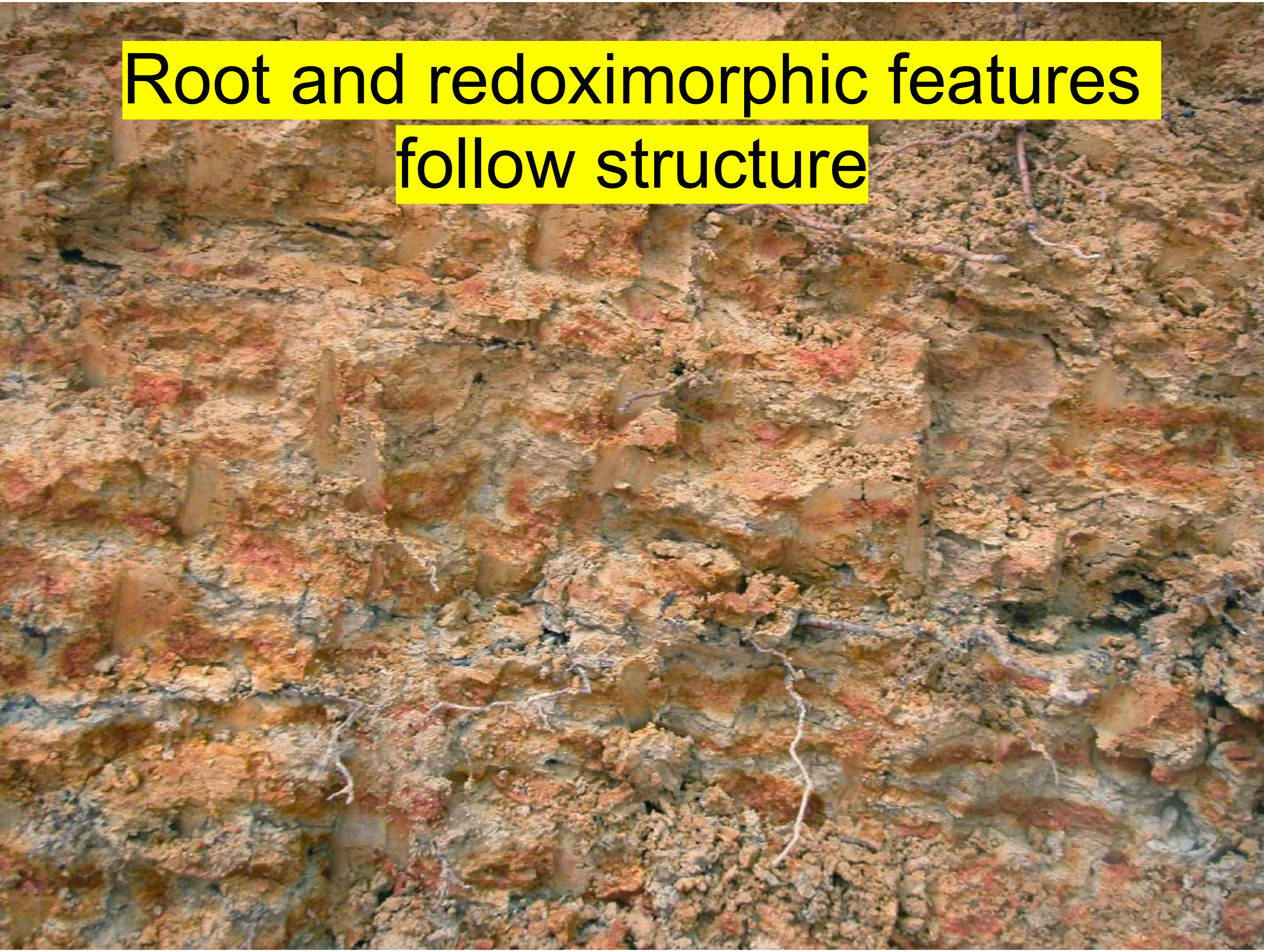
Plant Roots

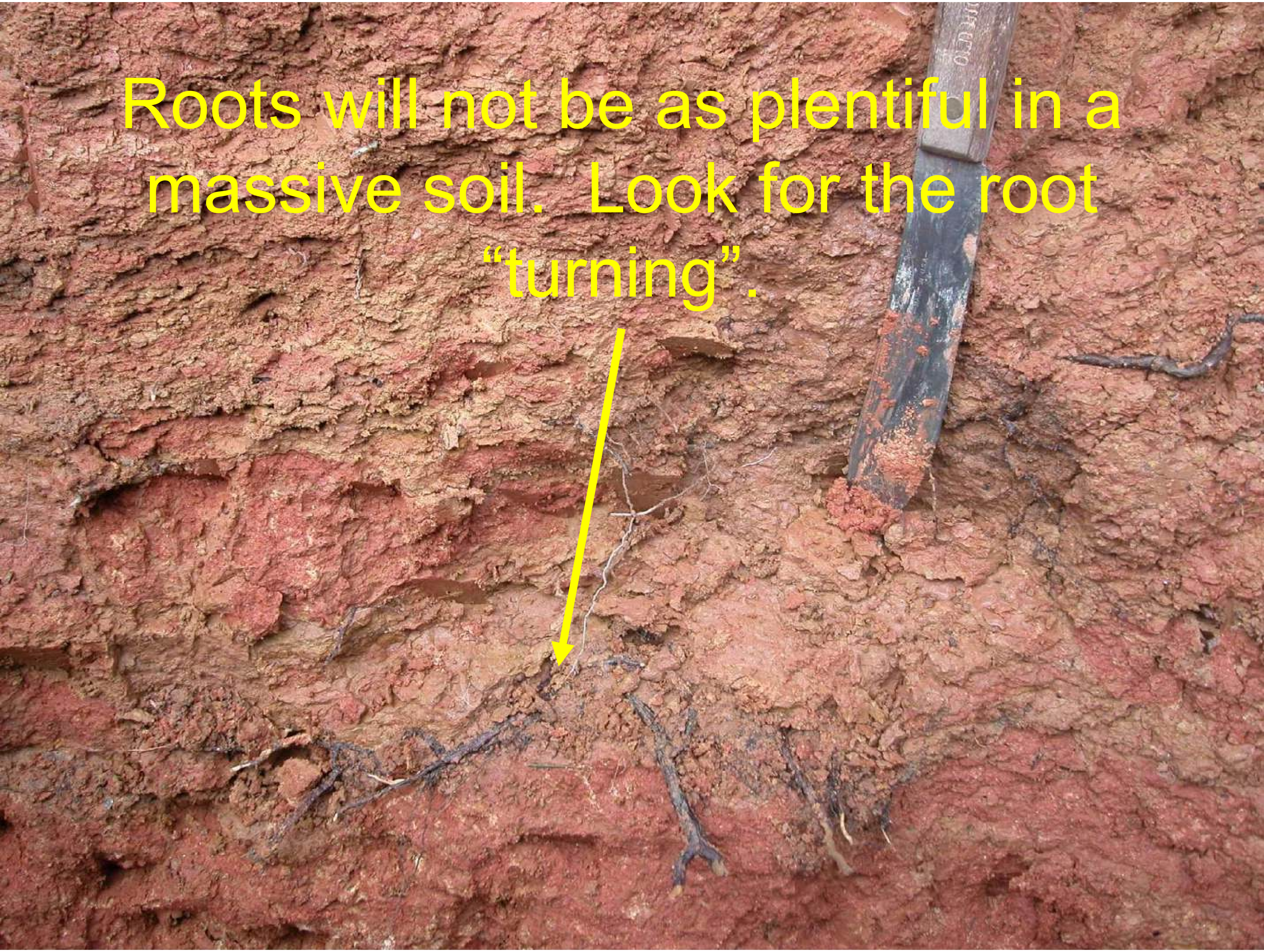
- In poorly structure soils they create larger pores
- Root growth physically compresses the voids
- In well structured soils they follow the path of least resistance
- Large roots can cause by-pass flow

Plant interactions



Root and redoximorphic features follow structure




Roots will not be as plentiful in a massive soil. Look for the root "turning".

Conclusions

- Structure is an important but overlooked aspect of soil evaluation
- Structure must be viewed in a test pit
- The relationship between structure and water movement is complex.