

Redox Reactions and Describing Redox Features

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Learning Objectives

- Explain the definition of hydric soils
- Recall the basic redox reactions
- Inspect and describe redox features

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A wetland with hydrophytic vegetation in the soil, floating aquatic vegetation, and open water.



Definition of Hydric Soil

A **hydric soil** is a soil that (1) *formed under conditions of saturation, flooding or ponding* (2) *long enough during the growing season* to develop (3) *anaerobic conditions* in the (4) *upper part*.

1. Formed under
2. Long enough, growing season
3. Anaerobic
4. Upper part

Redox - Defined

- **Redox** is short for **re**duction and **ox**idation.
- **Redoximorphic features** are characteristics that form as a result of redox reactions and soil solution movement.

Blue colors surrounded by orange indicate that redox reactions and Fe migration have taken place.



Basic Redox Reactions

- Redox reactions involve the transfer of electrons between two atoms.
- Reduction occurs as atoms gain electrons (charge gets more negative). Simultaneously, oxidation occurs as atoms lose electrons (charge gets more positive).
- Reduction is mostly microbial driven (less so in systems with sulfides or sulfates present)
- e^- are generated during metabolism of sugar and carbohydrates

Reduction

- Elements have varying affinity for the e^- (redox potential).
- Gas oxygen is reduced first, and if not replenished, the soil solution becomes anaerobic.
- Elements that produce characteristic features are reduced in the preference of: O, N + Mn, Fe, S, C
- Mn and Fe lose color and become soluble when reduced. They can move within the soil solution. If most of the Mn and Fe leave a zone in the soil, it becomes depleted of those elements, and the zone is said to be a *depletion*.
- N, S, and C produce a gas.

Oxidation

- Oxidation of a reduced element does not require microbes. Weathering and chemical oxidation also occur.
- As gas oxygen or nitrates or sulfates are introduced into the soil solution, the redox potential rises.
 - A soil is aerobic when oxygen is able to remain in gas form. This happens when the redox potential rises high enough.
 - Elements reoxidize in reverse order to their reduction sequence.
 - As they reoxidize, Mn and Fe precipitate as crystalline oxides and oxyhydroxides, each with characteristic colors.
 - Relocated accumulations of Mn and Fe are known as *concretions*. If process continues, cementation may occur.

Redox Features



Redox depletions in an oxidized matrix



Redox concentrations of Fe in a reduced matrix

Features

- Zones or surfaces of reduction, possibly depletion of Mn and Fe
- Zones of reduction, possibly depletion of clay
- Concentration of Mn and Fe oxides and oxyhydroxides
 - On surfaces
 - In pores or channels
 - Masses in ped interiors
 - Cemented forms

Depletion Zones



On ped surfaces and in soil mass



Depleted Aggregate Surfaces



Depletions in Pores



Depletion Zone in a Sandy Soil



Clay Depletions

Also called "albans" (alba means white)

Mn and Fe inside of silicate clays are reduced and if removed from the clay minerals, result in destruction of the mineral structure.

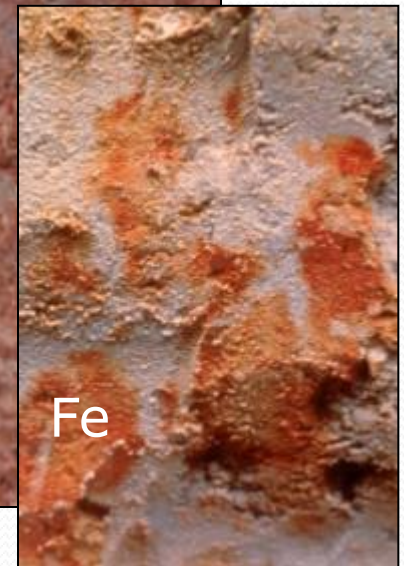
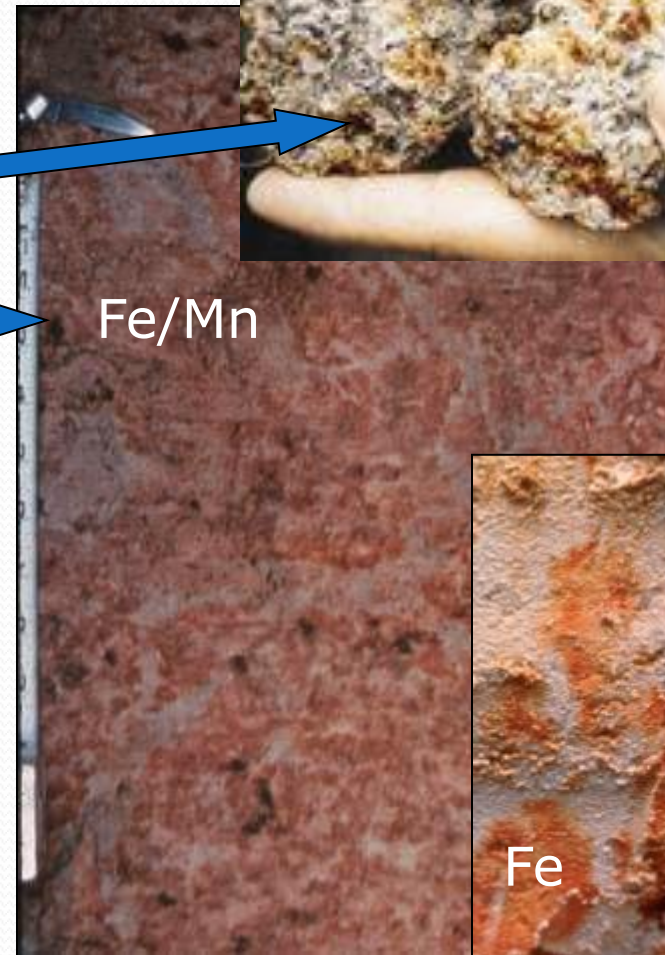
If there is removal of the weathering by-products, the clays break apart and the by-products are translocated.



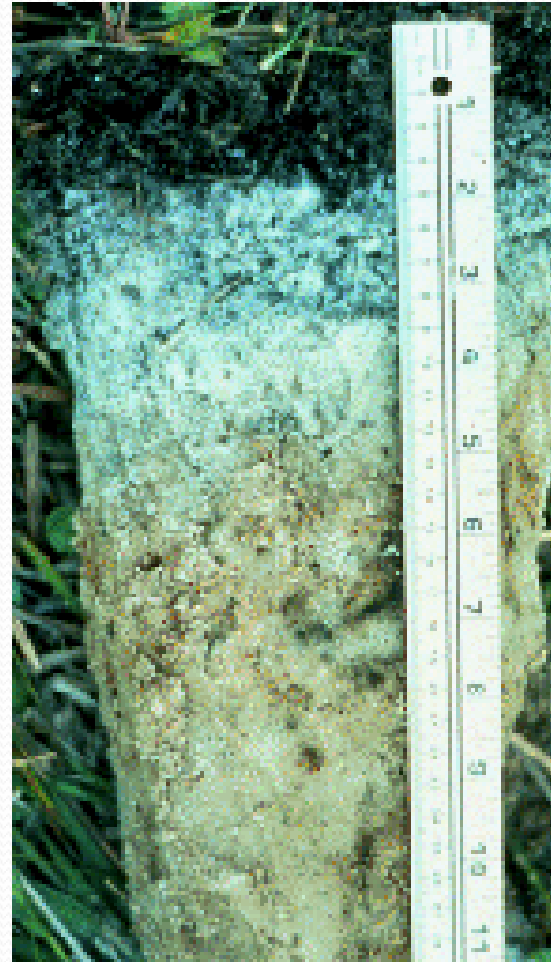
Plate 16. Horizontal section through a fragipan in Zanesville soil.

Soft Masses – Loamy Soil

- Variable in shape and color.
- Darker colors indicate increased higher Mn concentration.
- Adjacent to and higher chroma than the depletions.
- Fe is a higher chroma than the unmodified soil matrix.



Soft Masses in Sandy Soils



Pore Lining and Masses Around Pore or Root Channel



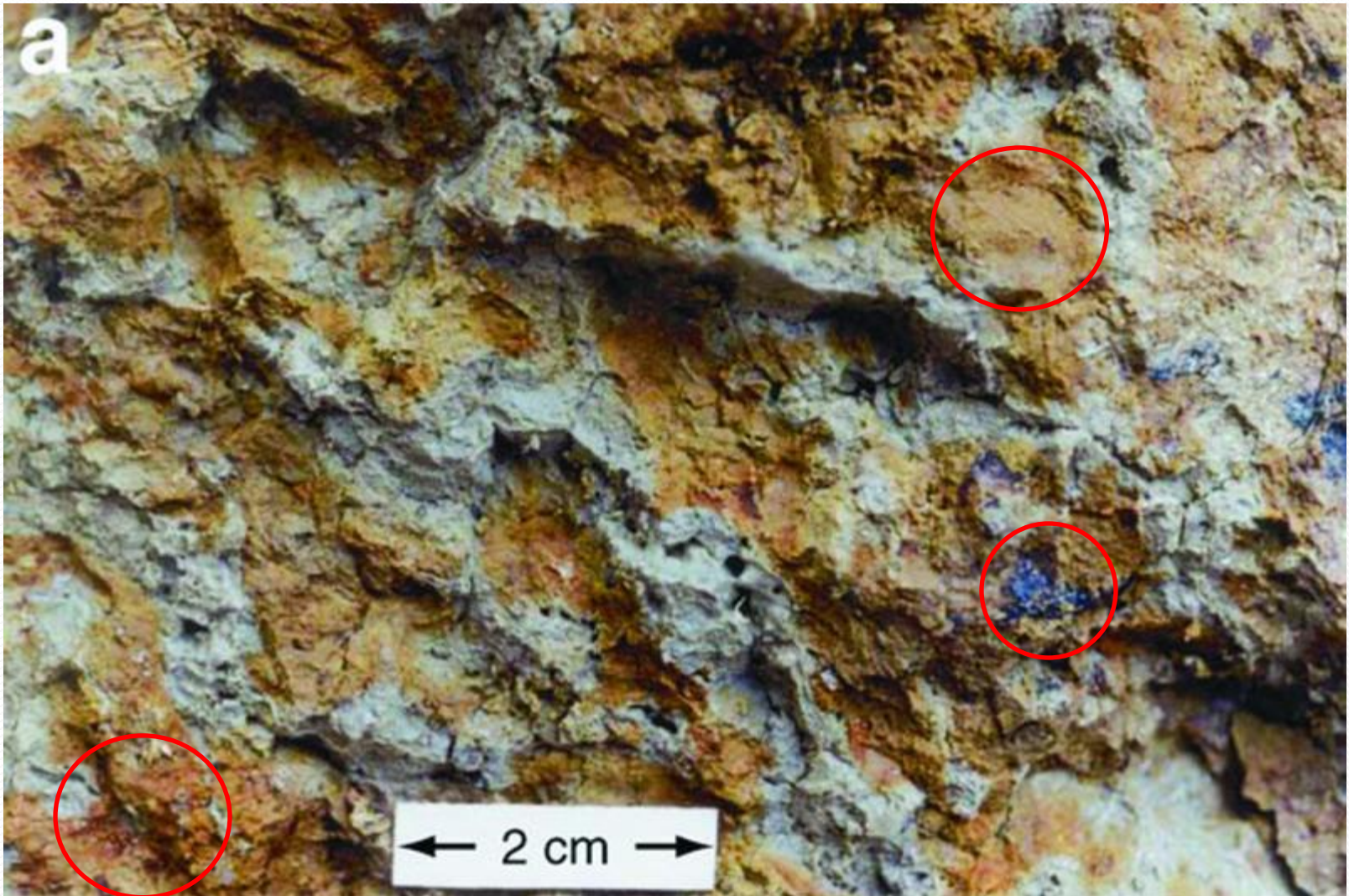
Redox Concentrations in Root Channels

Precipitated Fe
lines the root
channel.

Some extend into
the soil matrix.



Redox Concentrations on Ped Surfaces – Fe and Fe/Mn



Nodules and Concretions

- Nodules and concretions are cemented by high concentrations of Fe/Mn oxides and oxyhydroxides.
- May not be forming in today's soil climate.



Description of Features

- Type – depletion or concentration
- Location in horizon
- Color
- Size – f, m, c
- Contrast – f, d, p



Questions?

