Paleosols of the Upper Devonian Foreknobs Formation of Western Virginia and Eastern West Virginia*

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Abstract

Twenty paleosol profiles were measured from four separate exposures of the Upper Devonian Foreknobs Formation of northeastern West Virginia. Paleosols were identified by the presence of root traces, ped structure, slickensided curvilinear fracture planes, and differences in color suggestive of horizonation. We have identified four main types of paleosols within the Foreknobs Formation which represent both differences in soil orders (as per USDA Taxonomy) and gradations in the degree of pedogenic features within individual profiles (on a scale of 1-4 with 4 = greatest), as well as pedologic features critical to paleoenvironmental and paleoclimatic interpretations. Profiles range in thickness from 0.2 to 1.0 m and represent pedogenically modified fining-upward, fluvial packages.

The most distinctive macroscopic pedogenic feature within the paleosols of the Foreknobs Formation is horizonation, which is expressed as varying degrees of relict vs. pedogenic sedimentary structures and manifests as differences in erosional relief and the concentration of rooted horizons near the top of individual profiles. The most common root types within the Foreknobs Formation are light greenish gray to pale yellow drab-haloed root traces. Wedge-shaped aggregates and angular to subangular blocky peds are most common within these paleosols and range from 0.3 to 2 cm in size and become smaller toward the tops of individual profiles. Curvilinear fracture planes with slickensided surfaces are common, but not ubiquitous, throughout these profiles. The most common microscopic features within paleosols of the Foreknobs Formation include distinctive pedogenic fabrics within the soil matrix and zones of reduction associated with drab haloed root traces. Glaebules are absent from these profiles. Soil fabrics include skel-lattisepic, vosepic, and clinobimasepic varieties.

Paleosols of the Foreknobs Formation formed in response to relative changes in sea level. Periods of greater soil formation are likely the result of relatively large drops in sea level associated with 4th-order sequence boundaries and likely represent the interfluves of the incised valley fills throughout this sequence, whereas the groupings of multiple, weaker soils likely represent subaerial exposure of individual 5th-order

sequences. The facies overlying individual paleosols are variable, and reflect both the magnitude of sea level rise and the position along the parasequence for that particular profile.

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Purpose

- Investigate potential exposure surfaces within a series of stacked shoaling upward sequences.
- Determine type and degree of relative pedogenic development.
- Relate degree of pedogenic development to sequence architecture.

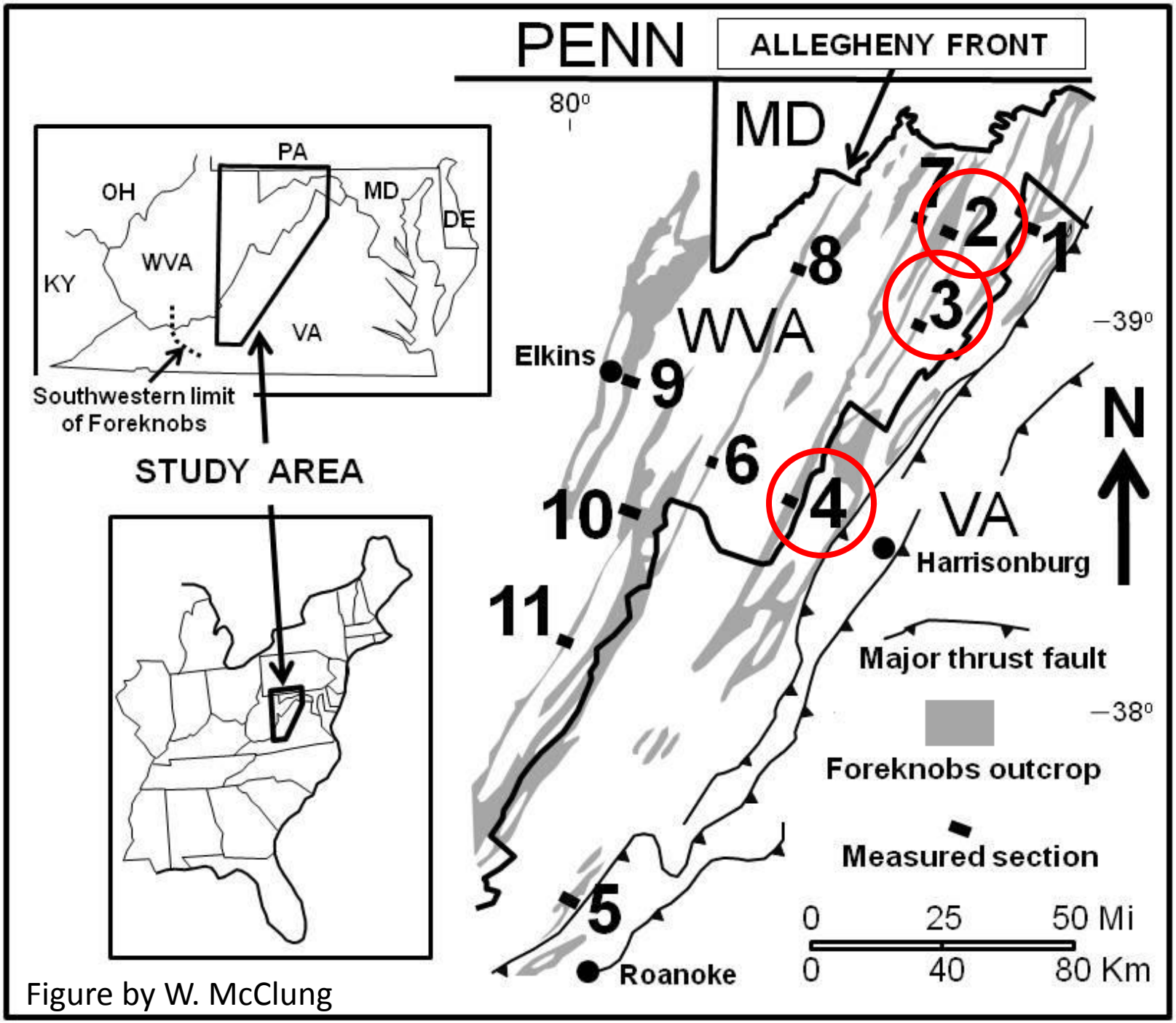
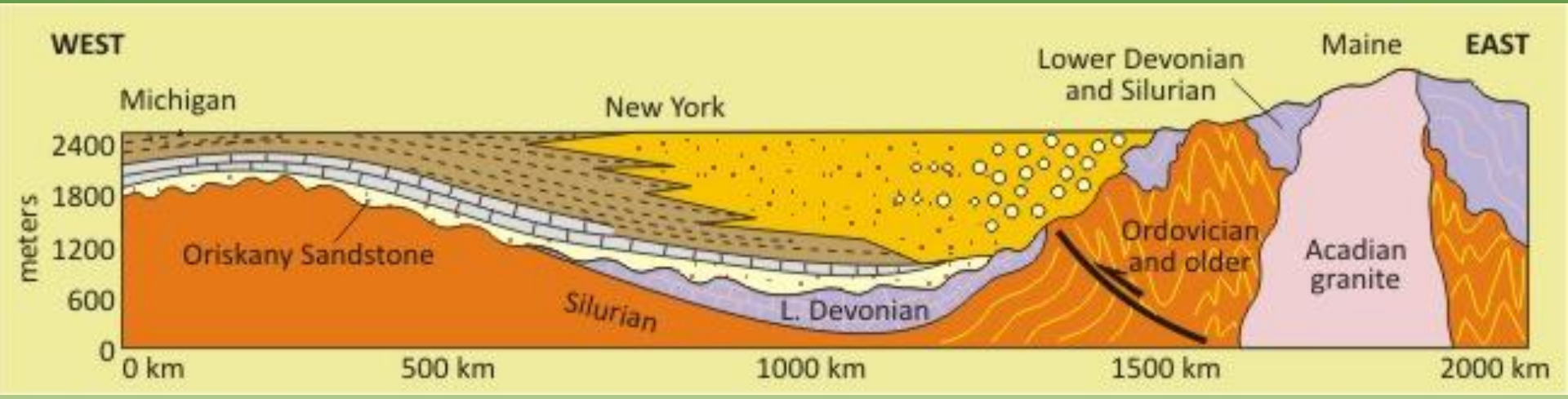


Figure by W. McClung

Tectonic Setting



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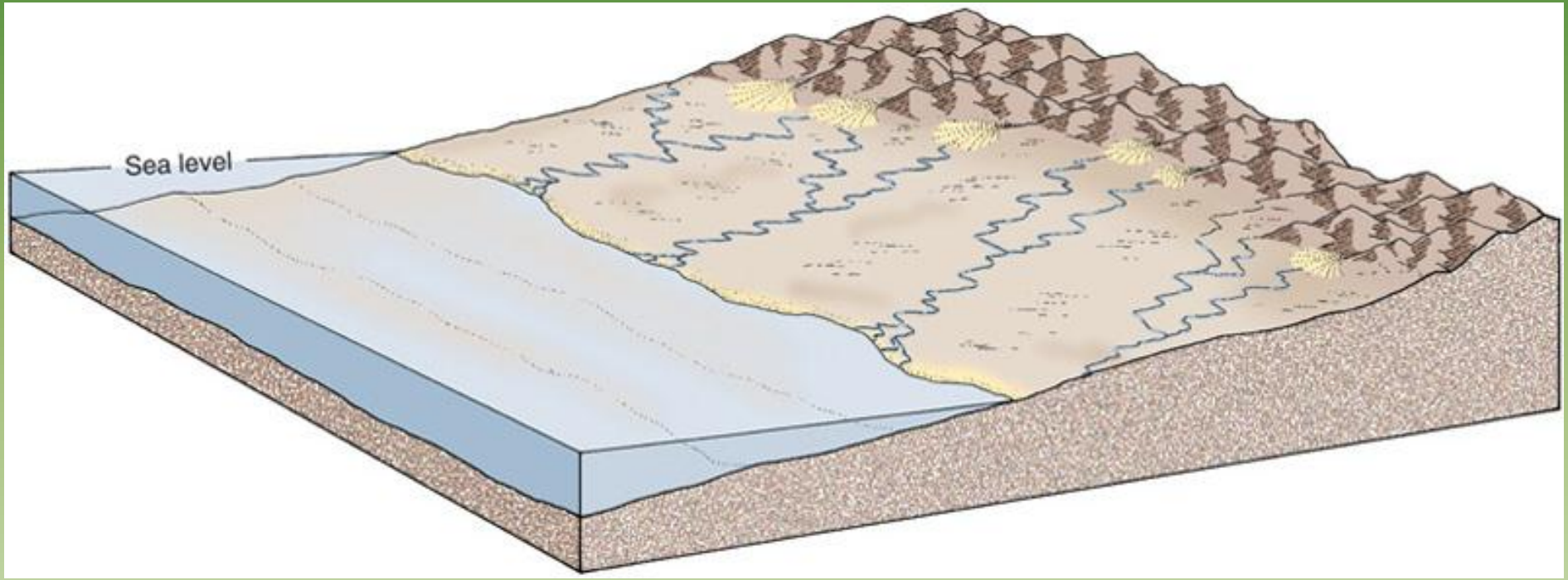
Tectonic setting



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Stratigraphy

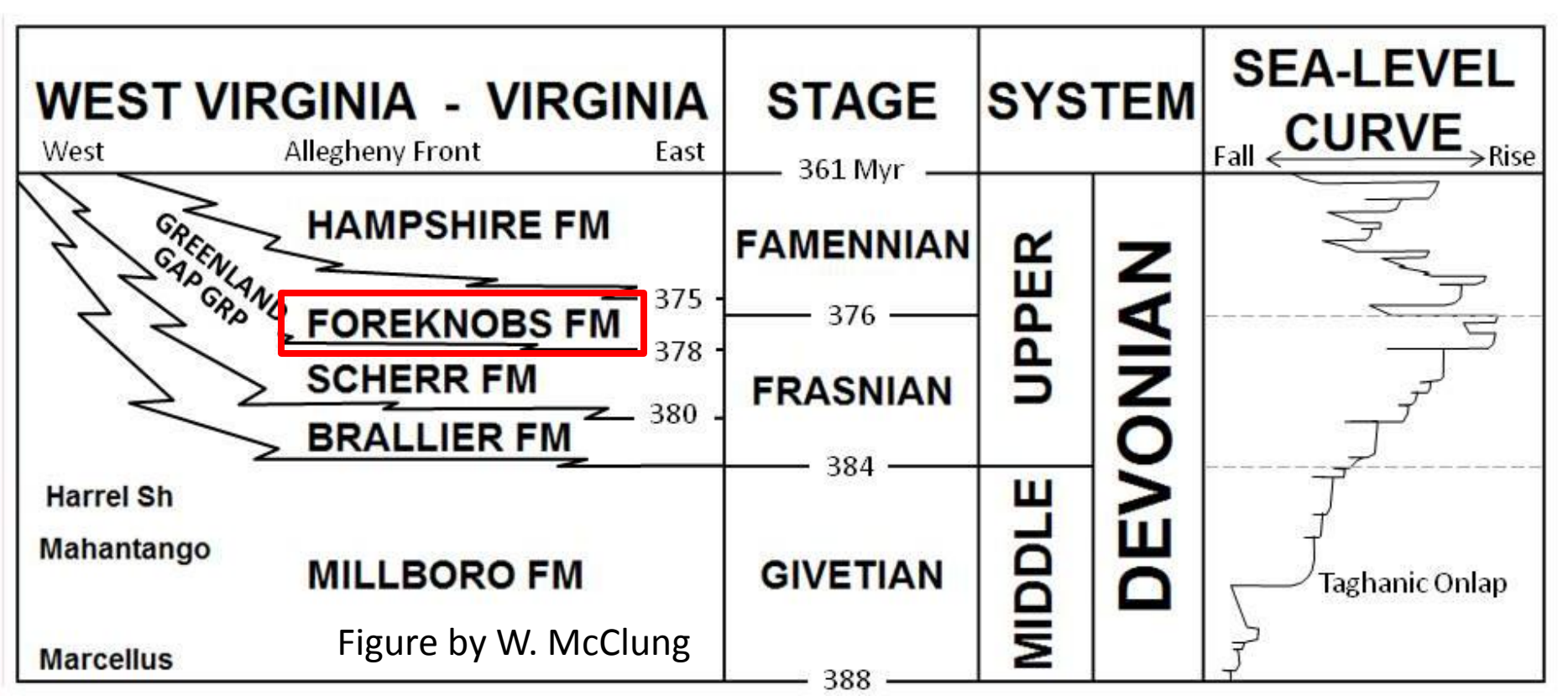
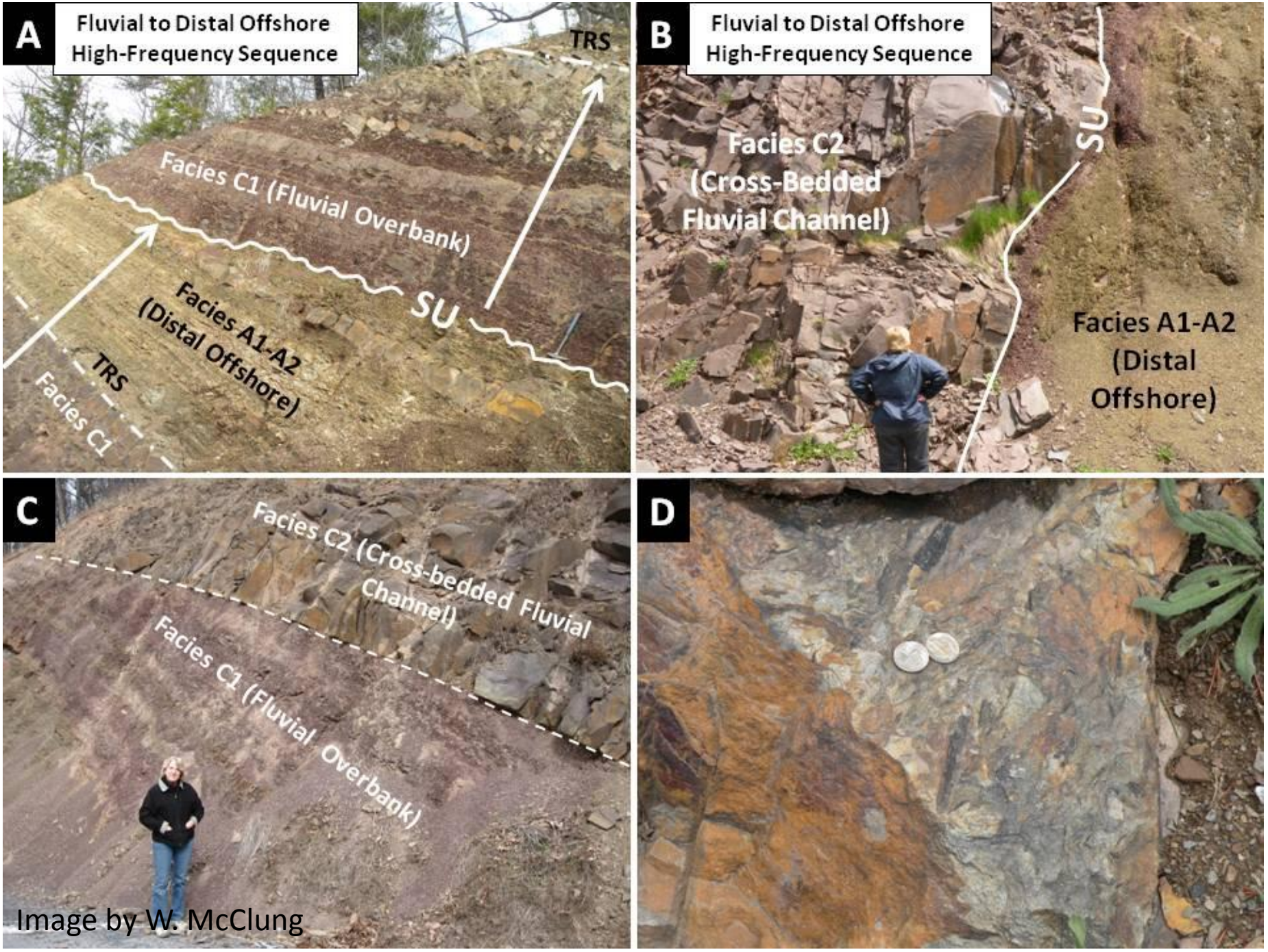


Figure by W. McClung


A
Fluvial to Distal Offshore
High-Frequency Sequence
TRS
Facies C1 (Fluvial Overbank)
SU
Facies A1-A2
(Distal Offshore)
TRS
Facies C1
B
Fluvial to Distal Offshore
High-Frequency Sequence
Facies C2
(Cross-Bedded
Fluvial Channel)
SU
Facies A1-A2
(Distal
Offshore)
C
Facies C2 (Cross-bedded Fluvial
Channel)
Facies C1 (Fluvial Overbank)
D
Image by W. McClung

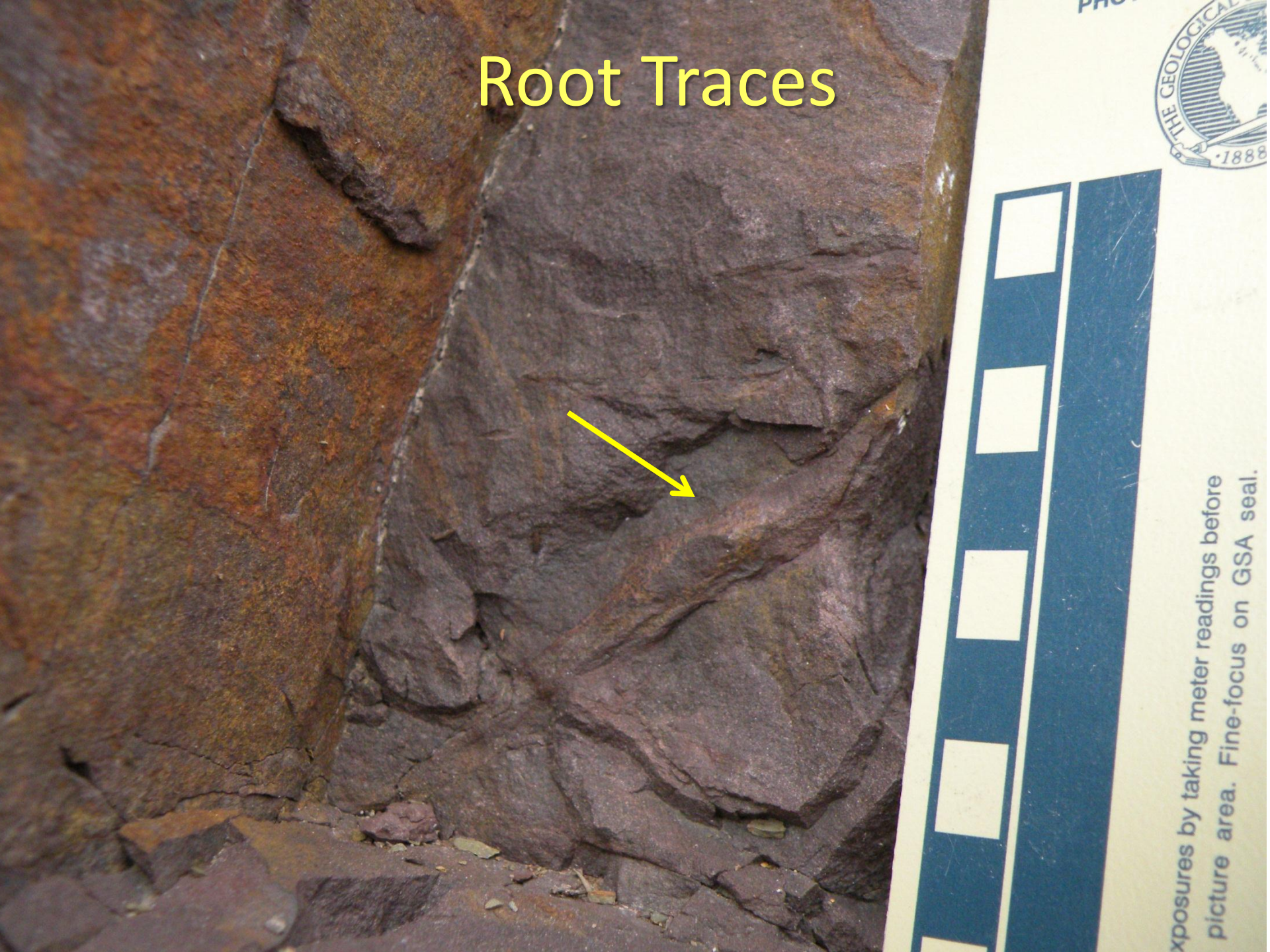
Paleosol Recognition

- Color banding
  - Horizonation
- Soil structure
  - Peds
  - Root traces
  - Nodules/concretions (glaebules)
  - Cutans (accumulations along void walls)

Image by W. McClung

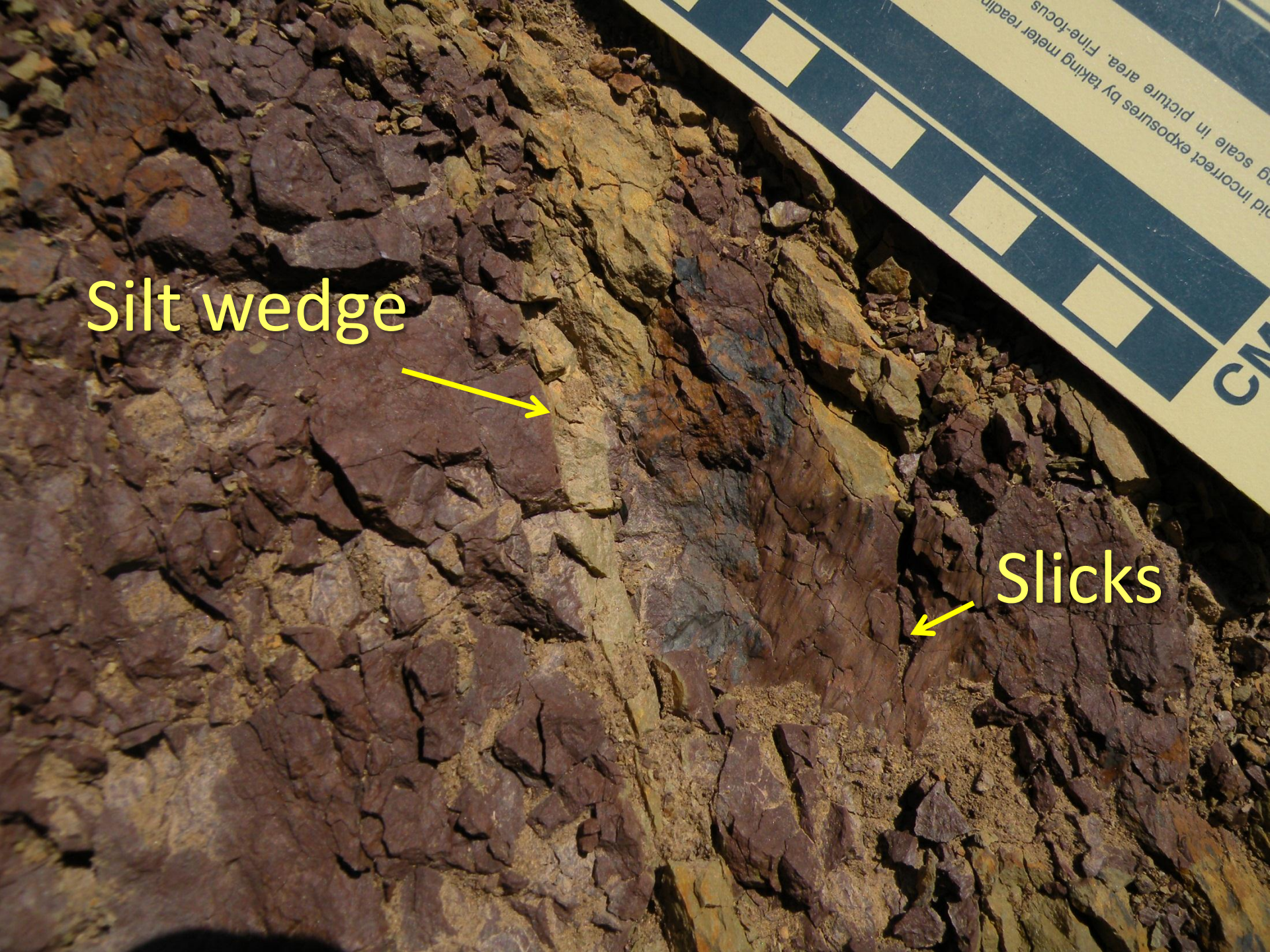
Root Traces

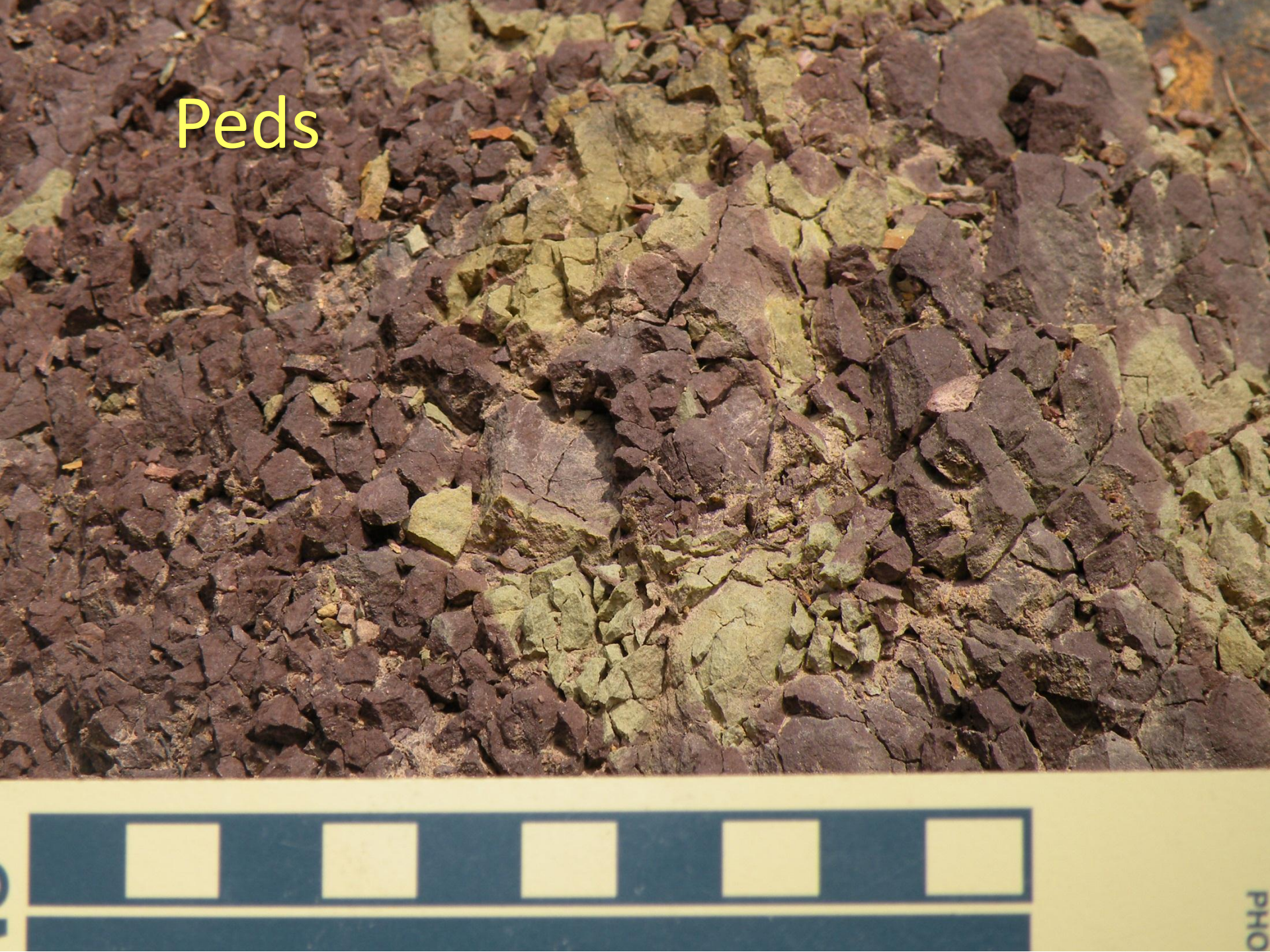

GSA
PHOTO SCALE/FOCUS
THE GEOLOGICAL SOCIETY OF AMERICA
1888
void incorrect exposures by taking meter readings before
scale in picture area. Fine-focus on GSA seal.


Root Traces
xposures by taking meter readings before
picture area. Fine-focus on GSA seal.

Burrows

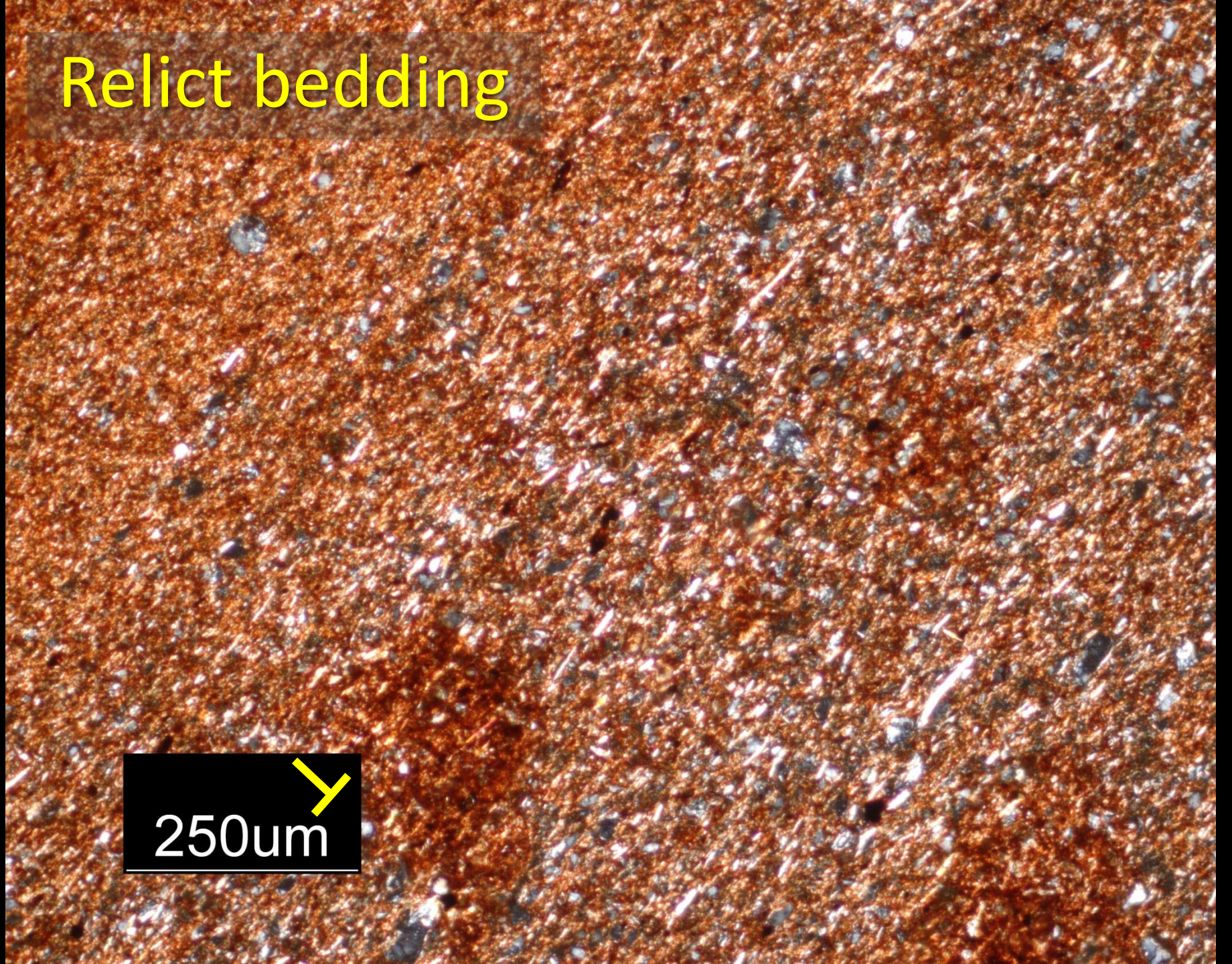
incorrect exposures by taking meter readings before
scale in picture area. Fine-focus on GSA seal.


Silt wedge
Slicks

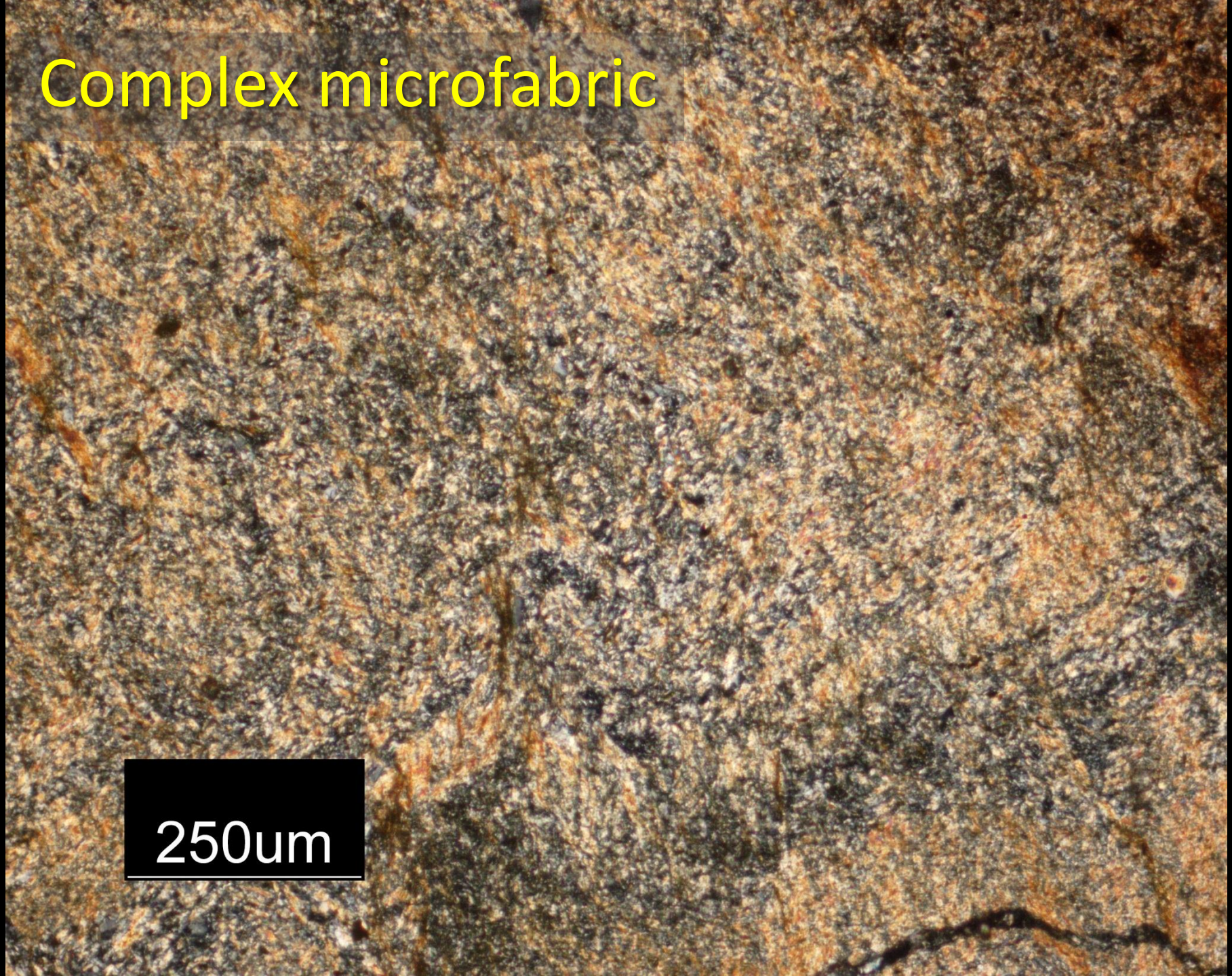

Peds


Curvilinear
fractures

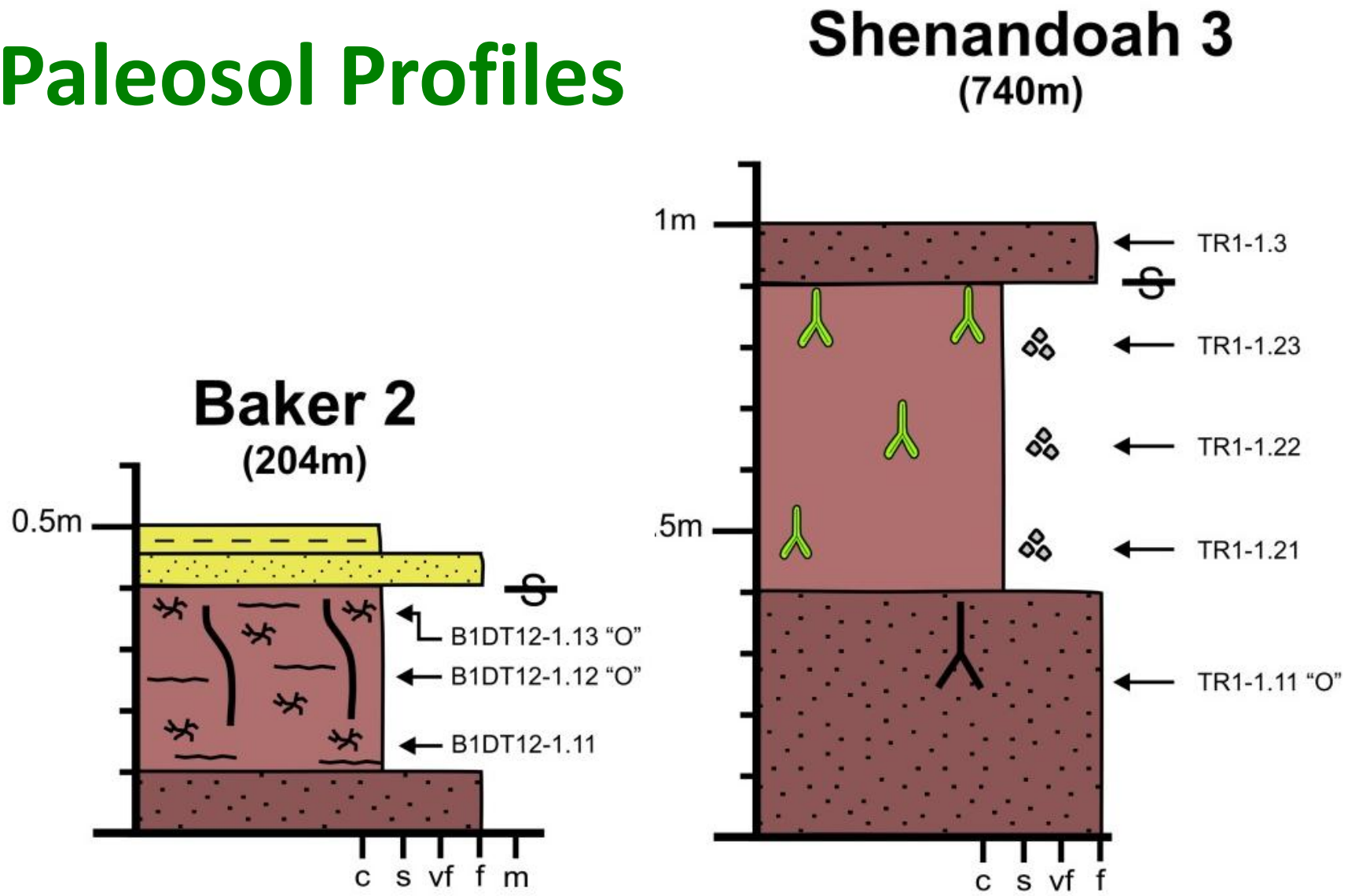

Weakly developed


Relict bedding
250um

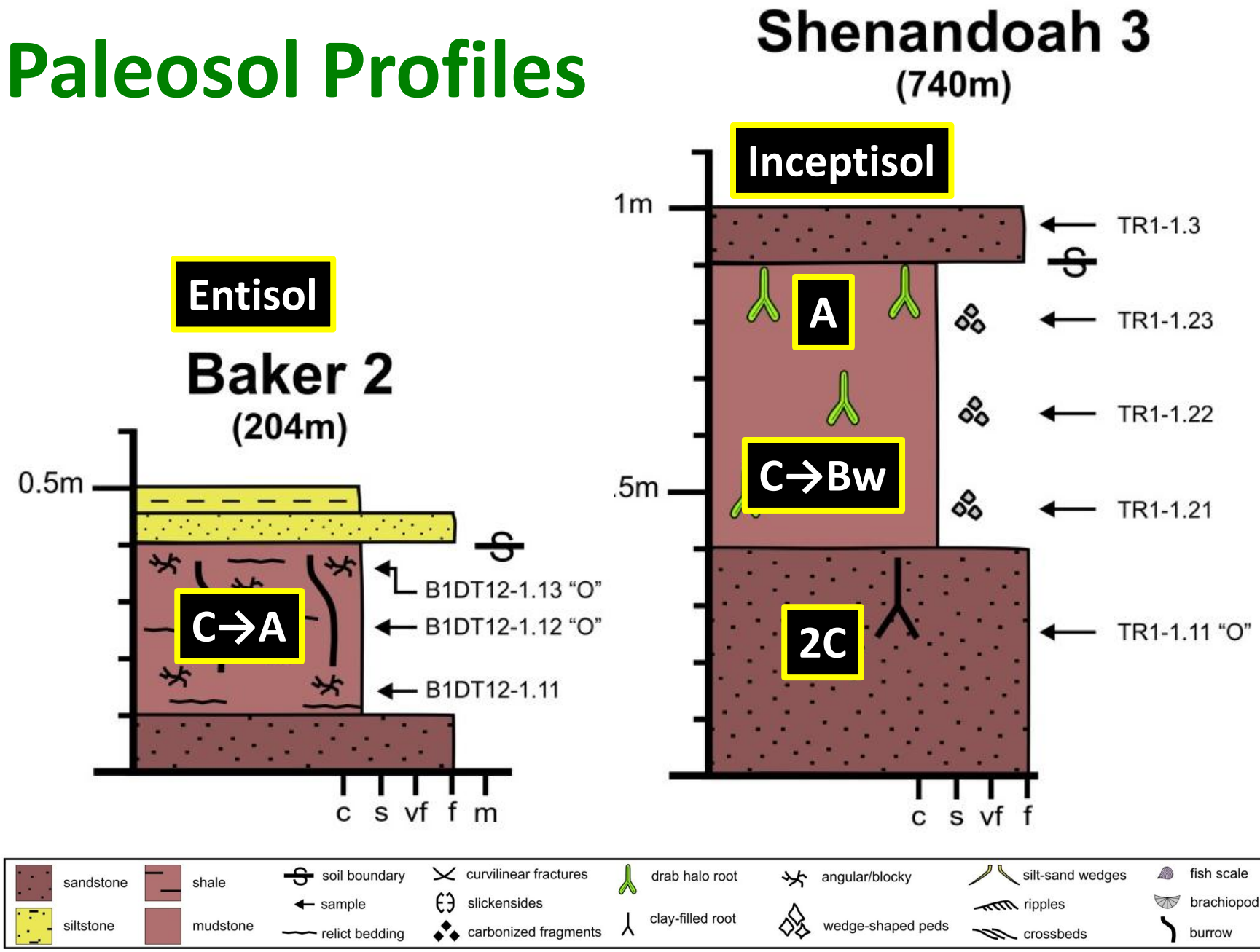

Strongly developed


Complex microfabric
250um

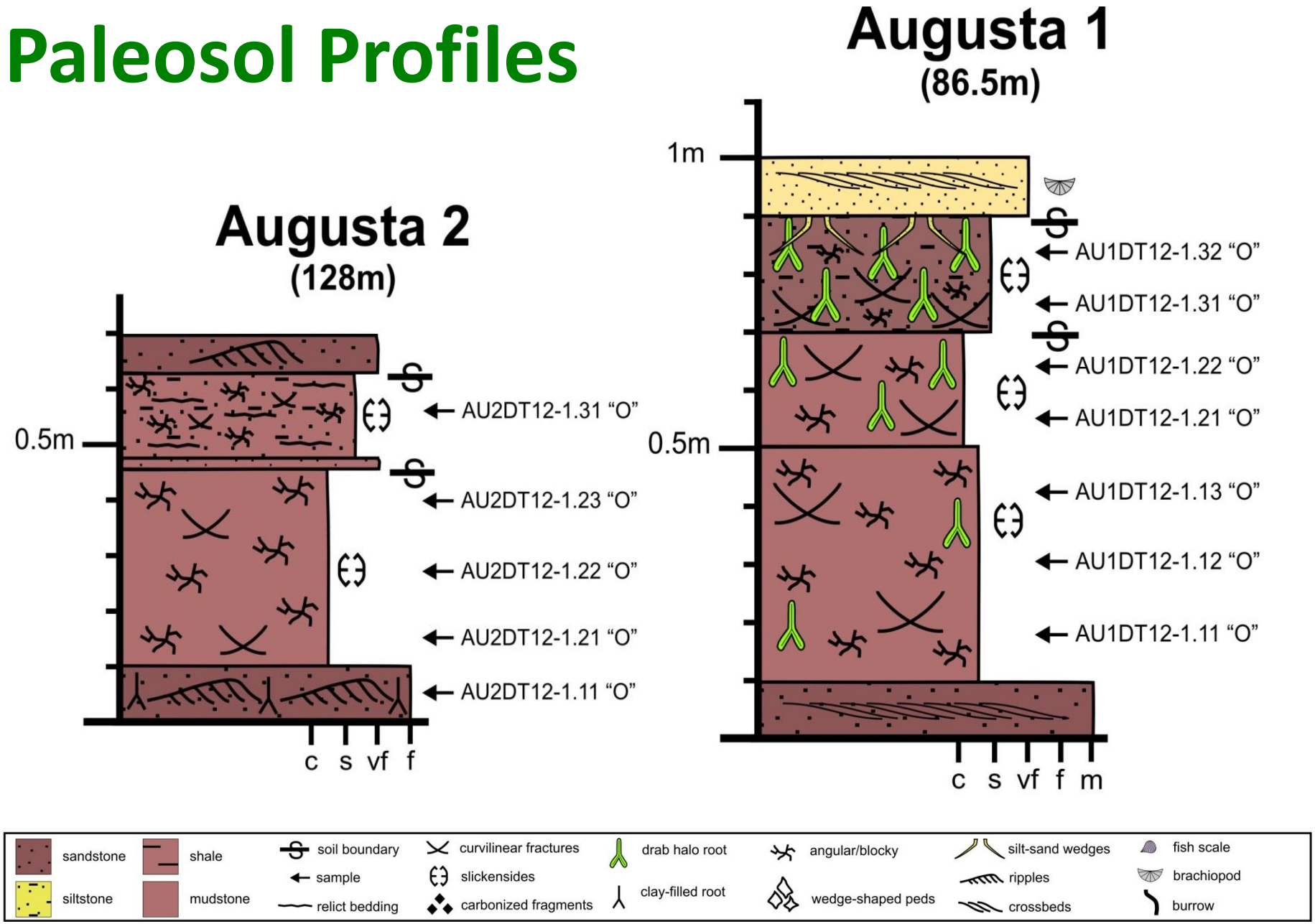
Paleosol Profiles



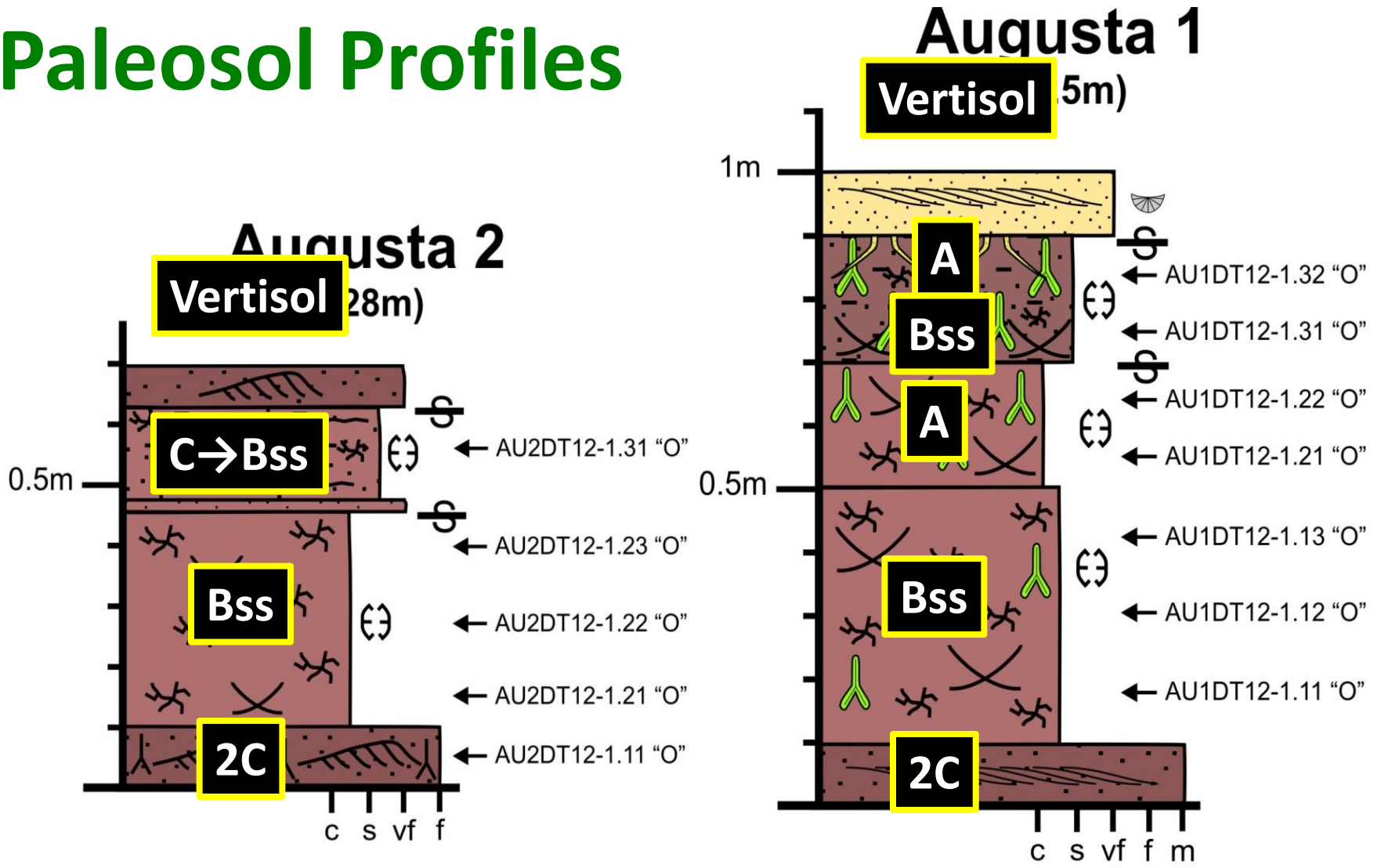
Paleosol Profiles



Paleosol Profiles



Paleosol Profiles



GENERAL FOREKNOBS MODEL

4th order Sequence Boundary w/ more mature pedogenic alteration of fluvial strata: congl. sharp-based shorefaces or congl. braided alluvial down paleoslope, sequences >10's meters thick

5th order Parasequences:
- **Distal: more gradational DIR to PIR/Shoreface**
- **Proximal: DIR to fluvial separated by subaerial unconformities**
- **Very weak pedogenesis, if any**
- **Parasequences typically <10 m thick**

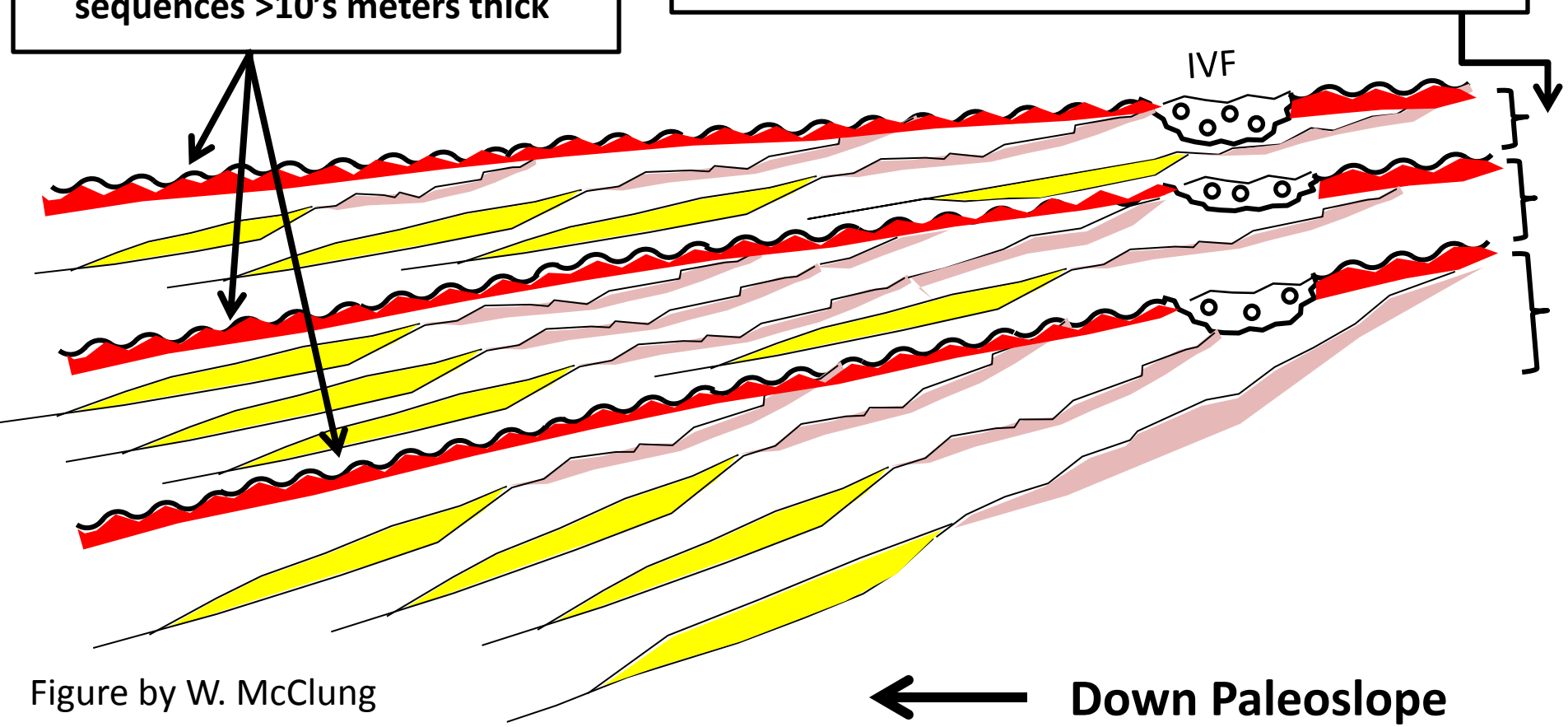


Figure by W. McClung

Down Paleoslope

Generalized Depositional Model of Foreknobs Fm.

- Progradation of highstand parasequence sets (5th-order parasequences) interrupted by 4th-order lowstand sequence boundaries

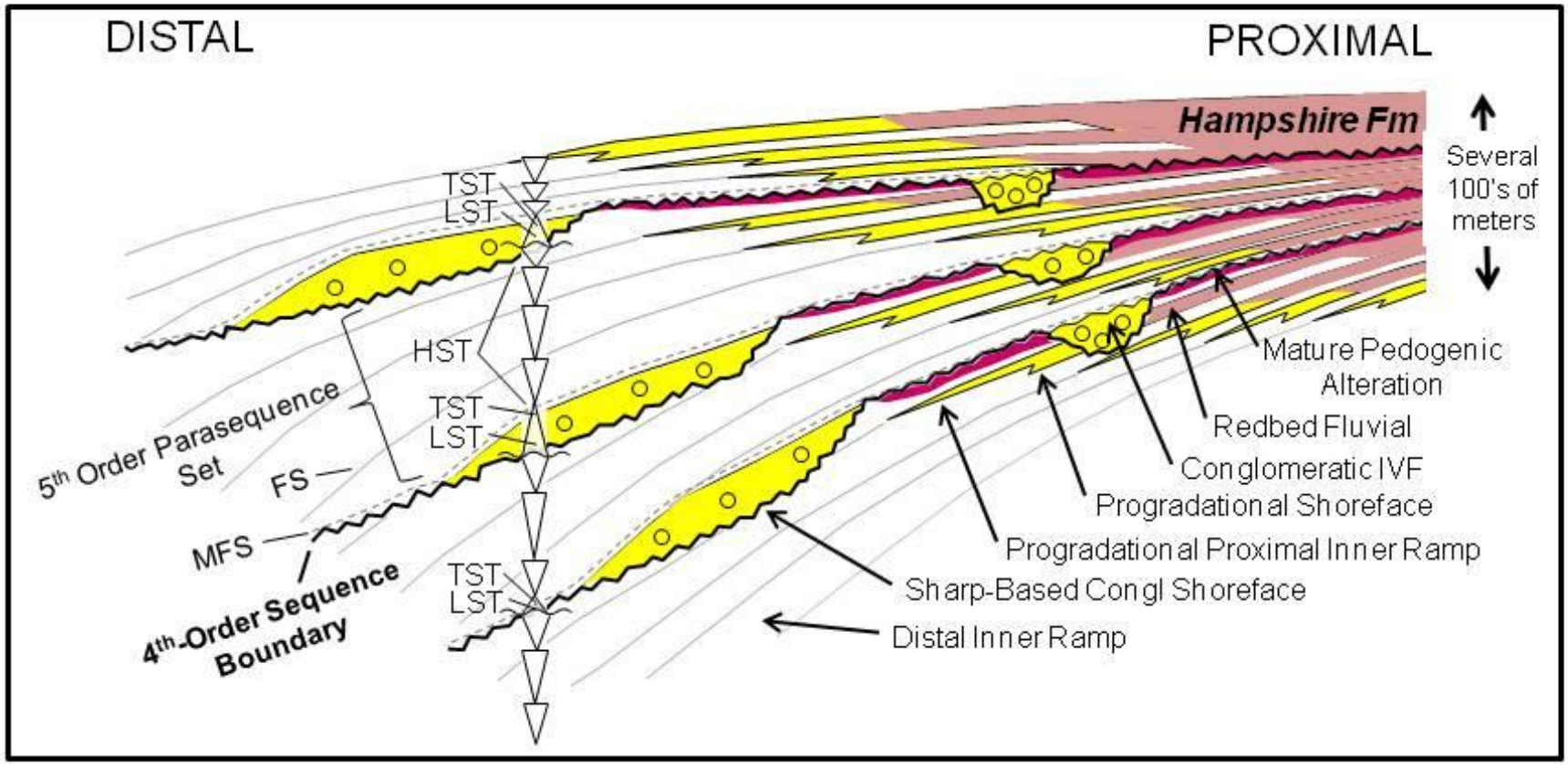


Figure by W. McClung

Who cares?

- Rise of vascular plants and Devonian ecosystem evolution.
- Subsequent effects of landscape stability on nonmarine facies architecture.
- Modification of the regional Devonian carbon cycle from source to sink.
- Linkage of marine and nonmarine sequence architecture.

Future work

- Additional fieldwork to describe paleosols over a broader region.
- Micromorphology.
- Geochemistry for developmental stage.
- Compare paleosols of transitional Foreknobs and overlying nonmarine Hampshire Formation.
- Decipher the paleopedological response to….

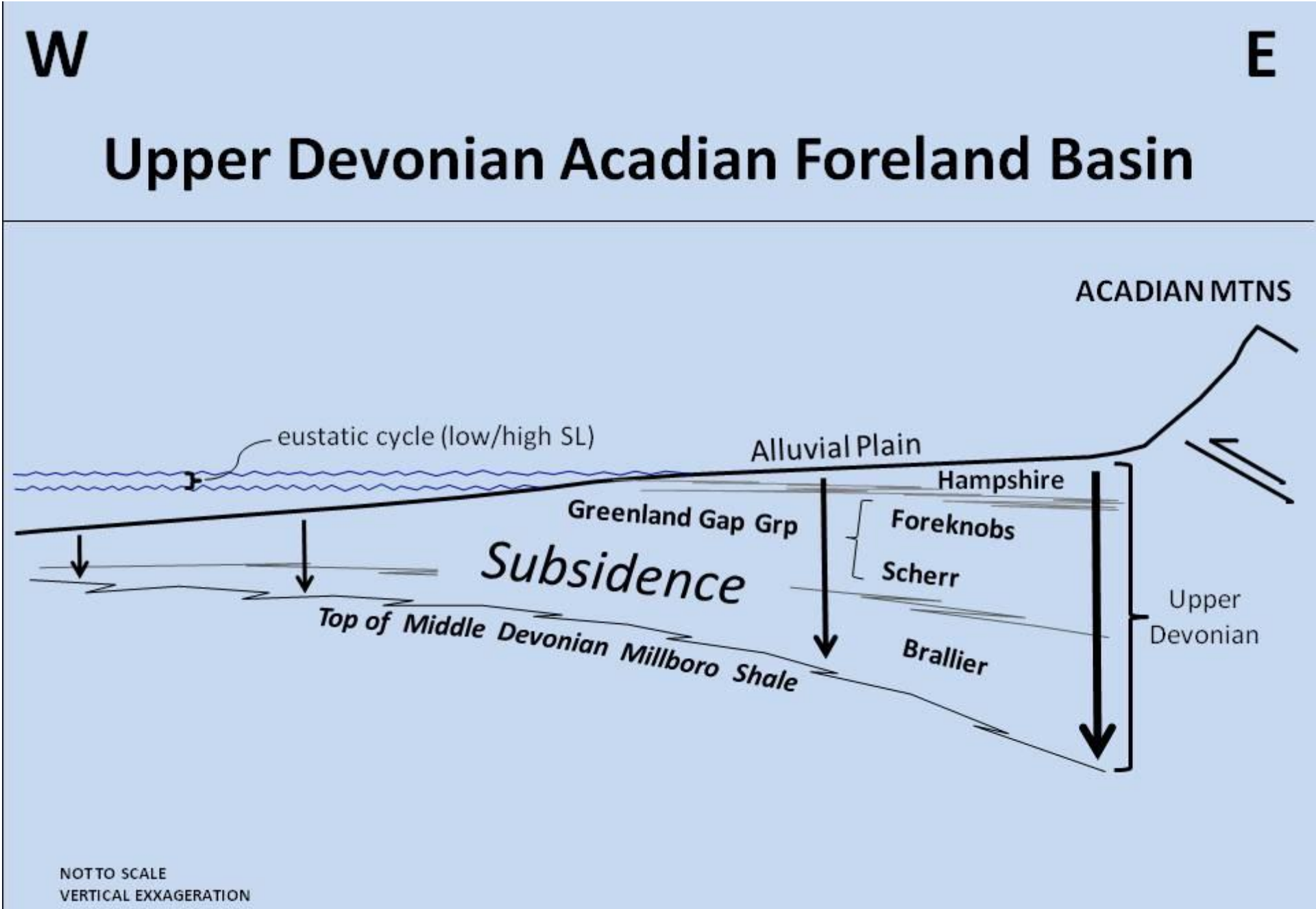


Figure by W. McClung

Conclusions

- Paleosols are preserved at the top of individual shoaling upward sequences.
- Paleosols include entisols, inceptisols, and vertisols.
- Degree of pedogenic development appears to be related to sequence architecture.