Morphological and Hydrological Correlations of Mafic Landscapes in the Piedmont of Georgia

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Introduction

Extended seasonal saturation results in the reduction of Fe and Mn found in high concentrations in mafic derived soils, causing development of redoximorphic features within a soil profile. The three common types of redoximorphic features studied in the soil are redox concentrations (accumulations of Fe/Mn), redox depletions (zones of low chroma (≤2) where Fe/Mn have been removed), and reduced matrices (horizon matrices that have low chroma (≤2) in situ, but undergo changes in hue or chroma when exposed to air). Of these types, redox concentrations and depletions are of particular interest at our site.

Redox potential is a commonly used method in the quantification of seasonal saturation. The assessment of soil redox potential is particularly useful for characterizing the onset of reducing conditions in a soil. A lag time between saturation of a horizon and the threshold redox potential for Fe and Mn reduction occurs because Fe and Mn reduction is a microbial mediated process.

Jenkinson and Franzmeier (2006) introduced Indicator of Reduction In Soil (IRIS) tubes as an alternative method of monitoring and quantifying the Fe reduction in soils.

At a site near Eatonton, Georgia, soils were developed in two parent materials. Lower horizons were formed in residuum from chlorite schist. Upper horizons were formed in loamy materials of unknown origin. Soils at site described as fine and fine-loamy, mixed, thermic, Typic Hapludalfs and Paleudalfs (Fig. 1A).

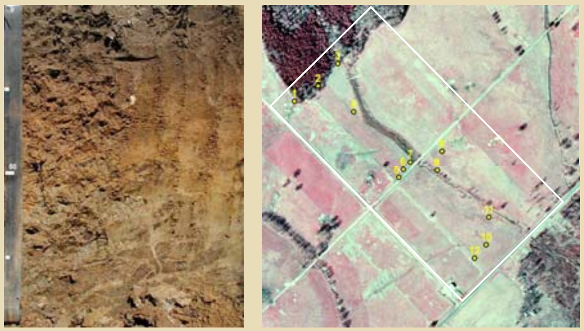

Fig. 1. A) Soil profile from site B) Site map showing sample locations.

Objective

1. Relate the frequency and duration of saturation and reduction to the type and abundance of redox features in mafic soils.

Materials and Methods

Research area: 40 ha pasture located at the Central Research and Education Center, Northeast Putnam County (Fig. 1B).

Undisturbed core samples taken by hydraulic probe at each site for soil description.

Redox electrodes installed at Sites 1, 4, 10, and 11 to measure onset of saturation (lag time).

IRIS tubes coated with ferrihydrite (FH) paint installed at Sites 1, 3, 4, 6, 7, 8, 10, 11, and 12 to relate Fe loss to number of saturation events (NSE) per horizon.

Seasonal water depths evaluated with piezometers read weekly (Fig. 2).

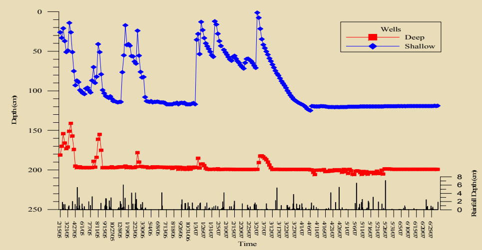

Fig. 2. Seasonal water depths for Site 1. Weekly readings taken until January 23, 2007, when auto loggers began daily readings.

Fig. 3. Percentage of FH loss from IRIS per horizon for each site. Loss from surface horizons could not accurately be analyzed; data here are not representative of Fe loss in the soil at these depths.

Results and Conclusions

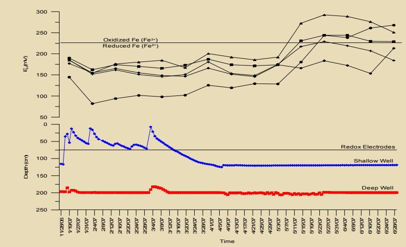

Fig. 4. Redox Potential (E_H) over time for Site 1. The horizon became saturated on December 25, 2006, and the initial E_H measurements indicated Fe was reduced.

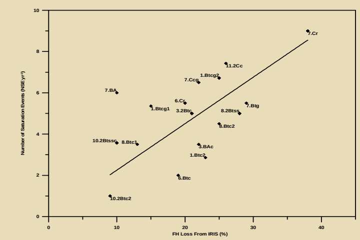

Fig. 5. Relationships between average NSEs and the percentage of FH loss from IRIS tubes per horizons. Data plotted for horizons >30 cm and NSE ≠ 0.

Table 1. Mean percentage time of saturation and number of saturation events for horizons with various redoximorphic features.

Redoximorphic Feature	Number of Horizons	Time Saturated Mean	Time Saturated Range	Number of Saturation Events Mean	Number of Saturation Events Range
		%	%	NSE yr^{-1}	NSE yr^{-1}
None	28	4	0 - 37	1.8	0 - 14.1
Redox concentrations	20	11	0 - 36	3.9	0 - 10.5
Redox depletions	7	10	0 - 33	7.6	1 - 14.3
Low chroma (≤2) matrix	15	58	25 - 100	24	11.5 - 40.1

1. Water is perching on residual parent material and moving downslope (Fig. 2).

2. Lag time for site was measured as 14 days (Fig. 4). NSE calculations based on 14 day saturation periods.

3. The data for the subhorizons with saturation events (NSE ≠ 0) show that linear relationships between NSE and % FH loss from IRIS tubes are justified, r^2 = 0.90 (Fig. 5) .

4. For soils on this site, occurrence of various types of redox features was associated with different times of saturation and NSE (Table 1).