Hydric Soil Morphology
Part 2 of 2

Ch. 7 – Richardson & Vepraskas

Outline:

1. Formation of Redoximorphic Features
2. Interpretation of Morphological Features of Hydric Soils

1. Formation of Redoximorphic Features

A. Factors Affecting the Development of Redoximorphic Features

B. Depletions

C. Concentrations

D. Specific Processes of Feature Formation
   1. Reduction/Removal of Coatings on Grains
   2. Addition of Coatings on Grains
   3. Oxidation of Coatings on Grains

1.A.1. Fate of Reduced Elements

Oxidized → Reduced Reaction			Fate in Reduced State
O_2	→	H_2O	Added to soil solution
NO_3^-	→	N_2O, N_2, NH_4^+	Converted to a gas or a ion (uptake)
Mn^{+4}	→	Mn^{+2}	Stays in-situ or moves in soil solution and precipitate as visible oxides when encounters O_2
Fe^{+3}	→	Fe^{+2}	
SO_4^{-2}	→	H_2S	Converted to a gas
CO_2	→	CH_4	Converted to a gas

1.A.2. Site Factors Affecting Development of Redox Features 1

- The amount of time needed to form redox depletions under saturated conditions is variable, increasing with temperature and readily-available OC content. See Table 7.2
- Redox depletions were found to increase dramatically in less than 3 years in created wetlands that were saturated 30% or more of the time during the year. See Table 7.3
- In created floodplains, the hue and amount of depletions were found to fluctuate annually depending on number, frequency, and duration of flooding. See Table 7.4

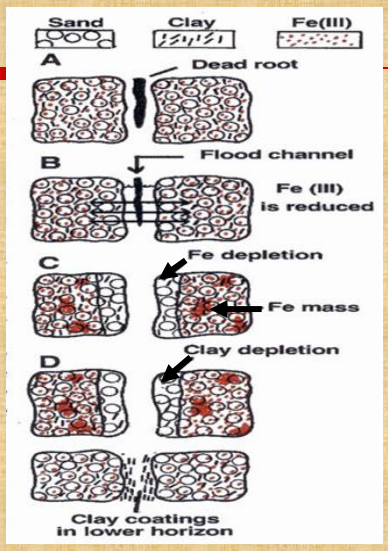
1.A.2. Site Factors Affecting Development of Redox Features 2

- The percent depletions at 30, 60, and 90 cm depth were expected to increase as the number of 3-week long or longer saturation events occurred. The increase was projected to be higher at the 30-cm depth, probably because of the higher OC content. See Figure 7.4
- Ditching does not affect the saturation of soils at > 60 m distance but does decrease the amount of reduction and increases the amount of redox concentrations formed between 30 and 60 m away. See Table 7.5

1.B. Redox Depletions

(Fig. 8) Vepraskas, 1994

A. A dead root provides an easily digestible OC supply.
B. After saturation between aggregates, the microbes reduce the N, Mn, and Fe in the anaerobic water, which is pulled into the aggregate interior.
C. The Mn/Fe were soluble and went with the soil solution. The O_2 inside aggregate pores caused oxidation and precipitation of Mn and Fe.
D. In subsequent events, Mn and Fe from inside the clay minerals is reduced and the clay breaks apart. Clay minerals components reform in lower layers as they oxidize and precipitate.



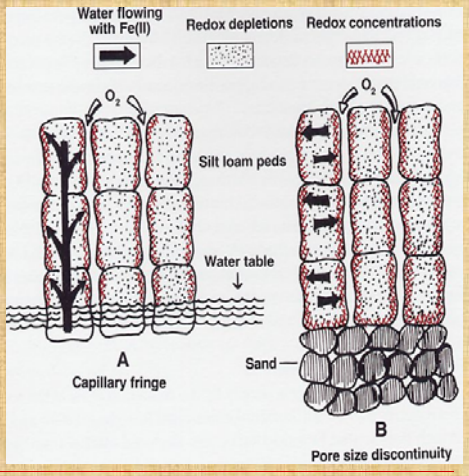
Depletions, Surrounded by Concentrations (gray next to dead roots)

1.C. Redox Concentrations

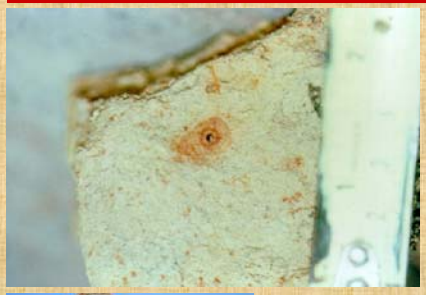
(Fig. 9) Vepraskas, 1994

A. Water with reduced Mn/Fe in it rises in the capillary fringe, and oxidizes on aggregate edges when exposed to atmospheric oxygen. The same could happen along empty pores or root channels.

B. Water with reduced Mn/Fe in it moves from a reduced aggregate interior to the edge, and oxidizes on aggregate edges when exposed to atmospheric oxygen. The same could happen along empty pores or root channels.



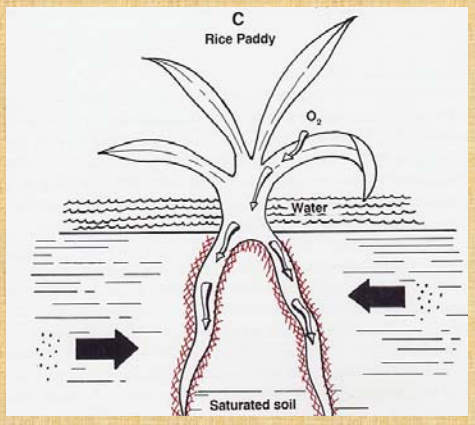
Concentrations Where O_2 Touches Reduced Soil (pores, ped surfaces, ped interiors)



1.C. Redox Concentrations

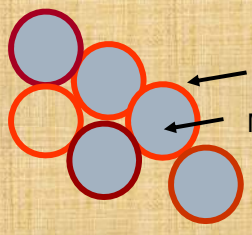
(Fig. 9) Vepraskas, 1994

C. Water with reduced Mn/Fe in it is pulled toward a rice plant, and oxidizes in the zone near the root where O_2 is pumped out by the plant to prevent hypoxia in stagnant water. (hypoxia prevents respiration). Mn and Fe oxidation occurs in the rhizosphere.



1.D.1. Reduction/Removal of Coatings on Grains 1

- In soil horizons, Fe and Mn oxide coatings on soil particles give soils their characteristic brown, orange, red, and yellow colors. Sand grains are typically colorless (or appear light gray). We will use them as examples to demonstrate the concepts of soil color patterns as related to redox reactions and hydric soil formation.



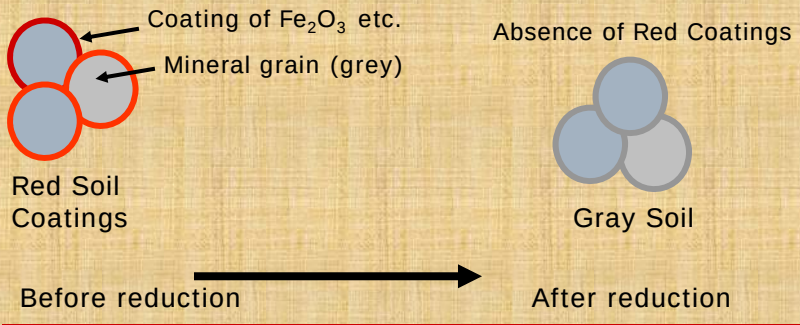
Coating of Fe_2O_3 (or other type of Fe mineral or clay)

Mineral sand grain (gray)

Reddish Soil

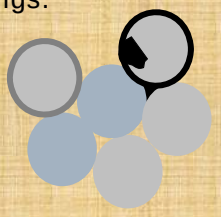
1.D.1. Reduction/Removal of Red Coatings on Grains 2

- When reduced, Fe and Mn compounds are soluble. They may or may not be translocated away from the soil particles with the soil solution.



1.D.1. Reduction/Removal of Red Coatings on Grains 3

- The reduction of coatings may disintegrate the Fe-oxides or silicate clays and leave some sand grains uncoated, especially if there is translocation of the byproducts within or out of the horizon. This process also disintegrates organic compound coatings.

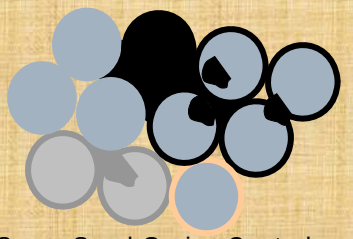


1.D.2. Addition of Coatings on Grains

- Soluble organic, Mn or Fe compounds may combine with oxygen and hydroxides during re-oxidation, forming new compounds that may precipitate on and between soil particles during oxidation.
- Not all uncoated sand grains become recoated and may appear as zones of clean grains.

Translocation or Synthesis
+ O_2 or CO_2

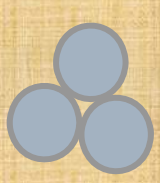
OM or clay
Mn-oxide or Fe-oxide
OC-Al or OC-Al-Fe



Uncoated Grey Sand → Some Sand Grains Coated, Masked, or Bridged

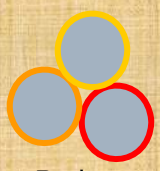
1.D.3. Oxidation of Coatings on Grains

- Exposure of reduced Fe or Mn-oxide coatings to O_2 or CO_2 results in instant re-oxidation.



Grey Soil

+ O_2 or CO_2

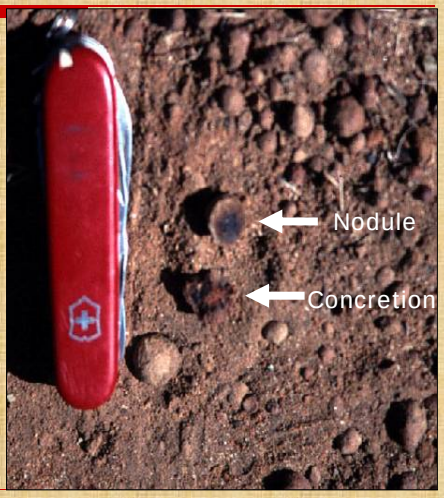


Redox concentration

2.A. Active Versus Inactive Features 1

Cemented concentrations

- Cemented redox concentrations have abrupt edges if not actively forming and can be extracted intact
- These are not actively forming if hardened to the edges with no soft material surrounding
- A light-colored rind means they are decomposing



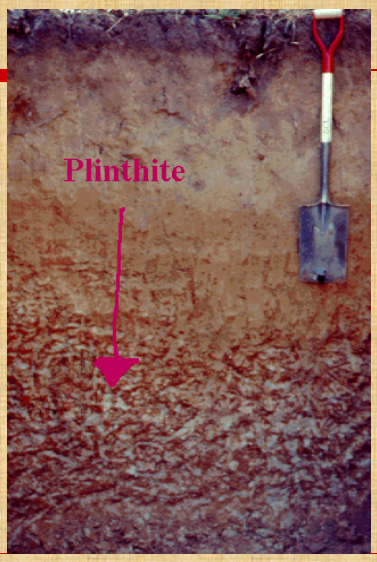
2.A. Active Versus Inactive Features 2

- If actively forming or dissolving, cemented redox concentrateions have diffuse boundary around them that looks like a “halo” or “corona”
- This concentration is cemented in the center but soft and uncemented on the outside edges, so it is still forming

2.A. Active Versus Inactive Features 3

Plinthite

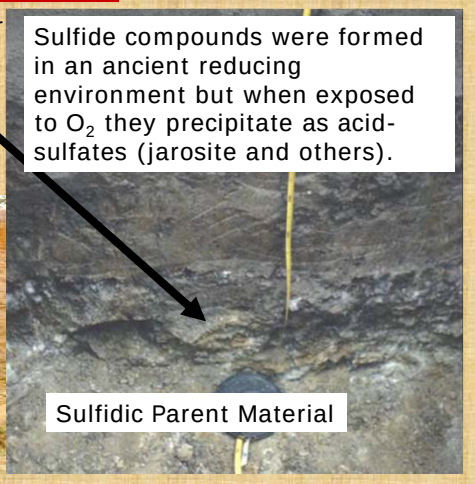
- Reticulated redox pattern.
- It is Fe-oxide cemented.
- Hardens after repeated wetting and drying.
- Forms in a hydric soils in subtropical or tropical climates.
- In Virginia, Plinthite formed in transported sediment above a water-restrictive contact in past climates.
- Plinthite is a precipitated and re-oxidized compound formed through redox reactions.



2.B. Lithochromic Colors and Mottles – Natural Result of Mineral Weathering

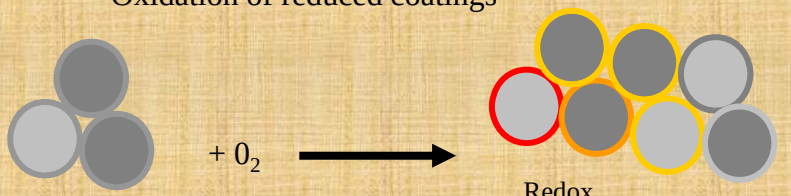
- Color patterns (may be any color from white to gray to black to red) inherited from minerals released from weathering of primary minerals.
- Below, colors from weathering of rock layers still evident.

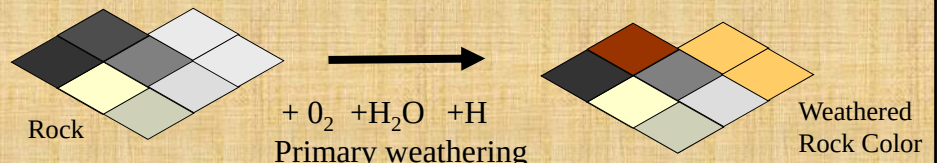
Sulfide compounds were formed in an ancient reducing environment but when exposed to O_2 they precipitate as acid-sulfates (jarosite and others).



2.B. Oxidative Color Change Processes

Oxidation of reduced coatings





2.C. Problem Hydric Soils

- There are problem soils that seem to have long-term saturation, become anaerobic and chemically reduced, but do not show the redox features expected. They will be explained in detail in Ch. 8 and in an accessory slideshow.
- These soils either require longer continuous saturation to become chemically reduced or have some soil or site property that prevents organic matter accumulation and development of redoximorphic features.

2.D. Altered Hydric Soils

- Hydrologic modification may result in:
  1. Artificial Hydric Soils
  2. Drained (Protected) Hydric Soils.
- Soil modification may result in:
  1. Artificial Hydric Soils
  2. Historic Hydric Soils
  3. Relict Hydric Soils

Some terms have been updated in recent Regional Supplements to the USA Corps of Engrs. Wetland Delineation Manual and USDA-NRCS http://www.usace.army.mil/cecw/pages/reg_supp.aspx

Altered Hydric Soils are explained in detail in Hydric Soil Technical Note 13 on the USDA-NRCS Hydric Soils web site (http://soils.usda.gov/use/hydric/).

ftp://ftp-fc.sc.egov.usda.gov/NSSC/Hydric_Soils/note13.pdf