HYDROMORPHOLOGY AND PLINTHITE CHARACTERIZATION OF SOME

ALABAMA COASTAL PLAIN SOILS

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HYDROMORPHOLOGY AND PLINTHITE CHARACTERIZATION OF SOME ALABAMA COASTAL PLAIN SOILS

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Date of Graduation

VITA

Richard Carter Smith, husband of Katherine Lipscomb Smith, father of Olivia Ellis Smith, Andrea Katherine Smith and Scott Henry Smith, son of Charles Holman Smith and Nancy Noble Smith, brother of Charles Holman Smith, Jr., was born on October 1, 1965 in Massena, New York. He attended Santa Fe High School in Santa Fe, New Mexico, and graduated in May 1984. He entered University of New Mexico in Albuquerque, New Mexico in August 1984, and graduated with a Bachelor of Arts degree in Psychology in May 1989. From November of 1995 to April of 2004 he worked as a Public Health Environmentalist with the Lee County Health Department. In 2000 he was the recipient of the Ansel C. Mullins award presented by the Alabama Environmental Health Association. Upon inspiration from his mentors, David Gray, William H. Niemeyer, and Lynn Scott, at the Alabama Department of Public Health, he entered Auburn University in Auburn, Alabama in September 1999, and graduated with a Bachelor of Science degree in Agronomy and Soils in May 2005. In May 2005 he entered the Auburn University Graduate School and began working toward a Master of Science degree in Agronomy and Soils.

THESIS ABSTRACT

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Estimating seasonal high water tables (SHWTs) within soils by the evaluation of redoximorphic features is critical for soil interpretations. Certain redoximorphic features indicate contemporary moisture regimes, while others indicate past moisture regimes (relict). Alabama Coastal Plain soils present challenges in identifying contemporary seasonal saturation due to low carbon and oxide content, perched water tables rich in dissolved oxygen, and the presence of plinthite. The role plinthite plays in identifying contemporary seasonal saturation is unclear, and characterization of its occurrence and properties will provide knowledge as to its role in contemporary hydromorphology assessment. This study, jointly conducted between the Natural Resources Conservation Service (NRCS) and the Alabama Agricultural Experiment Station (AAES), monitored the depth and duration of SHWTs (2004 – 2006) of some Alabama Coastal Plain (CP) soils to develop relationships between SHWT metrics and hydromorphic features. Twenty piezometers were installed in eleven CP pedons (Paleudults and Kandiudults, most with plinthite and sandy epipedons of varying thickness) at various depths. Water table data were recorded every six hours and daily rainfall was obtained from proximate weather stations. Soils were described, sampled, characterized and classified according to standard techniques. Plinthite was separated and quantified using a slaking technique. Characterization of plinthite versus whole soil properties was also conducted.

Plinthite contained 31% more carbon, 4% more clay, 259% more DCB extractable Fe (Fe_d), and 1280% more AOX extractable Fe (Fe_o) than the corresponding whole soil. Active Fe increased with saturation, providing evidence of contemporary Fe reduction in these soils.

Rainfall patterns were inconsistent during the study period, and only water table data within years of *normal* rainfall (as per Soil Taxonomy) were evaluated. Perched water tables were not consistently associated with any pedogenic feature. Horizons containing soft iron (Fe) accumulations were saturated for 11% of the monitoring period, horizons containing plinthite were saturated 20% of the monitoring period, horizons containing chroma ≤ 2 Fe depletions were saturated 25% of the monitoring period, and depleted horizons were saturated 56% of the monitoring period. The presence of plinthite in these soils occurred over a wide range of saturation durations (1 to 47% of the monitoring period). Eight of the eleven sites had water tables consistent with their field drainage class assessment.

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I. LITERATURE REVIEW

Introduction

Soils are the foundations for all living things to grow from, live on, and live within. Soils convey and are a reservoir for plant nutrients, biological activity, growth, and inhabitation as well as the retention of a very crucial component needed for all to survive, water (Foth, H.D. 1990). A soil's ability to accept, filter and retain water and provide available water is dependant upon pedogenic properties. Pedogenic properties are unique and affect specific land use applications such as crop production, waste disposal, foundation and road construction, and wildlife and wetland ecology. Protection of ground and surface waters is also dependant upon the filtering capabilities and physical characteristics of the soil. Soil use for most applications is counter productive without a thorough site and soil evaluation.

Many studies evaluating seasonal high water tables (SHWT) and cyclical redox processes provide a baseline of information to expand upon (Calmon et al., 1998; Genthner et al., 1998; Greenburg and Wilding, 1998; Griffin et al., 1998; Hobson and Dahlgren, 1998; Lindbo et al., 1998; Tangren et al., 1998; West et al., 1998; Jacobs et al., 2002; Reuter and Bell, 2003). Vepraskas (1996) provided guidelines to describe and understand soil hydromorphology and the redoximorphic features created by soil saturation. Uncertainty as to which features represent contemporary hydrology or are indicators of relict or false indicators of soil saturation still exist (Greenburg and

Wilding, 1998). Some redoximorphic features are indicators of past soil moisture regimes, while others represent current, contemporary conditions (Vepraskas and Wilding, 1983; Fanning and Fanning, 1989; Fanning et al., 1992; Vepraskas and Guertal, 1992; Vepraskas, 1996; Griffin et al., 1998). The relationship between soil saturation, SHWT, and redoximorphic features is of great importance in the assessment of sites for building development, road construction and on-site sewage disposal. Long term monitoring of water tables is expensive and warrants studies that correlate SHWT to identifiable features within the soil profile (Genthner et al., 1998).

Duration of saturated conditions needed to create redoximorphic features varies among landscape positions, soils, and climates. The Southern Coastal Plain encompasses the majority of the Major Land Resource Area 133 as outlined by the Natural Resources and Conservation Service (NRCS). In efforts to understand soil saturation and associated hydromorphological features within soils of this region, the National Cooperative Soil Survey (NCSS) initiated an extensive regional soil water table study. The NCSS is an undertaking between the NRCS and the Agricultural Experiment Stations. In Alabama, this study began in December of 2003 with twenty-two piezometers installed within nine different soil series of thirteen pedons spanning five different counties.

Sandy soils make up a great portion of the soils within this region and present challenges in the characterization of soil wetness features (Vepraskas and Wilding, 1983; Mokma and Sprecher, 1994; and Veneman et al., 1998). Water tables fluctuate for brief durations above and below redoximorphic features. Although saturation occurs for adequate periods to develop reducing conditions, the lack of redoximorphic feature formation occurs due to the absence of one or more of the necessary components of the biochemical redox processes (Vepraskas and Wilding, 1983; Genthner et al., 1998; Szögi and Hudnall, 1998). The presence of relict redoximorphic features (related to past hydrology) can mislead identification of contemporary soil hydrology (Vepraskas and Wilding, 1983; Fanning and Fanning, 1989; Fanning et al., 1992; Griffin et al., 1992; Vepraskas and Guertal, 1992; Vepraskas, 1996; Greenberg and Wilding, 1998; Griffin et al., 1998). In addition, terrain attributes related to landscape hydrological processes significantly affect soil hydrology and redox feature formation (Daniels et al., 1971; Galusky et al., 1998; Reuter and Bell, 2003).

Iron and manganese oxidation and reduction within soils during fluctuating periods of saturation have been described in many studies (Vepraskas, 1996; Calmon et al., 1998; Genthner et al., 1998; Galusky et al., 1998; Greenberg and Wilding, 1998; Griffin et al., 1998; Hobson and Dahlgren, 1998; Lindbo et al., 1998; Lynn and Austin, 1998; Stolt et al., 1998; Szögi and Hudnall, 1998; Tangren et al., 1998; Veneman et al., 1998; West et al., 1998; Scheinost and Schwertmann, 1999; Rabenhorst and Parikh, 2000; Shaw, 2001; Jacobs et al., 2002; and Shaw and West, 2002) . The acquisition of water table data coupled with descriptions of redoximorphic features present within these sandy soils of the Southeastern U.S Coastal Plain will aid in the understanding of the formation of hydromorphic features, conditions that favor their development, and the potential to differentiate contemporary from relict features.

Alabama Coastal Plain Soils

Geology

The Coastal Plain region of Alabama is diverse and dissected with recent fluvial deposits overlying fluvio-marine sediments that span the Cretaceous to Quaternary periods. The pedons within this study reside on seven different formations of the Tertiary and Quaternary periods. The Grossarenic Kandiudults in the northern portion of Crenshaw County lie over the transition of the Clayton and Porters Creek formations (Eocene). The Clayton formation consists of white limestone and micaceous sands where loose quartz sands are prominent. The Porters Creek formation, also known as the Sucarnoochee Clay, consists of dark clay and is calcareous. The Grossarenic Paleudult, in the middle portion of Crenshaw County, lies over the transition of the Porters Creek Formation and Alluvial Terrace Deposits. The Aquic Paleudult in Crenshaw County lies within the Nanafalia formation. The Nanafalia consists of alternating sands with bands of glauconitic sands. Both of the pedons in southern Crenshaw County lie on a transition line between High Terrace Deposits and the Tuscahoma Sand formation of the Wilcox Group (Eocene). The Tuscahoma Sand formation contains indurated sands, ferruginous nodules and laminated sheets of clay. In the northern portion of Washington County, the two Coarse-loamy soils within Plinthic and Plinthaquic subgroups lie over the undifferentiated Miocene Series. Younger deposits often overly this formation. Similar soils in our study found within Washington County are also found within Escambia County overlying the Citronelle formation (Pliocene). The Plinthic Paleudult in Baldwin County also lies within the Citronelle formation (Pliocene), which is comprised of thin veneers of cross-bedded sands with lenses of clay (Adams et al., 1926).

Soil Classification

The sites selected within this regional study typify the Alabama Coastal Plain. All of these soils have sandy ochric epipedons, which normally possess moderate to high infiltration rates. These soils all have either argillic or kandic subsurface diagnostic horizons that can initiate perched soil water tables of variable duration. The eleven sites for this study were initially classified as a Blanton (Loamy, siliceous, semiactive, thermic Grossarenic Paleudult), Bonifay (Loamy, siliceous, subactive, thermic Grossarenic Plinthic Paleudult), Clarendon (Fine-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult), Dothan (Fine-loamy, kaolinitic, thermic Plinthic Kandiudult), Escambia (Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult), Fuquay (Loamy, kaolinitic, thermic Arenic Plinthic Kandiudult), Malbis (Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult), and Poarch (Coarse-loamy, siliceous, semiactive, thermic Plinthic Paleudult). Subsequent laboratory characterization has led to revisions of the original classification. Nine of the eleven studied soils contain plinthite, and all are Ultisols.

Ultisols are strongly leached, highly weathered soils that contain a subsurface diagnostic horizon with translocated silicate clays. Base saturation is less than 35% (sum of the cations) in the lower solum and decreases with depth, resulting in an acidic soil incapable of sustaining productivity without amendments (Foth, H.D., 1990).

All of the studied soils contain sandy epipedons that present challenges in the identification of shallow seasonal high water tables (SHWT) due to the low quantities of organic carbon, Fe oxides, and the presence of oxygenated perched water tables (Vepraskas and Wilding, 1983; and Veneman et al., 1998).

Soil forming factors

The formation of soils by the physical and chemical degradation of parent material occurs through the interaction of organisms, climate and topography over time (Jenny, 1941; Foth, 1990). Landscape position and sedimentary geology of the Southern Coastal Plain are often the two most important soil forming factors describing soil distribution within this region (Shaw et al., 2003).

Weathering of parent material occurs due to the lack of equilibrium between the parent material and environment (Birkeland, 1974). Parent material weathering below the solum is termed geochemical weathering, and the weathering processes that take place within the solum are termed pedochemical (Buol et al., 1997). Soils that weather from the Coastal Plain geological formations vary greatly, but often have characteristics related to textural properties of the related lithologies. Because many of these sediments are "pre-weathered" and lack significant weatherable minerals, inherited characteristics of these soils are relatively more important.

Soil Color

Soil color is a result of the weathering of the parent material, the amount of organic matter, the combination of iron and manganese oxides, and the drainage characteristics of the soil. Hematite (α-Fe_2O_3) provides pigments red in color, and goethite (α-FeOOH) provides pigments that are yellow-brown in color (Bigham et al., 1978; Schwertmann, 1985; Fanning and Fanning, 1989; Schwertman and Taylor, 1989; Stolt et al., 1998; Shaw and West, 2002). Lepidocrocite (γ-FeOOH) provides orange pigments, and ferrihydrite (or soil Fe) is often similar in color to other Fe oxides due to variable composition and oxidation (Schwertmann, 1993; Shaw and West, 2002).

Manganese oxides are often dark brown to black, however, due to their limited quantity within the soils of the Southern Coastal Plain, they provide very little color (Vepraskas, 1996; Shaw and West, 2002). Hematite provides the highest level of pigmenting ability due to the small particle size and high surface area (Shaw and West, 2002). Other parameters affecting oxide pigmenting include oxide quantity and isomorphic substitution within the structure (Schwertmann, 1993).

Soil organic matter and texture also affect soil color (Schulze et al., 1993). Subsoils that contain very little organic matter result in an increase of pigmentation by Fe and Mn oxides (Schwertmann, 1993). Schulze et al. (1993) found that soil texture has an effect on the relationship between soil organic matter content and color where finer textures (e.g., silty versus sandy) had lower Munsell Values as organic matter increased. The sandy textured soils within their study contained less organic matter than the silty textured soils with the same Munsell Value color.

Redoximorphic Features

Redox Definition

Reduction is a biochemical process resulting from the gain of an electron, while oxidation is the loss of an electron (Cate, 1964). Reduction and oxidation of Fe and Mn oxides lead to the development of redoximorphic features (Calmon et al., 1998). Reduction of oxides within the soil occur during prolonged saturated conditions when labile organic carbon contents are relatively high, soil temperatures are above 5° C, dissolved oxygen within the soil water is depleted by microbial respiration, and oxides are present. During the reduction process, oxides become soluble and can translocate within the saturated zone or leach from the soil with the receding water table (Cate, 1964; Vepraskas, 1996). Zones without oxides generally expose their light-tan, white, or gray silicate minerals (Vepraskas, 1996; Shaw and West, 2002). When oxygen is re-introduced during the drying of the soil, the Fe (and Mn) in solution re-oxidizes, which could eventually lead to the formation of oxide accumulations and/or concentrations.

Redox processes

Eh potential

In saturated soils, oxidation of organic matter is affected by pH, organic matter availability, organic acids, oxide availability, microbial activity and micro-scale soil spatial heterogeneity (Mitsch and Gosslink, 1993). During the consumption of organic matter during microbial respiration, the electron activity of the soil solution increases. The redox status of the soil is dependant upon the electron activity; higher electron activities result in more reducing conditions. Dissolved oxygen in the soil solution is the primary acceptor of electrons when oxygen is available. When all the dissolved oxygen in the soil solution becomes reduced, hierarchical reduction of other elements occurs. The chain of electron acceptance (reduction) begins with the reduction of O_2, followed by NO_3^-, $Mn^{3,4+}$, Fe^{3+}, SO_4 and CO_2 (Bohn et al., 1985). Reduction potential is expressed as electron potential, *Eh or pe*, which is measured in volts (V). Typically, elements are reduced more readily at lower pH values (Ponnamperuma, 1967, 1969; Collins and Buol, 1970; Stolt et al., 1998).

The redox reactions associated with Fe are most valuable as they result in visible morphological features. Iron reduction occurs between 100 and 300 mV at a soil pH of 7

(Bohn et al., 1985), and occurs at a lower redox potential than Mn (Ponnamperuma et al., 1967, 1969; Ponnamperuma, 1972; Gambrell and Patrick, 1978). An example of a reduction half-reaction for Fe is shown in equations 1 and 2:

$$Fe^{3+} + e^{-} \leftrightarrow Fe^{2+} \qquad [EQ.\ 1]$$

$$FeOOH + e^{-} + 3H^{+} \leftrightarrow Fe^{2+} + 2H_2O \qquad [EQ.\ 2]$$

As the soil dries, oxides precipitate (oxidize) in the reverse order of reduction, e.g., Mn oxides precipitate after Fe has precipitated (Collins and Buol, 1970). Stability diagrams are utilized to relate redox potential (Eh) to soil pH for determining the form (oxidized/reduced) of the element in question (Bohn et al., 1985). Using platinum (Pt) electrodes to measure in situ redox potential, He et al. (2003) found in Atlantic Coastal Plain soils that durational saturation for 21 days or more was necessary to reduce Fe oxides.

Soil pH

Reduction and oxidation of oxides is cyclical and results in dynamic changes of soil pH and mineral weathering (Hobson and Dahlgren, 1998). The consumption of protons that occurs during reduction raises soil solution pH, and conversely, oxidation releases protons, which decreases soil solution pH (Brinkman, 1970; Van Breeman et al., 1984). Stability diagrams indicate high pH conditions retard reduction (Vepraskas, 1996).

Microbial activity and soil temperature

Microbial respiration is an essential component of redox processes (Vepraskas, 1996), and the kinetics are controlled by temperature (Stolt et al., 1998). Higher microbial metabolic activity for longer durations occurs within warmer regions (Coyne, 1999; Bonner and Ralston, 1968). Biological zero of redox processes occurs at temperatures less than five degrees C (Soil Survey Staff, 1992). Genthner et al. (1998) found saturated soil horizons, Virginia Upper Coastal Plain, in cold months (February and March) which lacked redoximorphic features; they attributed this to reduced microbial activity due to low temperatures.

Organic carbon content

Organic carbon within the soil drives the reduction of oxides during saturated anaerobic conditions. Labile organic carbon is the energy source for microbes and other soil fauna. In reducing environments, fermentation of glucose by microbes can occur, releasing acetate, pyruvate, and CO_2, which is the electron source in reduction reactions (Coyne, 1999). Vepraskas and Wilding (1983) suggest that a minimum of one percent organic matter must be present to drive oxide reducing biochemical reactions. It is widely believed that soil organisms must break down organic carbon to the water-soluble (labile) form to participate in the redox cycle (Zausig et al., 1993).

Dissolved Oxygen

Dissolved oxygen present in soil solution suppresses reduction of oxides (Coyne, 1999). Moving water contains dissolved oxygen that is difficult to deplete (Vepraskas and Faulkner, 2001). Daniels et al. (1973) measured oxygen levels present in seasonal high water tables of Aquults and Udults of North Carolina to establish redox status. In Daniels' study, laboratory measurement of the oxygen levels at the onset of reducing conditions was found to be 2 ppm. Using 2 ppm as the oxide reduction threshold, Aquults experienced reducing conditions in all horizons monitored, whereas Udults did not. The reduction of Fe was found to be buffered in vernal pools of California by both high levels of Mn (andesitic alluvium) and dissolved oxygen released by roots of aquatic plants (Hobsen and Dahlgren, 1998).

Oxides and their formation

As primary minerals weather, Fe and Mn are released and become free forms of these oxides (Buol et al., 1997). Some of the free Fe combines with oxygen or hydroxyls to form hematite (α-Fe_2O_3), goethite (α-FeOOH) or ferrihydrite (Buol et al., 1997). When subjected to environments dissimilar from that of their formation, oxides (Fe and Mn) weather more readily. The lack of equilibrium results in the instability of the minerals allowing reduction to occur under anaerobic conditions, and oxidation under aerobic conditions (discussed above). Schwertmann (1993) suggests that Fe present in most rocks is mostly divalent and oxidizes during aerobic weathering of the rock. Oxidized ferric Fe (Fe^{3+}) becomes vulnerable to reduction under anaerobic conditions or hydrolysis of the oxide. Upon oxidation of Fe from the rock matrix, variations in coloring pigmentation occur within the resulting soil.

Oxide accumulations and depletions

Reducing conditions during seasonal saturation reduces ferric forms of Fe (FeIII) to soluble ferrous forms of Fe (FeII), which become mobile within the soil solution. Loss of soluble forms of Fe results in depletions, and oxidized regions where soluble Fe precipitates results in the formation of Fe accumulations and/or concentrations (Vepraskas and Bouma, 1976). Solubility of oxides during saturated and reducing conditions allows for oxide losses and gains in a heterogeneous distribution (Schwertmann, 1993).

Redox concentrations and redox depletions form during significant duration of soil saturation (Veneman et al., 1998). D'Amore et al. (2004) found redox concretions of Fe to be four to nine times more concentrated with Fe than the associated soil matrices, while Mn concretions were 23 to 500 times more concentrated in wetland soils of Oregon. Newly developed accumulations have higher concentrations of Mn than aged accumulations (Schwertmann and Fanning, 1976). Coatings of Mn are developed when soils are satiated as compared to saturated (Vepraskas and Bouma, 1976).

Soft iron accumulations

Soft iron concentrations and accumulations consist of goethite (α-FeOOH), lepidocrocite (γ-FeOOH), ferrihydrite (soil Fe), and hematite (α-Fe_2O_3). Vepraskas (1996) suggests that hematite oxide concentrations indicate relict features. Stolt et al. (1998) found that during reduction, the different oxide species were reduced in a sequential order. Preferential reduction of hematite over goethite in soils with redder colors has been found in numerous studies (Torrent et al., 1983; Macedo and Bryant, 1989; Dobos et al., 1990; Schwertman, 1993). The color of the parent material and mineralogy of the soil affect the color, expression, abundance of oxides and redoximorphic features within a soil (Mokma and Sprecher, 1994; Elless et al., 1996).

Favorable conditions do not always indicate that oxide formation will occur. Stolt et al. (1998) found that a seasonally wet soil that contained sufficient Mn to produce Mn accumulations failed to do so. They found that the reduced Mn oxides were lost within the system because continued soil saturation never allowed Mn oxidation.

Depletions

Munsell values of four or more with chromas of two or less generally indicate redox depletions. In sandy soils, chromas #3 are thought to be indicators of oxide depletions (Fannzmeier et al., 1983). Other studies suggest that depletions of chroma #4 may be an indicator of occasional soil saturation (Vepraskas and Wilding, 1983; Evans and Franzmeier, 1986; Singleton, 1991). Low chroma colors fail to develop when lack of organic matter (OM), low temperatures or aerated groundwater are present and prevent the reduction-oxidation process from occurring (discussed above).

Fe reduction and oxidation cycles have a disintegrating effect on clay particles, mostly through ferrolysis (Brinkman, 1970; Buol et al., 1997; Hobson and Dahlgren, 1998). Release of metal cations, silicic acid and bases into plant available forms occurs during ferrolysis, which then may be lost by leaching (Buol et al., 1997; Hobson and Dahlgren, 1998).

Loss of clay in associated Fe depleted zones can form preferential flow pathways through the soil matrix. Carlan et al. (1985) and Blume et al. (1987) found preferential flow through depleted pores using dyes and a bromide (Br^-) tracer. Shaw et al. (1997) found preferential flow in regions of greater porosity as suggested by greater dye concentrations in these areas compared to more dense areas containing higher clay.

Plinthite and ironstone

Fe concentrations cemented to the extent that they can be removed from the soil intact and have a firm or very firm moist consistence meet the minimum criteria for plinthite. Ironstone has undergone irreversible hardening (Soil Survey Div. Staff, 1993). Plinthite nodules and concretions exist within the continuum of ironstone formation that begins with soft Fe accumulations. Daniels et al. (1978) present a guide for field identification of plinthite. Plinthite hues range from 10R to 7.5YR, size is greater than 2-mm, consistence is hard when dry but can be broken, and firm when wet.

The shape and amount of plinthite affect permeability and induce perching of water. Platy plinthite can perch water when its percentage by volume reaches 10%, whereas nodular plinthite does not readily perch water but can indicate subjacent horizons of lower permeability (Daniels et al., 1978). A previous study within a Plinthic Kandiudult found fluctuating perched water tables atop sandy clay loam horizons with a firm consistence containing 25% nodular plinthite (Guthrie and Hajek, 1979). Analysis of Fe oxides and particle size distribution within plinthic soils by Wood and Perkins (1976a) revealed differences between the surrounding soil and plinthite. Plinthite had coarser textures and more crystalline Fe oxides as compared to the soil matrix.

Slaking procedures separate and aid in identification of the different forms of Fe accumulations (Wood and Perkins, 1976b; Daniels et al., 1978). Slaking times range from two to eight hours, but all findings state that non-plinthic and non-cemented materials readily slake within the first few minutes.

Depleted matrices

Depleted matrices indicate periods of prolonged saturation for significant duration. Depleted matrices with chromas ≤ 2 are associated with permanently saturated soils (Franzmeier et al., 1983; Pickering and Veneman, 1984; Fiedler and Sommer, 2004). West et al. (1998) found depleted matrices in soil horizons saturated for a mean duration of 50% of their monitoring period. Depleted matrices develop during prolonged periods of saturation and aid in the identification of hydric soils if found within certain depths below dark surface horizons (Soil Survey Staff, 1999; Vepraskas et al., 2004).

Contemporary vs. relict features

The accumulation of oxides and redoximorphic features presents difficulty in the differentiation of relict and contemporary features (Greenburg and Wilding, 1998). Accumulation boundaries and distribution aid in the identification of contemporary and relict redoximorphic features. Diffuse boundaries represent contemporary water tables, and clear, defined boundaries are associated with past hydrology and are termed relict features (Vepraskas, 1996). In addition, random distributions of redoximorphic features have been found to indicate relict water tables in Texas Coast Prairie soils (Griffin et al., 1998).

Oxide mineralogy and color expression can aid in the separation of contemporary and relict features. Hematite concentrations are often associated with relict hydromorphic features. Vepraskas (1996) provides a table that separates hematite from goethite, lepidocrocite, ferrihydrite and jarosite by Munsell color as indicators of relict features, and aids in field determination. Reticulately mottled horizons with plinthite in Kandiudults of the Georgia Coastal Plain, when found on uplands, were not related to seasonal saturation and were interpreted to be relict features (Jacobs et al., 2002).

Seasonal high water tables and redoximorphic features

A study in Ohio by Zobeck and Ritchie (1984) found that average water table depths (10-year study) were shallower (13 cm) than Fe depletions in moderately well drained and well drained soils, whereas in poorly drained soils the water table depths were deeper than the redoximorphic features. In another study, reddish brown macropore linings and ped interiors occurred in somewhat poorly to poorly drained soil, whereas in very poorly drained soils, Fe depletions occurred in ped interiors and accumulations developed on ped faces (Richardson and Hole, 1979). Other studies have shown oxide depletions at the mean depth of the shallowest water table (Coventry and Williams, 1984). Genthner et al. (1998) suggested that Fe oxide concentrations are better estimators of seasonal high water tables in some well drained and moderately well drained Virginia Coastal Plain soils. Galusky et al. (1998) found relationships between soil saturation and matrix colors with chroma 3 or 4, and a relationship between depleted matrices (chroma 2 or less) and seasonal saturation in the wettest month of the year (March) in Maryland.

Numerous studies have demonstrated the relationship between prolonged periods of saturation and the development of redoximorphic features (Daniels et al., 1971; Calmon et al., 1998; Griffin et al., 1998; West et al., 1998). West et al. (1998) found horizons with redox concentrations were saturated 20% of the monitoring period, horizons with redox concentrations and depletions were saturated 40% of the monitoring period, and horizons with low chroma colors were saturated 50% of the monitoring period in Georgia Coastal Plain soils.

Episaturation

Episaturation, also known as a perched water table, occurs within soils with horizons of different permeabilities, resulting from contrasting property interfaces (i.e., texture, structure). Buol et al. (1997) defined episaturation as soil saturation shallower than 2-m in one or more layers, with unsaturated horizons within or underlying saturated zones. Once a perched water table is formed, rapid response to precipitation or infiltrating water occurs (McDaniel et al., 2001). During episaturation events, soil saturation and reduction of oxides occur at ped exteriors (termed faces), while ped interiors are generally dry and not affected (Vepraskas and Guertal, 1992). The dissolved Fe (and Mn) in the macropore soil solution slowly diffuses into the ped interiors, creating oxide concentrations within the interior of the ped and oxide depletions along ped faces (Blume and Schlicting, 1985; Vepraskas and Guertal, 1992). Oxide accumulation on the ped surfaces occurs as the soil dries as these areas are the first to undergo oxidization upon receding water tables (Fanning and Fanning, 1989; Vepraskas, 1996; Stolt et al., 1998). Genthner et al. (1998) suggested that reduced Fe diffuses within saturated macropores and oxidizes at the interface of the wetting front and the oxidized soil.

A study in an Argixeroll/Fragixeralf hillslope of Idaho suggested that ferrolysis and hydro-consolidation within eluvial horizons saturated for more than 6-mo in a year were driven by perched water tables (McDaniel et al., 2001). Simonson and Boersma (1972) related bleached eluvial horizons with perched water tables within soils of Oregon to impermeable Bt horizons. A relationship between the thickness of eluvial horizons and perched water tables existed in Fragixeralfs of Idaho (McDaniel and Falen, 1994). Studies performed in Udic moisture regimes (humid regions) revealed rapid fluctuations of perched water tables in spring and summer months due to increased evapotranspiration (Palkovics et al., 1975), and shallower depths to saturation than redoximorphic features suggested (Calmon et al., 1998).

Endosaturation

Endosaturation, also known as a true or apparent water table, occurs when contiguous saturation of the soil occurs at least to a depth of 2-m (Buol et al., 1997).

Where impermeable horizons are not present within the solum, water tables are continuous and relatively more connected to a regional water table. During endosaturation, soil depletions occur within the ped interior, while oxide accumulations occur along the ped faces and root channels (Vepraskas and Guertal, 1992; Buol et al., 1997; Vepraskas, 1996).

Landscape position

Landscape position and relief greatly influence soil water movement, soil water tables, saturation duration, and subsequently, reduction potential (Galusky et al., 1998). A study by Daniels et al. (1971) found that soils in the lower Coastal Plain of North Carolina, saturated for 25% of the monitoring period in lower landscape positions, developed chroma 3 oxide depletions. Local swales in moderately well drained soils required greater saturation (50% of the monitoring period) to develop chroma 2 oxide depletions. Horizons with gray matrices located in soils within drainage ways, furthest from the geomorphic edge of cut stream valleys, were saturated for 25% percent of their monitoring period.

Summary

Reduction and oxidation processes are microbially driven and subject to temperature, presence or absence of dissolved oxygen, saturated conditions, and adequate quantities of soluble carbon and oxides. Landscape position generally controls surface and subsurface water movement and ultimately contributes to prolonged saturated events that lead to the reduction and translocation of Fe oxides. Reduction and oxidation cycles or repeated wetting and drying of soils and redoximorphic features develop a continuum of features that link contemporary, diffuse boundary soft Fe accumulations, to well defined, sharp boundary plinthite and ironstone, which represent previous moisture regimes.

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II. HYDROMORPHOLOGY OF SOME ALABAMA COASTAL PLAIN SOILS

Abstract

Estimating seasonal high water tables (SHWTs) within soils using redoximorphic features is critical for soil interpretations. Certain redoximorphic features indicate contemporary moisture regimes, while others indicate past moisture regimes (relict). This study, conducted jointly between the Natural Resources Conservation Service (NRCS) and the Alabama Agricultural Experiment Station (AAES), monitored the depth and duration of seasonal high water tables (SHWTs) (December 2003 – May 2007) of some Alabama Coastal Plain (CP) soils to develop relationships between SHWT periodicity, duration and hydromorphic features. Twenty piezometers were installed in eleven CP pedons (Paleudults and Kandiudults, most with plinthite and sandy epipedons of varying thickness) at varying depths. Water table data were recorded every six hours and daily rainfall was obtained from proximate weather stations. Soils were described, sampled, characterized and classified according to standard techniques. Plinthite was quantified using a slaking technique. Perched water tables were not consistently associated with any pedogenic feature. Plinthite occurrence spanned from horizons saturated for 1 to 47% of the monitoring period (MP). Saturation percentage was greatest in depleted matrices for all soils. Grossarenic and Arenic Plinthic subgroups were saturated 29% of the MP where plinthite and chroma ≤ 3 depletions occurred together. Plinthic and Arenic Plinthic subgroups were saturated 5% of the MP

where plinthite and chroma ≤ 3 Fe depletions occurred together, and 19% of the MP in horizons with depleted matrices. Aquic and Plinthaquic subgroups were saturated 47% of the MP where plinthite and chroma ≤ 3 Fe depletions occurred together, and 59% of the MP in horizons where depleted matrices occurred. Iron depletions and depleted matrices were associated with duration and periodicity of seasonal saturation for these Alabama Coastal Plain soils.

Introduction

The protection of water resources is of great importance. In efforts to protect water resources during land use (e.g., on-site sewage disposal, urban development) and management (e.g., crop production), identification of seasonal high water tables (SHWTs through the interpretation of hydromorphic features is essential. Hydromorphic features, or indicators of contemporary hydrology, affect soil classification, land use and wetland determinations.

The reduction, translocation and oxidation of oxyhydroxides (driven by microbial respiration) result in the formation of soil hydromorphic features (Vepraskas, 1996). Oxyhydroxides form when Fe or Mn combines with oxygen or hydroxyls during weathering of primary minerals (Buol et al., 1997). Soil particles coated by oxyhydroxides express color associated with the oxide type and quantity (Schwertmann, 1993).

Prolonged periods of saturation create anoxic conditions suited for the reduction of oxyhydroxides. Microbes create anaerobic conditions by depleting dissolved oxygen during respiration. Reduced forms of oxides are more soluble than oxidized forms and either move with the soil solution to oxidized zones in the soil or are lost with migration of the soil solution (Vepraskas, 1996). Oxide and/or clay depletions occur where oxide minerals are reduced and solubilized (Vepraskas and Bouma, 1976). Precipitation of the oxides occurs within oxygenated zones and creates oxide accumulations or concentrations (Vepraskas and Bouma, 1976). Oxide accumulations sometimes develop into highly concentrated Fe concentrations and nodules (e.g., plinthite, ironstone).

Plinthite nodules develop from the cyclical wetting and drying of soil horizons and represent the bridge between soft iron accumulations and irreversibly cemented ironstone. Plinthite nodules are firm or very firm Fe accumulations with sharp boundaries, and can be withdrawn from the surrounding soil intact (Soil Survey Div. Staff, 1993). In sufficient quantities (>10%), platy plinthite can restrict vertical water movement and initiate a perched water table (Daniels et al., 1978). Nodular forms of plinthite may indicate subjacent horizons exist that are impermeable and perch water (Daniels et al., 1978; Shaw et al., 1997). Guthrie and Hajek (1979) found nodular plinthite (25% plinthite) was restrictive to gravitational water movement.

Redox depletions are generally identified by low chroma zones where Fe (or clay) has been removed. Although chroma ≤ 2 depletions are often used to indicate contemporary hydromorphic features, chroma 3 depletions may reflect contemporary hydrology in sandy (Franzmeier, 1983) or occasionally saturated soils (Vepraskas and Wilding, 1983; Evans and Franzmeier, 1986; Singleton, 1991). Horizons with reduced, depleted or gleyed matrices suggest greater saturation durations than horizons with accumulations and depletions (Daniels et al., 1971; West et al., 1998).

Several studies have related hydromorphic features to seasonal high water tables, with varying degrees of success (Calmon et al., 1998; Genthner et al., 1998; Greenburg and Wilding, 1998; Griffin et al., 1998; Tangren et al., 1998; West el al., 1998; Jacobs et al., 2002; Reuter and Bell, 2003). In Georgia's Coastal Plain soils, Jacobs et al. (2002) correlated Fe depletions, Fe accumulations, and gleyed matrices with saturation of 18%, 24%, and 50% of the monitoring period (MP), respectively. West et al. (1998) found saturation for 20% of their MP in horizons with Fe accumulations, 40% for depletions, and 50% in gleyed horizons of Georgia's Coastal Plain soils.

The presence of dissolved oxygen or absence of one or more of the interacting properties that affect redox processes may impede hydromorphic feature development (Vepraskas and Wilding, 1983; Genthner et al., 1998; Szögi and Hudnall, 1998). Microbial respiration drives the biochemical reduction during anaerobic conditions. Soil temperatures below biological zero (5°C) cease or slow microbial respiration (Bonner and Ralston, 1968). Low organic carbon contents, problematic within southeastern Coastal Plain (CP) soils, impede feature formation by limiting microbial respiration (Vepraskas and Wilding, 1983). Dissolved oxygen also prevents reduction of ferric iron (Coyne, 1999), which acts as an electron acceptor during microbial respiration. A low oxide concentration also leads to the lack of hydromorphic feature development (D'Amore, 2004).

Soils in the Coastal Plain are problematic for assessing soil hydromorphology due to perched water tables rich in dissolved oxygen, and low concentrations of oxides and soluble carbon (Vepraskas and Wilding, 1983; Mokma and Sprecher, 1994; Veneman et al., 1998). In addition, some hydromorphic features may be indicators of contemporary moisture regimes, while others may represent historical moisture regimes. This sometimes leads to a false interpretation of the duration of saturation (termed durational saturation) (Vepraskas and Wilding, 1983; Fanning and Fanning, 1989; Fanning et al., 1992; Vepraskas and Guertal, 1992; Vepraskas, 1996; Greenburg and Wilding, 1998; Griffin et al., 1998). Features developed from previous moisture regimes are termed "relict." Redox concentration boundary (Griffin et al., 1992), distribution (Vepraskas and Wilding, 1983), mineralogy, and degree of cementation can aid in identification of contemporary versus relict redox features.

Genthner et al. (1998) noted the great cost associated with long term water table monitoring and the need for studies to relate SHWT's to hydromorphic features. This study, conducted jointly with the USDA-NRCS, is designed to better develop soil hydromorphology relationships. Specifically, we are monitoring the depth and duration of SHWTs of some Alabama CP soils in relation to hydromorphic features. Efforts are underway to develop potential differences between contemporary and relict features, with particular interest on plinthite.

Materials and Methods

Soil Pedon Selection/Locations

The pedons evaluated in this study (Table 1) are representative of the Coastal Plain region of Alabama, and are located in Crenshaw (6), Escambia (2), Baldwin (1) and Washington (2) counties (Fig. 1). Crenshaw County sites were located along fencerows of pastures or croplands. The Escambia and Baldwin County sites are in pastures, and the Washington County sites are located in planted pine plantations.

Soil Pedon and Site Characteristics

The eleven studied pedons described lie within the Southern Hilly Gulf Plain and Southern Pine Plains and Hills ecoregions (Griffith et al., 2001) (Fig. 1). These two ecoregions differ slightly in topography and land use. Subsoil textures, depth of sandy epipedons, drainage class, and plinthite and/or hydromorphic features differentiate the soils within this study. Four of the eleven pedons possess deep sandy surfaces that classify in Arenic or Grossarenic subgroups (Table 1) (Soil Survey Staff, 2006). These soils are found on summit, shoulder and backslope positions. Nine of the soils contain plinthite, but three did not meet Plinthic requirements (>5%) at the subgroup level. One of the nine pedons containing plinthite classifies in an Oxyaquic subgroup. Soils containing plinthite were on all landscape positions, ranging from summits and shoulders to drainage ways. Three soils were located within low-lying areas with low gradients that produce conditions favorable for durational soil saturation.

The Coastal Plain region of Alabama is diverse and dissected with recent fluvial deposits overlying fluvio-marine sediments that span from the Cretaceous to Quaternary periods (Adams, et al., 1926). The pedons within this study reside in seven different formations of the Tertiary and Quaternary periods. The Grossarenic Kandiudults in the northern portion of Crenshaw County lie over the transition of the Clayton and Porters Creek formations (Eocene). The Grossarenic Paleudult, in the middle portion of Crenshaw County, lies over the transition of the Porters Creek Formation and alluvial terrace deposits. The Aquic Paleudult of this study lies within the Nanafalia formation. Both of the pedons in southern Crenshaw County lie on a transition between High Terrace Deposits and the Tuscahoma Sand formation (Eocene). In the northern portion of Washington County, the two Coarse-loamy soils in Plinthic and Plinthaquic subgroups lie over the undifferentiated Miocene Series. The same subgroups of soils overlie the Citronelle formation (Pliocene) in Escambia County. The Plinthic Paleudult in Baldwin County also lies within the Citronelle formation (Cooke, 1926).

Pedon Description, Sampling and Characterization

Soils were described and sampled using bucket augers or a truck-mounted Giddings Hydraulic Probe (Giddings Machine Company, Inc., Fort Collins, CO, USA). Pedons were described and sampled using standard soil survey techniques (Soil Survey Staff, 2006).

Soil samples were air-dried and separated into two approximately equal portions (one for characterization and one for plinthite analysis and quantification). Prior to laboratory analysis for characterization, soil samples were crushed with a rolling pin and passed through a 2-mm sieve. Particle size distribution was analyzed using the pipette method (Kilmer and Alexander, 1949). Cation exchange capacity and base saturation were determined by mechanical extraction with ammonium acetate (pH 7) (Soil Survey Inv. Staff, 2004). Bases were measured with atomic absorption (Ca and Mg) and atomic emission (K and Na) spectroscopy. Base saturation was calculated for both ammonium acetate (pH 7) and sum of cations (pH 8.2) methods (Adams and Evans, 1962; Hajek et al., 1972; Soil Survey Inv. Staff, 2004). Extractable Al was obtained by extraction with 1 N KCl followed by titration with NaOH (Soil Survey Inv. Staff, 2004). Effective cation exchange capacity (ECEC) was calculated by summing KCl extractable Al and exchangeable bases (Soil Survey Inv. Staff, 2004). Soil pH was determined in 1:1

soil:water (w/v) and 0.01 M $CaCl_2$ 1:2 soil:water (w/v). The Poarch-1 pedon was not characterized due to severe dry soil conditions during the time of excavation.

Estimation of plinthite quantities for soil horizons in the field were conducted per procedures in the *Field Book for Describing and Sampling Soils* (Schoenberger et al., 2002). Laboratory analysis of plinthite was determined by a procedure proposed by the USDA-NRCS, MO-14 (Kelley, personal communication), that is a modification of methods described by Daniels et al. (1978) and Wood and Perkins (1976). Prior to slaking the samples for 1-hr, dried and weighed soil samples were placed on a 2-mm sieve over a bucket and loose materials were discarded. Remaining material was placed on a 2-mm sieve and lowered into a five-gallon bucket filled with tap water (pH 6.4, EC = 23.4 $\mu S\ cm^{-1}$). Agitation provided consistent wetting and prevented sieve clogging. After the 1-hr slaking, the remaining material was removed and placed on brown craft paper for fifteen minutes. A rupture test was conducted on all remaining materials to separate plinthite (material that ruptured with pressure) from rock and ironstone materials (remaining material that would not rupture and classified as coarse fragments > 2-mm in size). Separated material was air-dried (48 hrs) and weighed. Cemented accumulations were separated into two groups (plinthite, and coarse fragments), and percentages per volume of soil were calculated.

Field estimates of the percentages of iron accumulations and depletions conducted during pedon description followed procedures within the *Field Book for Describing and Sampling Soils* (Schoenberger et al., 2002). Comparison of redox features with actual water table activity (described below) allowed calculation of the percentage of horizon saturation, maximum water table periodicity, duration, and cumulative saturation for years in which precipitation was *normal* (described below).

Drainage class assessment, as defined within the *Soil Survey Manual* (Soil Survey Div. Staff, 1993), combines depth to free water occurrence, soil permeability, and landscape position. Based on these criteria, assignment of soil drainage classes for each pedon was conducted and compared to actual water table activity, duration and cumulative days of saturation within a year.

Piezometers/Transducers (Data loggers)

WL-15 Pressure transducer and data loggers (Global Water, Gold River, CA) were used to monitor water table depths on 6-hr intervals from December 2003 to May 2007 (or shorter periods - see Table 1). This combination features a submersible pressure transducer with a silicone diaphragm connected to a stainless steel data logger. Data were retrieved on a quarterly basis.

Piezometers were constructed from PVC pipe (50.8-mm diameter) that was cut to the desired installation depth plus 30 cm (extension above grade), and multiple perforations were made throughout the lower 15 cm of the PVC pipe. The pipe was open at the bottom and geotechnical fabric covered the bottom and the perforations for prevention of sloughing and clogging of the pipe. Piezometers were placed into augered borings (81-mm diameter) and backfilled with clean sand to a height just above the perforations. Bentonite followed by soil excavated from the auger hole was used to backfill the remaining portions.

Physical measurements of the water table during data retrieval aided in calibration and ground-truthing of the data loggers. Manufacturer specifications of transducer accuracy are within 0.1% at constant temperature. True zero values were established for each transducer by empirical observations.

Weather Data

Weather data were collected from nine weather stations throughout the Coastal Plain of Alabama (AWIS-Alabama Weather Information Service) (Fig. 2). Daily, annual, thirty-year normal precipitation, and standard deviations were provided by AWIS for each of the weather stations for the determination of precipitation normality as per *Keys to Soil Taxonomy* (Soil Survey Staff, 2006). Selection of weather data used for analysis of each site was determined according to proximity of monitoring stations to piezometer locations.

Data Analyses

Many studies relating saturation to redoximorphic features express saturation as a percentage of the monitoring period (Zobeck and Ritchie, 1984; Evans and Franzmeier, 1986; Calmon et al., 1998; Griffin et al., 1998; West et al., 1998), or consecutive days within a year (Karathanasis et al., 2003; Vepraskas et al., 2004). He et al. (2003) found that an average of a 21-day period of saturation created Fe reducing conditions in some Atlantic Coastal Plain Soils of North Carolina when soil temperatures were > 5°C. The index developed by He et al. (2003) to identify the number of saturation events within a monitoring period that induce reducing conditions is:

$$NSE = (LDS / 21d) + (NPS - 1) \qquad \text{[EQ. 3]}$$

where NSE is the number of saturation events, LDS is the longest duration of saturation experienced, and NPS is the number of periods the soil experienced saturation for 21 days or more. From equation [3] we can identify how many reducing events occur during a period of interest.

Water table metrics include annual saturation percentage, annual cumulative days, the NSE, and number of events (periodicity) for horizons that contained hydromorphic indicators. Analyses were only conducted for *normal* precipitation years (as per Soil Taxonomy) occurring within the 2004-2006 monitoring period. Saturation percentage is the annual average amount of time a specific depth within a soil was saturated for the monitoring period. Cumulative days are the average annual number of total days within the monitoring period that a specific depth within a soil was saturated. Periodicity is the average annual number of events the soil was saturated at a specific depth within the monitoring period.

Results and Discussion

Weather Data

Rainfall data from nine different weather stations (November of 2003 through May 2007) were analyzed against thirty-year average monthly and yearly rainfall totals (Table 2). The four weather stations closest in proximity to the piezometer sites (Atmore, Bay Minette, Fairhope, and Highland Home) were used to infer *normal* precipitation. *Normal* precipitation, as defined in the *Keys to Soil Taxonomy* (Soil Survey Staff, 2006), are years that have at least eight of twelve months of precipitation within one standard deviation of the thirty year average, and are also within one standard deviation of the annual thirty year average. In 2004, 2005, and 2006, Bay Minette (closest to the Washington County sites), and Highland Home (Crenshaw County) had *normal* precipitation. The Atmore (Escambia County) weather station had *normal* precipitation in 2006. Fairhope (Baldwin County) precipitation amounts were too high in 2004 and 2005, and met monthly standards in 2006; however, it did not meet *normal* standards in any year. Although the Fairhope weather station did not meet *normal* precipitation criterion, we used 2006 data because it met monthly parameters. From this point forward, analyses and discussion of water table data only includes years that meet *normal* precipitation criteria; for the Crenshaw and Washington county pedons this includes 2004, 2005 and 2006; for the Escambia and Baldwin county sites, this only includes 2006.

Plinthite Analyses

Plinthite estimates in the field were on average 3% higher than laboratory analyses (Table 3). During field observations and description, many weakly formed iron accumulations removed from the surrounding soil intact readily slaked during the laboratory analysis. Plinthite is within the continuum of soft Fe accumulation and cementation, and some Fe nodules that may actually qualify as plinthite in the field (Soil Survey Div. Staff 1993), slake readily when submerged in water. Differences between field and laboratory analysis varied as much as 12% by volume; for example, within the Btv2 horizon of the Plinthaquic Paleudult in Washington County (Fig. 1), the difference between the field estimate and laboratory analysis was 12%. Field estimates were higher than lab estimates in 24 of 36 (66%) horizons.

Plinthite was present in horizons that were saturated from < 1% to 85% of the MP (Table 4). In horizons with plinthite, average annual saturation duration was 34 days, with 3.7 events, 63 cumulative days, and 20% saturation (Table 5). Horizons with plinthite and redox depletions (chroma ≤ 3) in combination had an average saturation of 43 days duration, 5.1 events, 86 cumulative days, and 27% saturation.

For further evaluation of the relationships between hydromorphic features and water tables, we combined soils as per taxonomic groupings. The names of groupings do not imply strict Soil Taxonomic adherence, but are rather connotative for the soil (Table 1). Soils within the Arenic and Grossarenic subgroups are treated as similar and are hereafter referenced as the Arenic soils (four pedons). Plinthic and Arenic Plinthic subgroups are similar and referenced as the Plinthic soils (four pedons). The Oxyaquic subgroup will be referenced as itself, and Aquic and Plinthaquic subgroups were similar and will be referred to as Aquic soils (three pedons). Soil 7 (Table 1), an Arenic Plinthic Kandiudult, belongs to two separate groups (Arenic and Plinthic).

Average saturation of horizons containing plinthite in Plinthic and Arenic soils was 2 and 14%, respectively, of the MP (Table 5, Fig. 2 and 3). Average saturation of horizons with plinthite in Oxyaquic and Aquic soils was 1 and 47%, respectively, of the MP (Table 5, Fig. 4 and 5).

In this study, nodular plinthite was predominant, and its occurrence did not initiate significant perching as found by Guthrie and Hajek (1979). A Grossarenic Kandiudult in Crenshaw County (soil 3) (Fig. 1) experienced significant saturation, but only one piezometer was installed in the pedon rendering it impossible to detect perching (Fig. 6). Plinthite increased from 4 to 17% from the B/E to the Btv1 horizon, where seasonal saturation was found. The Btv1 horizon also contained Fe accumulations, depletions of chroma 3, and 19% clay. This pedon was located on a long backslope with a slope of approximately 5 to 8%. Thus, it is hypothesized that a combination of landscape and soil factors contributed to the occurrence of this water table.

The highest amount of nodular plinthite (19% by volume) occurred in the Btv2 horizon of the Plinthic Paleudult in Baldwin County (Table 3). This horizon was found to be saturated 19% of the MP, but it did not have a perched water table. Nodular plinthite in this study was predominantly found within mottled horizons as well as above reticulately mottled horizons, which correlated with previous studies (Daniels et al., 1978).

Soft Iron Accumulations

Field estimates of soft Fe accumulations ranged from few (0-2%) to many (>20%) for the eleven pedons of this study. Saturation of horizons with soft Fe accumulations was on average 11% of the MP for all soils (Table 5). In horizons with combinations of soft Fe accumulations and depletions of chroma ≤ 3, average saturation for all soils was 19% of the MP. West et al. (1998) separated hydromorphic features for Georgia soils into three categories: redox concentrations, redox depletions and low chroma matrix. Horizons with redox concentrations were saturated from 18-21% of their MP. In our study, horizons with redox concentrations (for all soils) had a lower saturation percentage (11%) than in their study. Separation of pedons into the four groups described above found horizons with redox concentrations saturated 10% (of MP) in Arenic soils, 2% in Plinthic soils, 1% in Oxyaquic soils, and 23% in Aquic soils (Table 5).

In horizons with soft Fe accumulations, averaged for all soils, annual saturation duration was 16 days (Table 5). Soft Fe accumulations in combination with Fe depletions of chroma ≤ 3 had a saturation duration average of 28 days. Horizons with soft Fe accumulations in Plinthic and Oxyaquic soils had a saturation duration average of less than 4 days. Because 4 days is not considered sufficiently long to develop reducing conditions, this short saturation duration suggests these soils developed soft Fe accumulations during a previous hydrologic regime. Conversely, horizons in Aquic soils with soft Fe accumulations had average saturation duration of 29 days. In combination with Fe depletions of chroma ≤ 3, average saturation duration was 49 days.

Chroma 3 Fe Depletions

In previous research, Fe depletions of chroma ≤ 3 have been related to saturation in sandy soils (Franzmeier, 1983; Vepraskas and Wilding, 1983; Evans and Franzmeier, 1986; Singleton, 1991). All soils in this study contained loamy sand to sandy loam epipedons, and four of the soils were within Arenic or Grossarenic subgroups. Averaged for all soils, horizons with chroma 3 depletions were saturated 16% of the MP (Table 5). In horizons with both chroma 3 depletions and soft Fe accumulations, saturation averaged 19% of the MP. In combination with plinthite, saturation averaged 27% of the MP. Average annual saturation duration (all soils) for horizons with chroma 3 depletions was 19 days, and 28 days when combined with soft Fe accumulations.

In horizons of Plinthic soils with chroma 3 depletions, annual saturation duration averaged 2 days. Horizons in Arenic soils had the highest (compared to other grouping of soils) average annual saturation percentage at 20% of the MP, and the highest average saturation duration of 23 days. The Aquic soils that contained horizons with chroma 3 Fe depletions were saturated, on average, for 19% of the MP, with average saturation duration of 20 days.

Chroma ≤ 2 Iron Depletions

Chroma ≤ 2 Fe depletions are often interpreted as the most consistent indicator of prolonged periods of saturation (Evans and Franzmeier, 1986). A study by West et al. (1998) in the Georgia Coastal Plain found that horizons with redox depletions of chroma ≤ 2 were saturated > 41% of their MP. Evans and Franzmeier (1986) found that horizons with chroma ≤ 2 depletions were saturated for > 50% of their MP. Averaged for all horizons, we found lower saturation percentages (25% of MP) for horizons with chroma ≤ 2 Fe depletions compared to previous studies. However, horizons in Arenic soils and Aquic soils with chroma ≤ 2 depletions were saturated 29% and 41 % of the MP, respectively. In Plinthic and Oxyaquic soils, horizons with chroma 2 or less Fe depletions were saturated for 8 and 9% of the MP, respectively. Horizons with chroma ≤ 2 depletions exhibited a wide range of average annual durational saturation periods; from 11 days in Oxyaquic soils to 82 days in Aquic soils.

Depleted Matrices

Depleted matrices indicate prolonged duration of reducing conditions (Vepraskas, 1996; Karathanasis et al., 2003). West et al. (1998) found that sixty-two low chroma horizons within their study experienced saturation for an average of 51% of their MP, while Griffin et al. (1998) found that gleyed horizons of a soil within a depression experienced saturation for 77% of their MP. Evans and Franzmeier (1986) found horizons in Indiana soils with matrix chroma of 1 or less were saturated more than 40% of their MP.

The five depleted horizons in this study did not readily change color upon aeration, thus qualifying these as depleted matrices. This is an indication that Fe (and

Mn) within these depleted horizons is absent or depleted. These five depleted horizons were saturated for an average of 56% of the MP (Table 5). One depleted horizon found at the lower depth of an Oxyaquic Paleudult, which also contained plinthite and soft Fe accumulations, experienced average annual saturation for 107 durational days, and 62% of the MP. Saturation in the three depleted horizons of the Aquic soils averaged 59% of the MP, and occurred for an average of 88 durational days. A depleted horizon found within the Plinthic soils was saturated for 19% of the MP, which was the lowest saturation percentage found in all the soils monitored.

In summary, averaged overall, horizons with Fe depletions (chroma < 3) were saturated 16 to 27% of MP, had annual saturation durations of 19 to 43 days, and 40 to 86 cumulative saturation days.

NSE Index

Previous research in North Carolina Coastal Plain soils indicated Fe reduction occurred within 21 days (on average) of durational saturation during the growing season (He et al., 2003). This 21-day benchmark was used in hydrologic model (DRAINMOD) simulations to determine if reducing events occurred during periods of interest. Interestingly, they found that horizons with greater percentages of hydromorphic features had similar saturation periods and duration as horizons with lower percentages of features. In order to address these findings, He at al. (2003) developed an index (NSE-defined in methods) that relates the number of saturation events (NSE) to saturation duration and periodicity.

In our study, NSE values were relatively higher in soil horizons with depletions and depleted matrices, and soils classified in Aquic and Plinthaquic subgroups. Horizons with depleted matrices experienced the greatest saturation and had NSE values (Table 5) that were twice as high (5.7) as any other horizon with hydromorphic features. Horizons with plinthite in combination with Fe depletions (chroma ≤ 3), and horizons with Fe depletions of chroma ≤ 2 had the second highest average annual NSE value (2.4).

Perched and Apparent Water Tables

Perched water tables are detected with nested piezometers (Zobeck and Ritchie, 1984). Although perched water tables were not prevalent in our study, of the eleven pedons within this study, three experienced perched water tables of varying degree. The Aquic Paleudult in Crenshaw County (soil 4) (Fig. 1) had a prolonged perched water table during a dry period from May to December of 2006 (Fig. 7). The deep piezometer showed no activity during this period, while the shallow piezometer indicated limited water table activity. The perching occurred at the transition between the sandy loam Btv horizon with 3% plinthite to the sandy loam Btg horizon without plinthite. This activity differs from the rest of the MP, where water tables from both piezometers coincided during periods of higher water table activity.

An Arenic Plinthic Kandiudult in Crenshaw County (soil 7) (Fig. 1) had two separate short periods of activity in the shallower piezometer suggestive of a perched water table (Fig. 8). The two short duration perched water table observations occurred at the transition between the E2 and Btv1 horizons. The Btv1 horizon increased in clay, plinthite, and had a firm moist consistence. The Plinthaquic Paleudult in Escambia County (soil 8) (Fig. 1) experienced a long period of perching during the same period, although of shorter duration than soil 7 (Fig. 9). The perched water table in this soil was associated with the Btvg2 horizon, which was higher in clay than the overlying horizons.

In summary, perched water tables were not prevalent. In soils where perched water tables were detected, occurrence was seen at horizon transitions. In Arenic soils, perching occurred above argillic and/or kandic horizons that are marked by increased clay, a more firm moist consistence, and structural change. Both Aquic soils experienced perched water tables within the argillic horizons above depleted horizons. No consistent pattern was observed within these three soils that would relate perched water tables occurrence to any particular pedogenic feature.

All pedons had rapid infiltration (assumed by response of water table to rainfall, and sandy epipedons) and upland soils experienced rapid recession of the water table, which is expected in relatively sandy upland soils. Pedons located within landscapes of low relief or drainage ways had water tables of longer duration than sloping, terrace, and upland soils.

Depleted horizons in soils located in drainage ways were saturated for 67% of the MP, and up to 101 durational days (on an annual basis). In comparison, depleted horizons in upland and terrace soils were saturated 51 and 12%, and 92 and 10 durational days, respectively (Table 1). Horizons in drainage way soils containing plinthite and depletions of chroma ≤ 3 were saturated for 54% of the MP, and up to 96 average annual durational days, compared to similar horizons in upland and terrace soils that were saturated 18 and 9%, and 24 and 7 durational days, respectively. High average annual NSE values were found in drainage way soils, with an NSE of 7 in depleted horizons, and 6 in horizons containing both plinthite and chroma ≤ 3 Fe depletions. Soils on terrace positions had NSE values of zero for all horizons. Depleted horizons in upland soils contained an average annual NSE value of 6, and an NSE value of 1 in horizons containing both plinthite and chroma ≤ 3 Fe depletions. For horizons that experienced periodic saturation, average annual frequency of saturation events was highest in drainage way soils (10 events), followed by terrace soils (8) and upland soils (4). Although terrace soils experienced more average annual saturation events than upland soils, average duration of the events was shorter. These data indicate that interpretation of soil hydromorphological features is landscape dependent, and hydromorphic features in soils located in concave positions suggest increased saturation compared with similar features in soils on upland convex or linear positions.

Drainage Class Assessment

Internal drainage class field assessment is largely based on observed depth to redoximorphic features (Soil Survey Div. Staff, 1993). Minimal saturation was recorded within most of the Grossarenic, Arenic and Plinthic pedons, which corresponds to their upland landscape positions and conventional drainage class assessment (well drained to somewhat excessively drained). Those pedons on low-lying (drainage ways) landscape positions (Aquic and Plinthaquic soils) had significant water table activity that matched the somewhat poorly to poorly drained drainage classes (Table 6). Six of the eleven pedons experienced saturation (with 20 annual durational days or 30 annual cumulative days as benchmarks for reducing conditions) that matched their drainage class. Five of the six pedons that met their drainage class field assessment were upland soils that were well drained to somewhat excessively well drained. Three of the five pedons that did not meet their respective drainage class field assignments were drier than indicators suggested, and the remaining two experienced benchmark saturation at shallower depths than hydromorphic features suggested.

Two of the five pedons that did not match their drainage class field assessment had durational saturation for events ≥ 20 days or cumulative ≥ 30 days (in one year of *normal* precipitation) at shallower depths than redox depletions. No similarities between these two soils were evident; one pedon is a Grossarenic Kandiudult located on a backslope and the other is an Aquic Paleudult located on a low terrace position. Three of the five that did not match their drainage class field assessment did not have durational saturation as shallow as the redox depletions. These three were located on terrace positions and it is likely these redox features are relict, and represent a soil hydrological regime that existed when the soil was at a lower terrace position.

In summary, eight of the eleven pedons had water tables that met their field drainage class assessment for the majority of the MP.

Conclusion

Field estimates generally over estimated plinthite compared to laboratory slaking methods. Most of the soils did not have evidence of a perched water table, possibly due to low concentrations of nodular plinthite. Plinthite was found in horizons saturated for as little as 1% to as much as 85% of the MP, but was not consistently associated with observed water tables of significant duration. Thus, plinthite occurrence is mostly not associated with contemporary soil hydrology and likely reflects previous moisture regimes.

Soft Fe accumulations were found in horizons with a wide range of saturation percentages, and were indicators of significant durational water tables in Aquic and Plinthaquic subgroups. Soft Fe accumulations found in combination with other hydromorphic features (e.g., depletions of chroma ≤ 2) indicated significant saturation duration within all soils of this study.

Iron depletions with chroma of 3 alone did not indicate durational saturation in Plinthic or Oxyaquic subgroups, but when found with other hydromorphic features, were suggestive of saturation. Horizons with iron depletions of chroma ≤ 2 were significantly saturated and had higher NSE values, indicating repetitive events of reducing conditions. Horizons with depleted matrices experienced the greatest annual average cumulative days of saturation, saturation percentage, saturation duration and highest NSE values.

Drainage class field assessment closely matched observed water table activity in most of the pedons. It was apparent within our study of Alabama Coastal Plain soils that water table activity was influenced by landscape position. Durational saturation was significant in pedons located within drainage ways. Somewhat excessively drained Grossarenic soils on summit or shoulder (upland) landscape positions had very little water table activity, whereas Grossarenic soils found on middle backslope positions experienced water tables for significant duration.

The use of hydromorphic features for the interpretation and prediction of prolonged seasonal high water tables in the soils of the Alabama Coastal Plain is viable and beneficial. Hydromorphic features indicating contemporary hydrology include Fe depletions, soft Fe accumulations and depleted matrices.

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Table 1. Pedon classification, soil grouping, and landscape position of eleven water table monitoring sites located throughout the Alabama Coastal Plain.

Soil ID	Data Logger (s)	County	Classification
1	30637, 30736	Baldwin	Fine-loamy, kaolinitic, thermic Plinthic Kandiudult
2	30742	Crenshaw	Loamy, kaolinitic, thermic Grossarenic Kandiudult
3	30715, 30723	Crenshaw	Loamy, kaolinitic, thermic Grossarenic Kandiudult
4	30602, 30627	Crenshaw	Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult
5	30747, 47731/30606†	Crenshaw	Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult
6	30704, 30732	Crenshaw	Loamy, siliceous, subactive, thermic Grossarenic Paleudult
7	30748, 30634	Crenshaw	Loamy, kaolinitic, thermic Arenic Plinthic Kandiudult
8	30733, 30662/30611†	Escambia	Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult
9	30621, 30694	Washington	Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult
10	30624, 30737	Washington	Fine-loamy, siliceous, semiactive, thermic Oxyaquic Paleudult
11	30661, 30698	Escambia	Coarse-loamy, siliceous, semiactive, thermic Plinthic Paleudult

Soil ID	Pedon	Installation Date	Soil Grouping §	Landscape position
1	S06AL-003-1	11/19/2003	Plinthic	Backslope (upland)
2	S06AL-041-1	12/2/2003	Arenic	Shoulder (upland)
3	S06AL-041-2	2/3/2004	Arenic	Backslope (upland)
4	S06AL-041-3	3/17/2004	Aquic	Drainage way
5	S06AL-041-4	12/2/2003	Plinthic	High Terrace
6	S06AL-041-5	12/3/2003	Arenic	Backslope (upland)
7	S06AL-041-6	12/2/2003	Plinthic & Arenic	Shoulder (upland)
8	S06AL-053-1	11/19/2003	Aquic	High Terrace with low relief
9	S06AL-129-1	11/18/2003	Aquic	Drainage way
10	S06AL-129-2	11/18/2003	Oxyaquic	Backslope (upland)
11	Poarch 1‡	11/19/2003	Plinthic	High Terrace

† Pressure transducer replacement.
‡ Without laboratory characterization data.
§ Plinthic (4) soil grouping includes Plinthic and Arenic Plinthic subgroups, Arenic (4) soil grouping includes Arenic Plinthic and Grossarenic subgroups, Aquic (3) soil grouping includes Aquic and Plinthaquic subgroups, and Oxyaquic soil grouping includes the Oxyaquic soil.

Table 2. Weather station proximity to pedons, and monthly and annual comparison to 30-yr rainfall.

Station	County	2004 mo†	2004 yr‡	2004 Normal§	2005 mo†	2005 yr‡	2005 Normal§	2006 mo†	2006 yr‡	2006 Normal§	Closest Pedons	Approximate Distance (km)
Atmore	Escambia	4	yes	no	6	yes	no	9	yes	yes	S06AL-053-1	13
	Escambia	4	yes	no	6	yes	no	9	yes	yes	Poarch 1	13
Bay Minette	Baldwin	8	yes	yes	9	yes	yes	10	yes	yes	S06AL-129-1	63
	Baldwin	8	yes	yes	9	yes	yes	10	yes	yes	S06AL-129-2	63
Fairhope	Baldwin	7	yes	no	7	no	no	9	no	no	S06AL-003-1	1
Highland Home	Crenshaw	8	yes	yes	8	yes	yes	10	yes	yes	S06AL-041-1	10
	Crenshaw	8	yes	yes	8	yes	yes	10	yes	yes	S06AL-041-2	5
	Crenshaw	8	yes	yes	8	yes	yes	10	yes	yes	S06AL-041-3	47
	Crenshaw	8	yes	yes	8	yes	yes	10	yes	yes	S06AL-041-4	53
	Crenshaw	8	yes	yes	8	yes	yes	10	yes	yes	S06AL-041-5	32
	Crenshaw	8	yes	yes	8	yes	yes	10	yes	yes	S06AL-041-6	52

† number of normal months(+/- 1 SD of 30 yr avg.).
‡=does annual total fall within+/-1 SD of 30 yr avg.
§=does year meet Soil Taxonomy normal requirements.

Table 3. Comparison of field and laboratory estimates of plinthite for nine of the eleven Alabama Coastal Plain soils studied.

Pedon	Horizons with plinthite	Lower Depth	Plinthite % Field Estimate	Plinthite % Laboratory (by volume)
		(cm)	-------------------(%)-------------------	
S06AL-003-1	Bt2	113	5	0
	Btv1	138	5	2
	Btv2	190	12	19
	Btg	215	0	3
S06AL-041-1	E1	82	<2	0
	E2	139	2 to 20	0
	E3	156	2 to 20	1
	E4	169	2 to 20	1
S06AL-041-2	E3	142	5	0
	BE	156	7	4
	Btv1	179	15	17
	Btv2	200	5	10
S06AL-041-3	Bt	43	0	1
	Btv	68	10	3
	B't1	125	0	1
	B't3	187	0	1
S06AL-041-4	Btv1	128	10	1
	Btv2	155	10	6
	Btv3	186	5	2
	BC	196	0	3
S06AL-041-6	Btv1	97	8 to 12	4
	Btv2	124	8	5
	Bt	152	5	1
S06AL-053-1	Bt	60	5	0
	Btvg1	90	5	3
	Btvg2	114	10	1
	Btvg3	140	15	6
	B'tv	151	15	6
S06Al-129-1	Btv1	90	12	5
	Btv2	110	15	3
	Btv3	129	10	5
S06Al-129-2	E2	60	0	2
	Btv1	94	8	13
	Btv2	121	12	7
	Btv3	152	8	3
	Btg	190	<2	3

Table 4. Saturation metrics of horizons containing plinthite for nine of eleven studied Alabama Coastal Plain soils. Analysis conducted for *normal* years as defined by Soil Taxonomy.

Soil Pedon	Horizons with plinthite	Lower Depth	Saturation† Longest Duration	Periodicity	Cumulative	%
			Average Annual			
		(cm)	(days)	(events)	(days)	
S06AL-003-1	Bt2	113	0	0	0	0
	Btv1	138	0	0	0	0
	Btv2	190	47	4	68	19
	Btg	215	nm	nm	nm	nm
S06AL-041-1	E1	82	0	0	0	0
	E2	139	0	0	0	0
	E3	156	0	0	0	0
	E4	169	2	1	2	0
S06AL-041-2	E3	142	52	3	71	14
	BE	156	71	5	112	29
	Btv1	179	78	5	151	44
	Btv2	200	nm	nm	nm	nm
S06AL-041-3	Bt	43	51	6	148	28
	Btv	68	131	7	247	45
	B't1	125	365	1	365	79
	B't3	187	365	1	365	85
S06AL-041-4	Btv1	128	0	0	0	0
	Btv2	155	3	5	9	4
	Btv3	186	11	7	31	13
	BC	196	nm	nm	nm	nm
S06AL-041-6	Btv1	97	2	4	2	0
	Btv2	124	nm	nm	nm	nm
	Bt	152	nm	nm	nm	nm
S06AL-053-1	Bt	60	7	7	16	4
	Btvg1	90	10	8	42	12
	Btvg2	114	36	7	76	21
	Btvg3	140	134	7	238	65
	B'tv	151	nm	nm	nm	nm
S06Al-129-1	Btv1	90	81	8	227	54
	Btv2	110	84	6	247	59
	Btv3	129	85	6	251	61
S06Al-129-2	E2	60	3	1	3	1
	Btv1	94	8	3	10	3
	Btv2	121	13	7	42	9
	Btv3	152	34	12	106	21
	Btg	190	100	4	269	62

† = Saturation metrics calculated for 30-yr normal precipitation, where longest duration = average annual longest saturated period, periodicity = average annual frequency of saturation, cumulative = average annual number of days experiencing saturation, % = average percent of annual saturation.

nm = not measured due to depth of piezometer installation.

Table 5. The relationships between hydromorphic features and water table metrics for *normal* years (as per Soil Taxonomy) occurring within the 2004-2006 monitoring period for the studied Alabama Coastal Plain soils.

Hydromorphic Feature	n†	Saturation‡				21 day§	NSE
		Cumulative	Durational	Periodicity	%		
		----------(days)----------		(events)			
		All Soils					
Soft Fe Acc.	27	33.6	16.0	4.1	11	0.4	0.7
Chroma 3	15	40.3	18.6	3.5	16	0.5	0.9
Soft Fe Acc. & Chroma ≤ 3	24	57.7	27.6	5.1	19	0.6	1.4
Plinthite	24	63.0	33.8	3.7	20	0.8	1.9
Chroma ≤ 2	21	78.4	42.1	4.9	25	1.0	2.4
Plinthite & Chroma ≤ 3	21	85.9	42.9	5.1	27	1.0	2.4
Depleted Matrix	11	199.6	89.7	8.0	56	2.5	5.7
		Arenic soils					
Soft Fe Acc.	12	22.1	16.2	1.1	10	0.3	0.8
Plinthite	9	29.1	21.2	1.2	14	0.4	1.1
Chroma 3	9	43.3	23.1	1.4	20	0.7	1.4
Soft Fe Acc. & Chroma ≤ 3	9	43.3	23.1	1.4	20	0.7	1.4
Plinthite & Chroma ≤ 3	6	64.8	34.5	2.0	29	1.0	2.1
Chroma ≤ 2	6	64.3	34.3	1.8	29	1.0	2.1
		Plinthic soils					
Chroma 3	6	4.8	2.3	1.5	1	0.0	0.0
Soft Fe Acc.	8	7.1	3.4	2.1	2	0.0	0.0
Plinthite	8	8.3	3.5	2.6	2	0.0	0.0
Plinthite & Chroma ≤ 3	8	17.3	9.4	3.4	5	0.1	0.3
Soft Fe Acc. & Chroma ≤ 3	8	17.8	9.6	3.6	5	0.1	0.3
Chroma ≤ 2	5	27.6	15.0	5.4	8	0.2	0.4
Depleted Matrix	1	68.0	47.0	4.0	19	1.0	2.2
		Oxyaquic soils					
Plinthite	3	4.3	3.3	2.3	1	0.0	0.0
Soft Fe Acc.	3	4.3	3.3	2.3	1	0.0	0.0
Chroma ≤ 2	3	33.7	11.0	6.0	9	0.0	0.0
Soft Fe Acc. & Chroma ≤ 3	3	33.7	11.0	6.0	9	0.0	0.0
Plinthite & Chroma ≤ 3	3	33.7	11.0	6.0	9	0.0	0.0
Depleted Matrix	3	227.7	107.3	4.7	62	2.7	6.8
		Aquic soils					
Chroma 3	3	63.3	19.7	11.0	19	0.3	0.5
Soft Fe Acc.	7	82.3	29.0	11.0	23	0.9	1.4
Soft Fe Acc. & Chroma ≤ 3	7	107.9	49.4	9.3	30	1.1	2.7
Chroma ≤ 2	7	146.0	81.6	6.7	41	2.0	5.0
Plinthite	7	168.0	83.6	7.3	47	2.1	5.2
Plinthite & Chroma ≤ 3	7	168.0	83.6	7.3	47	2.1	5.2
Depleted Matrix	7	206.4	88.3	10.0	59	2.6	5.7

† number of horizons.

‡ saturation metrics calculated for 30-yr normal precipitation, where cumulative = average annual number of days experiencing saturation; durational = average annual longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

§ 21 days = onset of reducing conditions found by He et al. (2003); NSE = number of saturation events.

Table 6. Soil drainage class interpretation by field morphology (Soil Survey Staff, 1993) compared to water table assessment for *normal* years (as per Soil Taxonomy) for the studied Alabama Coastal Plain soils.

Pedon	Depth to saturation indicator			Drainage Class†	
	Chroma ≤2	Saturation Durational ≥ 20 days	Cumulative Saturation ≥ 30 days	Field Morphology	Water Table Assessment
	------------------------(cm)---------------------------------				
S06AL-003-1	138	>100	>100	WD	WD
S06AL-041-1	>211	>100	>100	SWED	SWED
S06AL-041-2	179	75-100	>100	SWED	SWED ('04,'06) MWD ('05)
S06AL-041-3	43	0-25	0-25	SWPD	PD ('04), SWPD ('05-'06)
S06AL-041-4	128	>100	>100	WD	WD
S06AL-041-5	174	>100	>100	SWED	SWED
S06AL-041-6	>200	>100	>100	WD	WD
S06AL-053-1	38	50-75	25-50	SWPD	MWD
Poarch 1	75	>100	50-75	MWD	WD
S06AL-129-1	23	0-25	0-25	PD	PD
S06AL-129-2	94	>100	>100	MWD	WD

† SWED = somewhat excessively drained, WD =well drained, MWD = moderately well drained, SWPD = somewhat poorly drained, PD = poorly drained.

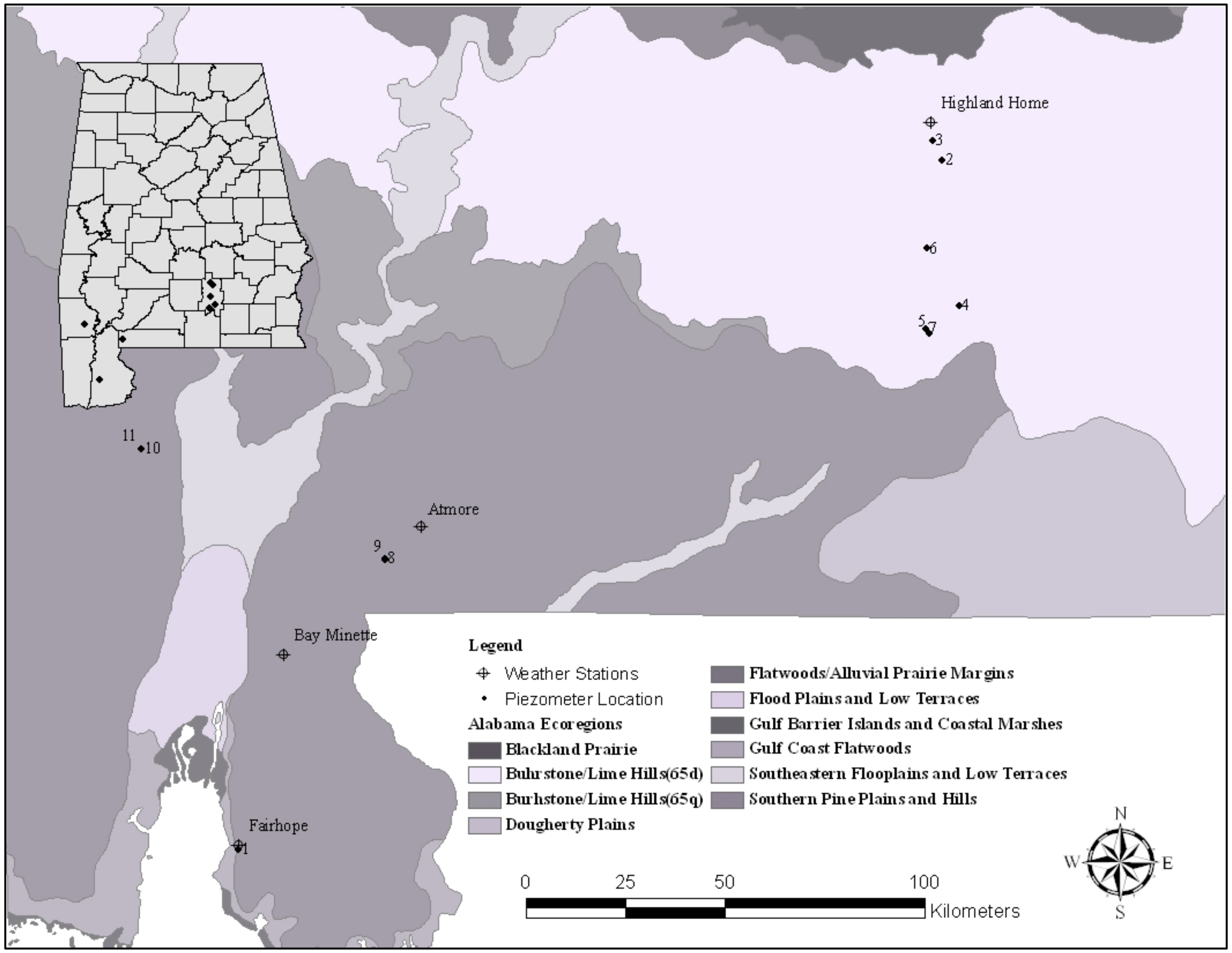

Fig. 1. Ecoregions of the Alabama Coastal Plain with pedon and weather monitoring station locations.

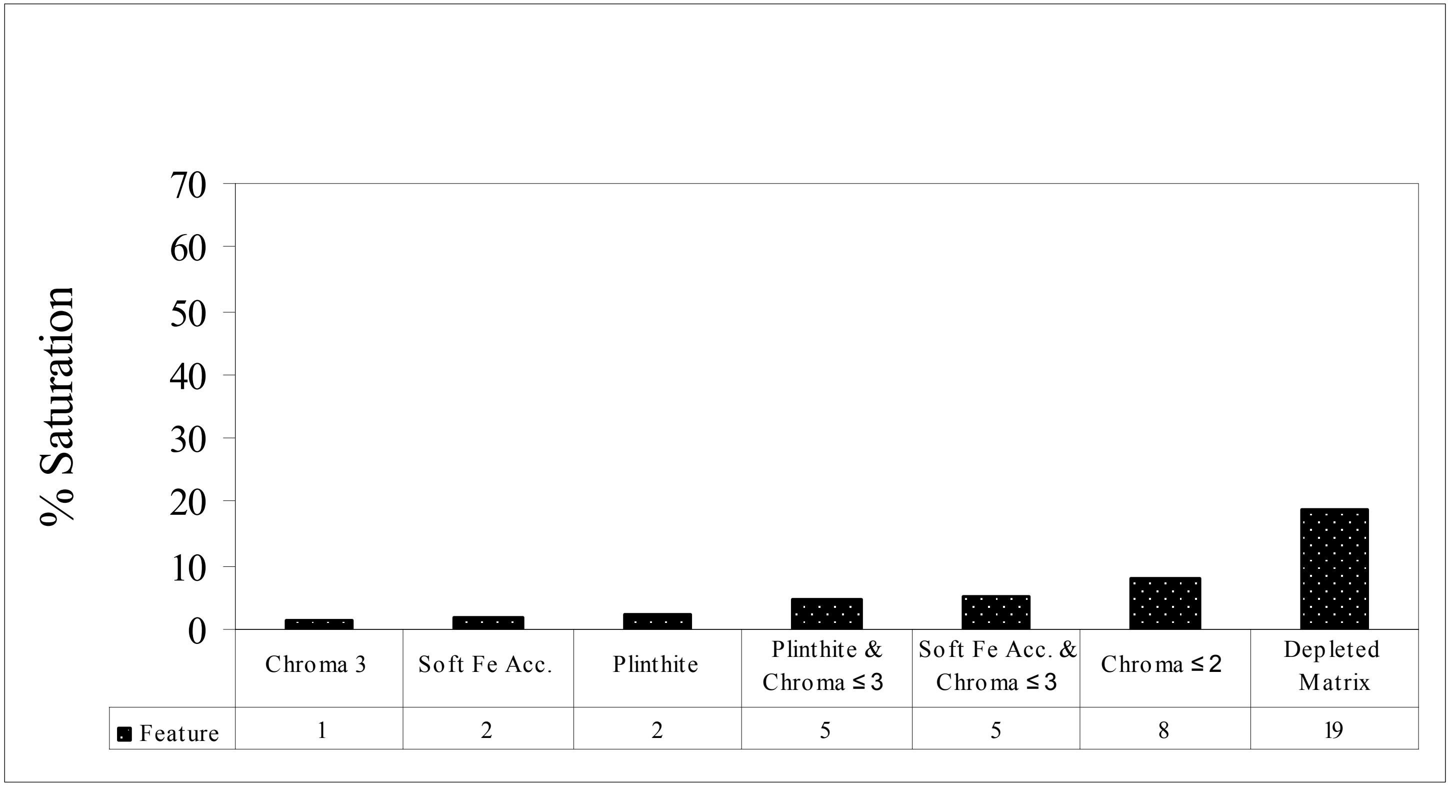

Fig. 2. Average annual saturation percentage of horizons with hydromorphic features for four Plinthic soils of the Alabama Coastal Plain. Saturation percentages calculated for *normal* years (as per Soil Taxonomy) occurring within the 2004-2006 monitoring period.

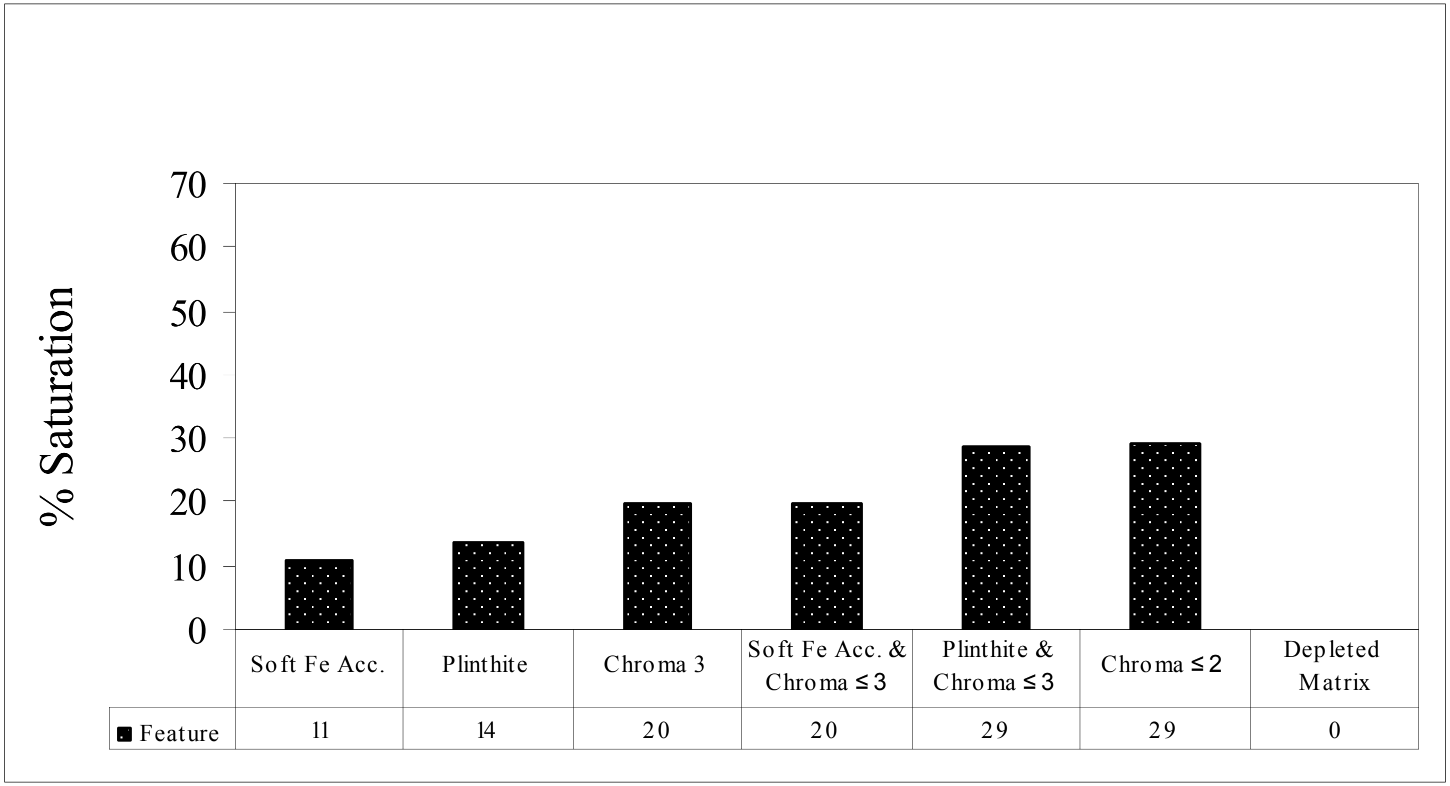

Fig. 3. Average annual saturation percentage of horizons with hydromorphic features for four Arenic soils of the Alabama Coastal Plain. Saturation percentages calculated for *normal* years (as per Soil Taxonomy) occurring within the 2004-2006 monitoring period.

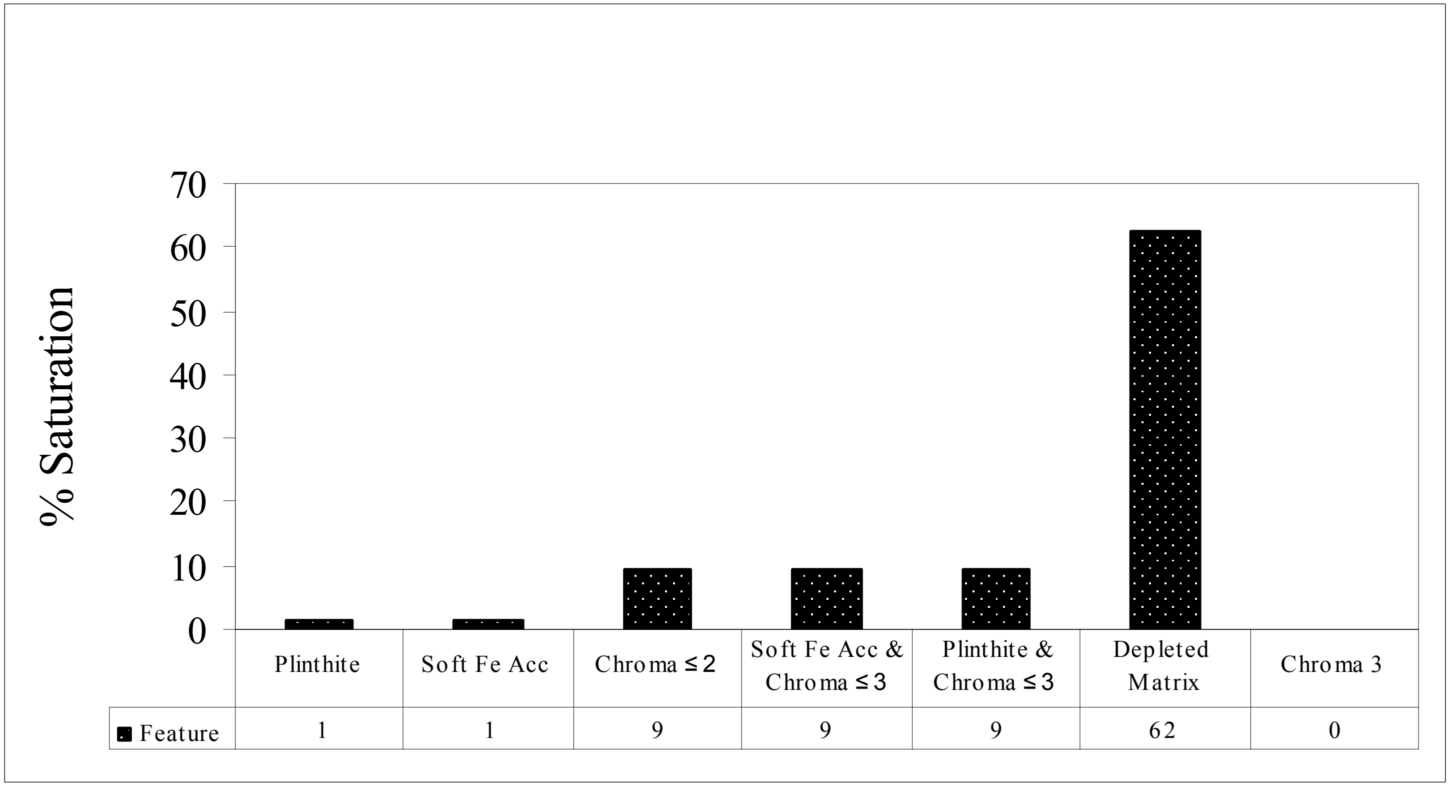

Fig. 4. Average annual saturation percentage of horizons with hydromorphic features for a soil in an Oxyaquic subgroup of the Alabama Coastal Plain. Saturation percentages calculated for *normal* years (as per Soil Taxonomy) occurring within the 2004-2006 monitoring period.

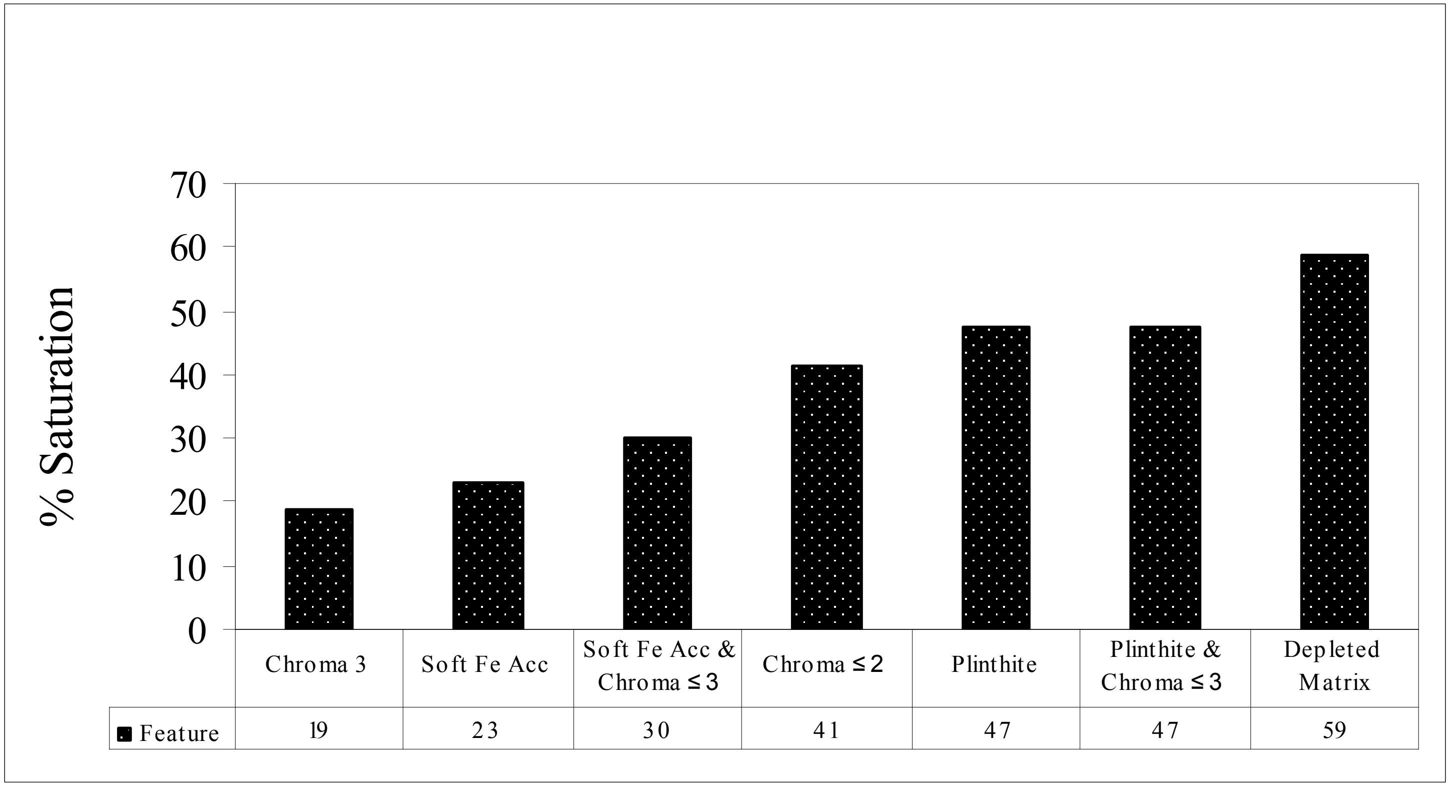

Fig. 5. Average annual saturation percentage of horizons with hydromorphic features for three Aquic soils of the Alabama Coastal Plain. Saturation percentages calculated for *normal* years (as per Soil Taxonomy) occurring within the 2004-2006 monitoring period.

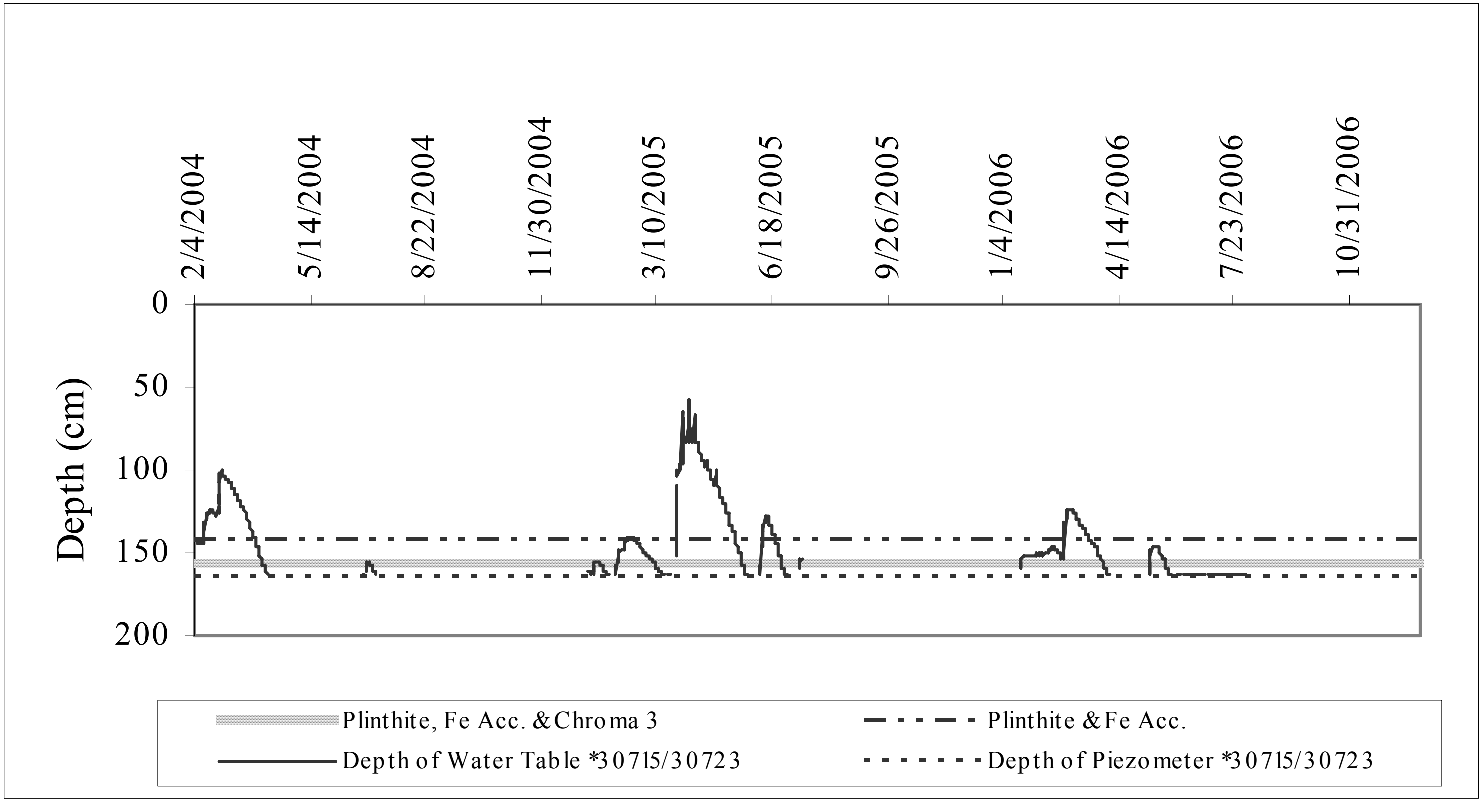

Fig. 6. Water-table depth in relation to hydromorphic feature occurrence in Crenshaw County pedon S06AL-041-2 (Loamy, kaolinitic, thermic Grossarenic Kandiudult). The 2004 to 2006 monitoring period had *normal* precipitation as per Soil Taxonomy.

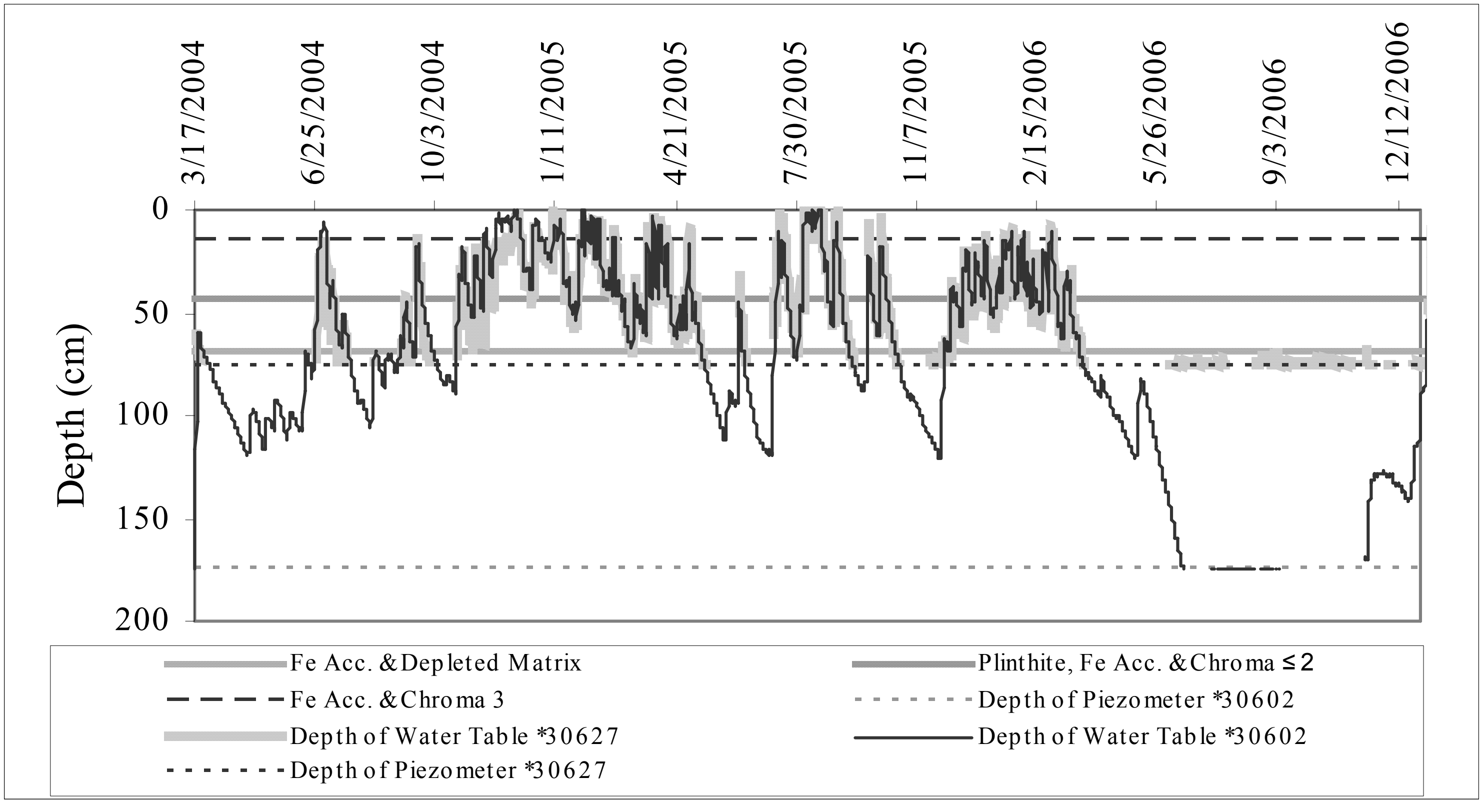

Fig. 7. Water-table depth in relation to hydromorphic feature occurrence in Crenshaw County pedon S06AL-041-3 (Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult). The 2004 to 2006 monitoring period had *normal* precipitation as per Soil Taxonomy.

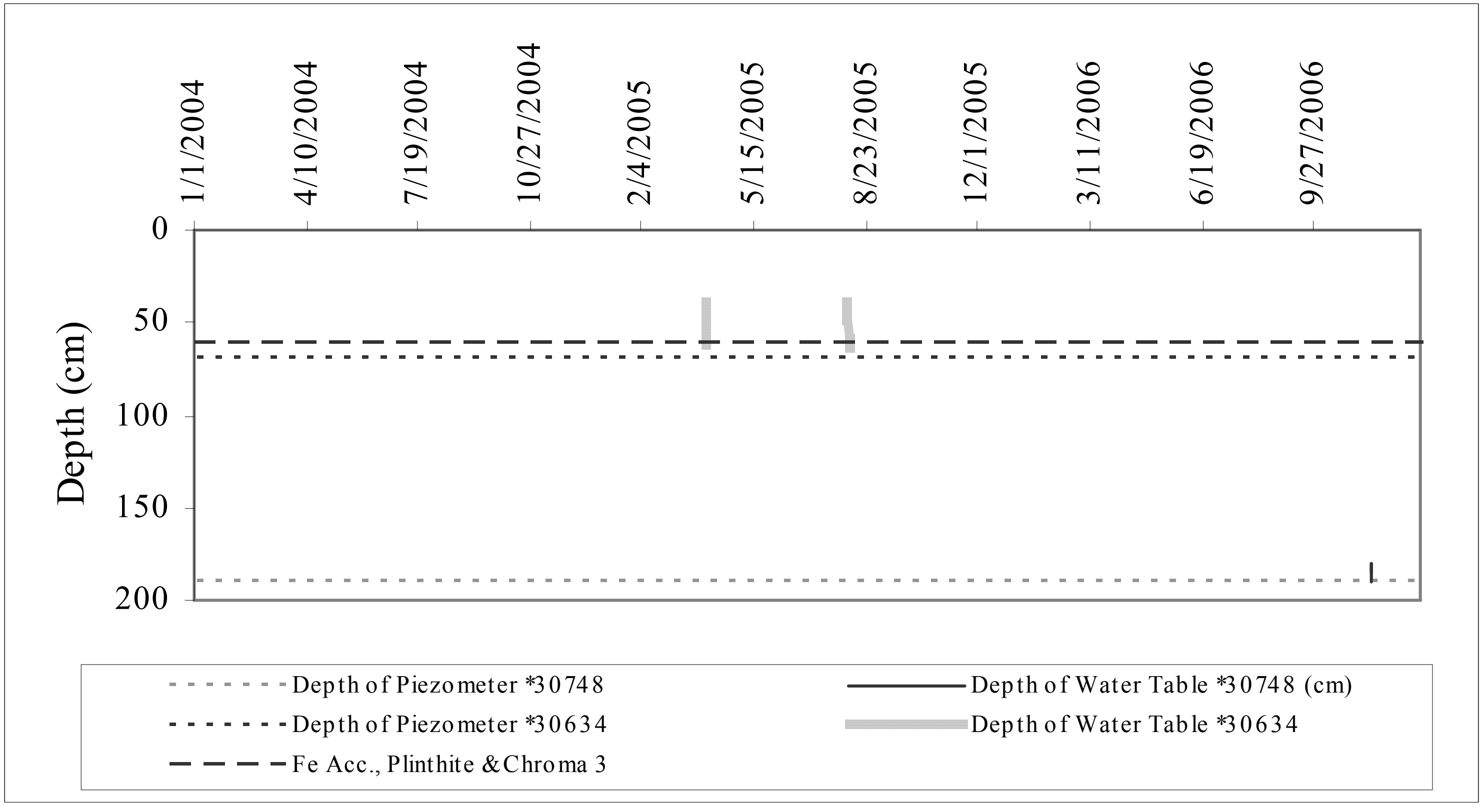

Fig. 8. Water-table depth in relation to hydromorphic feature occurrence in Crenshaw County pedon S06AL-041-6 (Loamy, kaolinitic, thermic Arenic Plinthic Kandiudult). The 2004 to 2006 monitoring period had *normal* precipitation as defined by Soil Taxonomy.

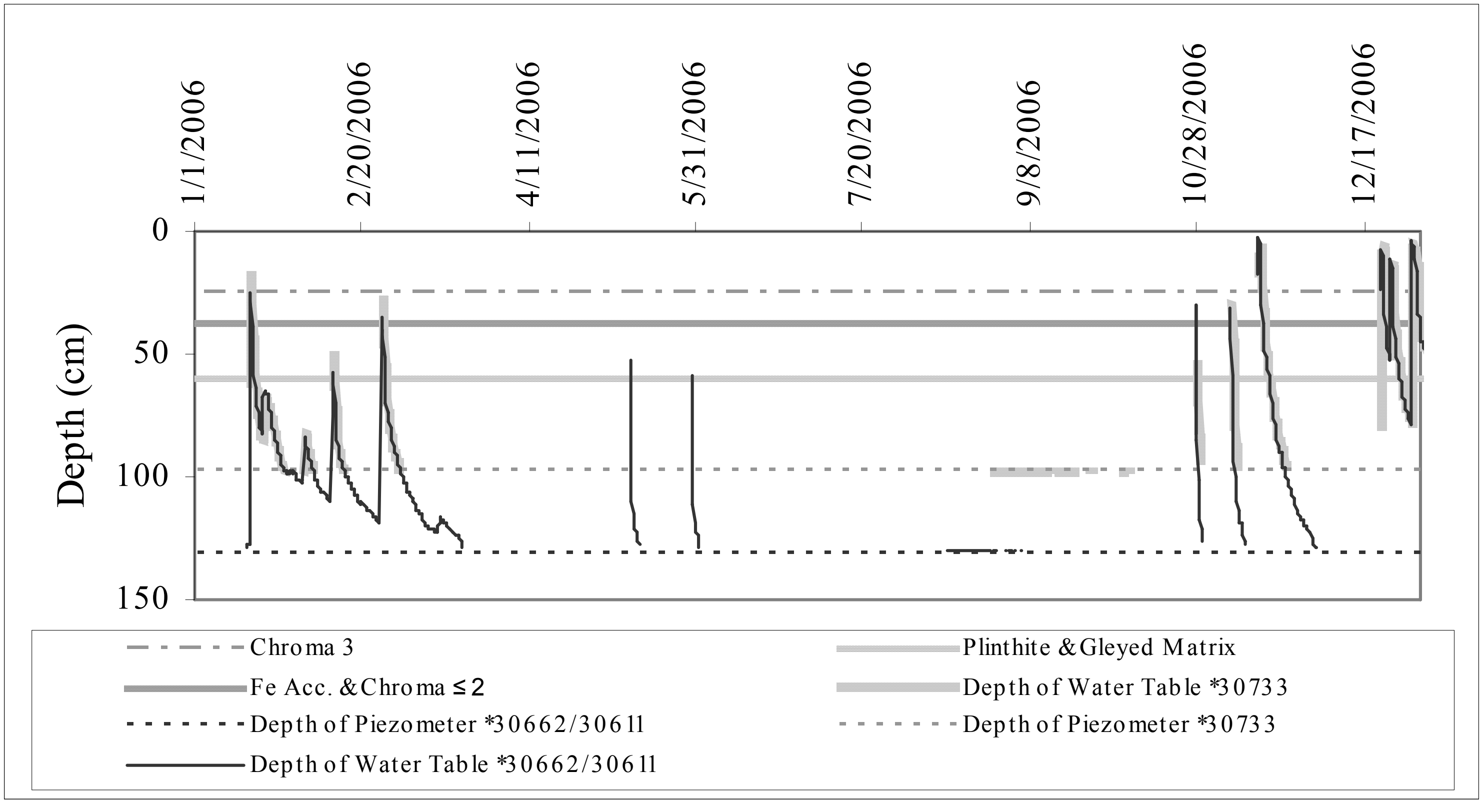

Fig. 9. Water-table depth in relation to hydromorphic feature occurrence in Escambia County pedon S06AL-053-1 (Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult). The 2006 monitoring period had *normal* precipitation as per Soil Taxonomy.

III. PLINTHITE CHARACTERIZATION IN SOME SEASONALLY SATURATED ALABAMA COASTAL PLAIN SOILS

Abstract

The role plinthite plays in identifying contemporary seasonal saturation in Alabama Coastal Plain soils is largely unknown. Plinthite characterization and its relation to seasonal high water tables will provide knowledge of the role of this hydromorphic feature in contemporary water table assessment. An on-going water table study conducted in cooperation with the Natural Resources Conservation Service (NRCS) and the Alabama Agricultural Experiment Station (AAES) monitored an Aquic and two Plinthic Paleudults from 2004 to 2006. Water table data were recorded every six hours for duration, periodicity and cumulative saturation. Soils were described, sampled, characterized and classified according to standard techniques. Plinthite was quantified using a slaking technique. Soil physical and chemical properties were analyzed within segregated plinthite nodules and whole soils. Averaged by horizon, plinthite contained 31% more carbon, 4 % more clay, 259% more dithionite extractable Fe, and 1280% more poorly crystalline Fe than the corresponding whole soil. Plinthite quantities were positively correlated with whole soil dithionite extractable Fe, and negatively with active soil Fe. Whole soil Fe_o/Fe_d increased as a function of percent saturation, suggesting a relationship between active Fe and seasonal saturation. Plinthite was found in horizons saturated for 0% to 60% of the monitoring period. Plinthite occurrence and quantity

largely reflects past soil moisture regimes, and although continually maturing, was not an indicator of contemporary hydrology in this study.

Introduction

Water table monitoring is beneficial for developing relationships between the duration of soil saturation and hydromorphic features. Soil scientists rely on the interpretation of soil morphological features to infer land use feasibility for urban development, crop production, and waste disposal. Identification and separation of contemporary hydromorphic features is critical for these interpretations.

Iron (Fe) oxide reduction and oxidation within soils that experience fluctuating periods of saturation initiate the translocation and accumulation of Fe oxides (Calmon et al., 1998; Genthner et al., 1998). Soft Fe accumulations have diffuse boundaries and indicate contemporary seasonal saturation (Griffin et al., 1992). Cyclical reduction and oxidation of Fe leads to oxide accumulation (or concentration), that is marked by increased Fe oxide content (Daniels et al., 1978). D'Amore et al. (2004) found redox concentrations four to nine times more concentrated with Fe than the surrounding soil in Oregon wetlands. A cementation continuum exits between soft Fe oxide accumulations, plinthite nodules, and ironstone (Daniels et al., 1978). Accumulations with distinct boundaries and higher densities (more cemented) often represent past hydrological regimes, and are considered relict features (Griffin et al., 1992; Vepraskas, 1996).

Cementation leads to plinthite development, which are firm or very firm in consistence and removable from the soil matrix. Plinthite nodules and concretions are described as Fe-rich, humus-poor, accumulations (Daniels et al., 1985). Plinthite, by definition, consists of Fe accumulations cemented to such a degree that they can be removed intact from the surrounding soil (Soil Survey Div. Staff, 1993). Plinthite is commonly found in Coastal Plain soils. Plinthite nodules have hues of 10R to 7.5YR, are generally greater than 2-mm in size, and can be crushed with moderate pressure (Wood and Perkins, 1976; Daniels et al., 1978). Separation of plinthite from other materials is achieved by slaking bulk soil samples in water. Wood and Perkins (1976) and Daniels et al. (1978) introduced slaking procedures with soaking times of 2 to 8 hours. Plinthic material, rock, and ironstone remain intact during slaking procedures, while non-cemented materials slake quickly.

Plinthite quantity and physical shape affect soil permeability and water movement. Quantities of > 10% platy plinthite or > 25% nodular plinthite can perch water (Daniels et al., 1978; Guthrie and Hajek, 1979). In a study of Georgia Coastal Plain soils, hydraulic conductivity of soil horizons with plinthite (Btv) were intermediate between horizons without plinthite (Bt) and horizons (BC) with less structure (Shaw et al., 1997). Plinthite was determined to have no profound effect on hydraulic properties when present in low quantities. Coarser textures and more crystalline Fe oxides have been found in plinthite nodules relative to the surrounding soil (Wood and Perkins, 1976). Higher silt was found in plinthite of Georgia Coastal Plain soils compared with the surrounding soil matrix, and kaolinite was the primary clay mineral (Wood and Perkins, 1976). Comparison between plinthic and non-plinthic materials from a Typic Plinthaquult in Brazil showed greater silt/clay ratios in plinthic materials (dos Anjos et al., 1995).

Higher concentrations of Fe oxides are generally found in finer particle size fractions (Schwertmann and Taylor, 1989; Aide et al., 2004). Vepraskas and Wilding (1983) suggested that Fe oxides and clay fractions migrate simultaneously upon reduction. Iron oxides vary in mineralogy (e.g., hematite, goethite, lepidocrocite, ferrihydrite) and crystallinity (e.g., crystalline, paracrystalline, amorphous) (Jackson et al., 1986; Schwertmann and Taylor, 1989). Secondary iron oxide formation is dependant on pedo-environmental conditions. Vepraskas (1996) suggests that hematite enriched redoximorphic features may represent relict features. Typically, iron oxides become more crystalline with age.

Methods are available for extracting the various forms of Fe (and Al). Acid ammonium oxalate (AOX) extracts poorly crystalline Fe and organically bound Fe (Holmgren et al., 1977; Wada, 1989). Dithionite citrate bicarbonate (DCB) extracts crystalline, paracrystalline, and amorphous Fe and organically bound Fe (Jackson, 1979). Ratios of AOX/DCB Fe (Fe_o and Fe_d, respectively) are used to indicate Fe in the active fraction. Higher Fe_o/Fe_d ratios often indicate soil environments with contemporary reduction and oxidation cycles (Schwertmann and Taylor, 1989). Higher Fe_d concentrations have been found in plinthite bodies than in the surrounding soil matrix, and the Fe_o/Fe_d ratio (indicative of active Fe) was higher in the soil than in plinthite nodules of a Typic Plinthaquult of Brazil (dos Anjos et al., 1995).

Sandy soils of the Alabama Coastal Plain present challenges in redoximorphic feature assessment due to low concentrations of Fe and carbon (Vepraskas and Wilding, 1983; Veneman et al., 1998). In addition, identification and separation of contemporary and relict redoximorphic features is arduous. Greenburg and Wilding (1998) suggest that some of this is due to the stabilization and cementation of accumulations that occurs over time. Iron accumulation boundary and distribution may be the best field evaluation technique available to aid in the interpretation of contemporary versus relict features (Vepraskas and Wilding, 1983; Fanning and Fanning, 1989; Fanning et al., 1992; Griffin et al., 1992; Vepraskas and Guertal, 1992; Vepraskas, 1996; Griffin et al., 1998). Plinthite nodules are cemented and have clear defined boundaries that suggest their occurrence does not represent contemporary moisture regimes.

A water table study in the Alabama Coastal Plain was initiated in 2003 in plinthic soils in order to identify and separate contemporary hydromorphic features from relict features. This study, conducted jointly with the Natural Resources Conservation Service (NRCS) and Alabama Agricultural Experiment Station (AAES), is monitoring water table metrics (saturation duration, periodicity, cumulative, and percentage) in three Alabama Coastal Plain soils (Plinthic (2) and Aquic (1) Paleudults). The goal is to: 1) characterize plinthite, and 2) relate its occurrence to seasonal high water tables.

Materials and Methods

Soil pedon and site characteristics

The three representative pedons evaluated in this study are located in Baldwin (1) and Washington Counties (2) (Table 7). These sites were selected from eleven sites in a companion study where water table activity is being monitored and related to hydromorphic feature occurrence. The Baldwin County site is located within a gently sloping pasture, and the Washington County sites are located in gently sloping and level planted pine plantations.

The Coastal Plain region of Alabama is diverse and dissected with recent fluvial deposits overlying fluvio-marine sediments that span from the Cretaceous to Quaternary periods. Coarse-loamy soils in Plinthic and Aquic Subgroups in Washington County lie over the undifferentiated Miocene Series. The Plinthic Paleudult in Baldwin County lies within the Citronelle formation (Pliocene) (Cooke, 1926). The three soil pedons described lie within the Southern Pine Plains and Hills eco-region (Griffith et al., 2001). Soils in this study possess plinthite, hydromorphic features, sandy epipedons, and experience fluctuating seasonal saturation.

Soil description, sampling and characterization

Soils were described and sampled from backhoe excavations to a depth of two meters. Horizons were separated, described, and sampled for laboratory analysis using standard soil survey techniques (Soil Survey Staff, 2006). Bulk density was determined by horizon (in triplicate) by the clod method (Soil Survey Inv. Staff, 2004).

Field estimates of the percentages of plinthite conducted during pedon description followed procedures within the *Field Book for Describing and Sampling Soils* (Schoenberger et al., 2002). Comparison of plinthite, with or without Fe depletions ≤ 3, with actual water table activity allowed for calculation of the percentage of horizon saturation, maximum water table periodicity, duration, and cumulative saturation for years in which precipitation was *normal* (described below).

Soil samples were air-dried and separated into two approximately equal portions (one for soil characterization and one for plinthite analyses). Prior to laboratory analysis, soil samples were crushed with a rolling pin and passed through a 2-mm sieve. Particle size distribution of the soil was analyzed using the pipette method (Kilmer and

Alexander, 1949). Cation exchange capacity and base saturation were determined by mechanical extraction with ammonium acetate (pH 7) (Soil Survey Inv. Staff, 2004). Bases were measured with atomic absorption (Ca and Mg) and atomic emission (K and Na) spectroscopy. Base saturation of the soil samples were calculated from ammonium acetate (pH 7) and sum of cations (pH 8.2) methods (Adams and Evans, 1962; Hajek et al., 1972; Soil Survey Inv. Staff, 2004). Extractable Al was obtained by extraction with 1 N KCl followed by titration with NaOH (Soil Survey Inv. Staff, 2004). Effective cation exchange capacity (ECEC) was calculated by summing KCl extractable Al and exchangeable bases (Soil Survey Inv. Staff, 2004). Soil pH was determined in 1:1 soil:water (w/v) and 0.01 M $CaCl_2$ 1:2 soil:water (w/v).

Plinthite analyses

Laboratory analysis of plinthite was determined by a procedure proposed by the USDA-NRCS, MO 14 (Kelley, personal communication), which is a modification of methods described by Daniels et al. (1978) and Wood and Perkins (1976). Prior to slaking the samples for 1-hr, air-dried and weighed soil samples were placed on a 2-mm sieve over a bucket to allow separation of loose material. Remaining material on the 2-mm sieve was lowered into a five-gallon bucket filled with tap water (pH 6.4, EC = 23.4 $\mu S\ cm^{-1}$). Periodic agitation provided consistent wetting of soil material and prevented sieve clogging. After slaking the soil sample for 1-hr, the remaining material was removed and placed on brown craft paper for fifteen minutes. A rupture test was conducted on all remaining materials to separate plinthite (material that ruptured with pressure) from rock and ironstone materials (remaining material that would not rupture and classified as coarse fragments > 2mm in size). Coarse fragments were subsequently separated into rock (i.e., siliceous gravel) and ironstone by rupturing and visual analysis. Separated material was air-dried and weighed. Cemented accumulations were separated into three groups (plinthite, rock and ironstone), and percentages per volume of soil were calculated.

Air-dried plinthite was crushed with a rolling pin for further analysis. Extractable Fe and Al were determined by sodium dithionite citrate bicarbonate (DCB) selective dissolution analysis on both plinthite and whole soil after organic matter removal with H_2O_2 (Soil Survey Inv. Staff, 2004). The Fe and Al in the extractions were quantified using inductively coupled plasma (ICP) atomic spectroscopy. Poorly crystalline, amorphous and organically bound Fe and Al concentrations were extracted by acid ammonium oxalate (AOX) in the dark (Soil Survey Inv. Staff, 2004), and analyzed by ICP.

Particle size distribution of the plinthite was determined by a modified Kilmer and Alexander (1949) pipette procedure after the removal of organic matter and free Fe (DCB extraction). Organic carbon and nitrogen content for all soil horizons and selected plinthite samples were analyzed by dry combustion (Leco CN 2000, St. Joseph, MI.).

Piezometer/transducers (data loggers)

Water tables were monitored with WL-15 Pressure transducers and data loggers (Global Water, Gold River, CA) on 6-hr intervals from 2003 to June 2007 (or shorter periods- see Table 7). This combination features a submersible pressure transducer, with a silicone diaphragm, connected to a stainless steel data logger. Data were retrieved on a quarterly basis.

Piezometers were constructed from PVC pipe (50.8-mm diameter) cut to the desired installation depth plus 30 cm (extension above grade), and multiple perforations were made throughout the lower 15 cm of the PVC pipe. The pipe was open at the bottom and geotechnical fabric covered the bottom and the perforations for prevention of sloughing and clogging of the pipe. Piezometers were placed into augered borings (81-mm) and backfilled with clean sand to a height just above the perforations. Bentonite followed by soil excavated from the auger hole was used to backfill the remaining portions.

Physical measurements of the water table during data retrieval aided in calibration and ground-truthing the pressure transducers and data loggers. Manufacturer specifications of transducer accuracy are within 0.1% at constant temperature. True zero values were established for each transducer by empirical observations.

Water table metrics analyzed were saturation percent, duration, event periodicity, and cumulative days, and from these metrics, number of events greater than or equal to twenty-one days was calculated. He et al. (2003) found that durational soil saturation ≥ 21 days was sufficient for the reduction of Fe oxides (Atlantic Coastal Plain soils in North Carolina). They derived the following formula for determining the number of saturation events (NSE) with reducing conditions:

$$NSE = (LDS / 21d) + (NPS - 1) \qquad \text{[EQ. 4]}$$

where LDS is the longest duration of saturation experienced, and NPS is the number of periods the soil experienced saturation for 21 days or more. From equation [4] we can calculate the number of reducing events occurring during a period of interest.

Weather data

Weather data from the two weather stations closest to the study sites was provided by AWIS (Alabama Weather Information Service) (Fig. 10). Daily, annual, thirty-year normal precipitation and standard deviations were provided by AWIS for each of the weather stations, which aided in the determination of precipitation normality as per *Keys to Soil Taxonomy* (Soil Survey Staff, 2006).

Statistical Analysis

Soil physical and chemical properties of plinthite versus whole soil were compared using paired t- tests. Pearson linear correlation coefficients were used to relate plinthite to other soil properties. Stepwise linear regression was also used to relate plinthite to soil and seasonal saturation. All analyses were conducted in SAS (SAS Institute Inc., 2003, Cary, NC v.9.1) at the $\alpha = 0.10$ significance level unless otherwise noted.

Results and Discussion

Weather Data

Rainfall data from two weather stations (November of 2003 through May 2007) were analyzed against thirty-year average monthly and yearly rainfall totals (Table 8). The two weather stations (Bay Minette, and Fairhope) closest to the study sites were used to evaluate precipitation amounts. Normal years for precipitation, outlined in the *Keys to Soil Taxonomy* (Soil Survey Staff, 2006), have at least eight of twelve months of precipitation within one standard deviation of the thirty-year average, and are also within one standard deviation of the annual thirty year normal precipitation totals. In 2004, 2005, and 2006, the Bay Minette weather station (closest in proximity to the Washington County sites) had precipitation amounts that met *normal* standards. Fairhope (Baldwin County) precipitation amounts only met monthly standards in 2006; however, it did not meet annual precipitation requirements. Although the Fairhope weather station did not meet annual precipitation criterion, we used water table metrics of this pedon for 2006 because it met monthly parameters. Based on this, analyses will include data from the Washington County (both S07AL-129 pedons) sites for 2004-2006, and 2006 for the Baldwin County (S07AL-003-1) site. This will be referred to as the monitoring period (MP).

Organic Carbon and Nitrogen

Total organic carbon (C) and nitrogen (N) levels were relatively low (1.2 - 6.9 g kg^{-1}) in these soils (Table 9). Carbon and C:N ratios declined as a function of depth. Labile C sources must be available for Fe reduction (Vepraskas and Wilding, 1983; Coyne, 1999). Vepraskas and Wilding (1983) suggested that a minimum of 1% organic matter is necessary to drive redox reactions. The surface horizons of the three soils in this study were the only horizons that contained greater than 1% organic matter. Szögi and Hudnall (1998) suggested that longer saturation durations might be needed to develop reducing conditions when C sources are low.

Plinthite had higher C and C:N ratios than whole soils (Table 10). Concentrations of N in the plinthite were similar to whole soil samples. Organic C plays an active role in the reduction of Fe oxides. Carbon is thought to be lower in whole soil where reduction (and other C consumptive) processes continue to occur, versus lower activity within plinthite nodules. Increased C content in plinthite nodules may also be due to its formation in the presence of higher C sources, inclusion and sequestration of roots during formation, and protection of C from further oxidation. Alternatively, plinthite nodules may have formed in near surface environments in soils with polygenetic pathways.

Extractable Fe and Al

Significant differences in Fe_d, Fe_o, and Fe_o/Fe_d existed between whole soil and plinthite (Table 10). Plinthite nodules contained greater extractable Fe concentrations than the surrounding soil (Fig. 11). The DCB extractable Fe (Fe_d) in plinthite was (on average) 130% greater than that of the surrounding soil in the Plinthic Paleudult located in Baldwin County (soil 1), 426% greater than that of the surrounding soil in the Plinthic Paleudult in Washington County (soil 2), and 750% greater than that of the surrounding soil in the Aquic Paleudult in Washington County (soil 3) (Fig. 10). The oxalate extractable Fe (Fe_o) in plinthite was (on average) 1649% greater than that of the surrounding soil in the Plinthic Paleudult in Baldwin County, 1154% greater than that of the surrounding soil in the Plinthic Paleudult in Washington County, and 1072% greater than that of the surrounding soil in the Aquic Paleudult in Washington County.

As saturation percentage increased, differences between extractable Fe_d in the whole soil and plinthite increased. Active Fe in the whole soil, as noted by the Fe_o/Fe_d ratio, also increased as saturation increased (Fig. 12). This suggests increased soil saturation reduces crystalline Fe in the soil, while the plinthite nodules retain more crystalline Fe due to cementation and lower porosity. These findings collectively infer that Fe reduction cycles are on-going in the saturated horizons of these soils. Conversely, active Fe in plinthite nodules remained constant with increasing saturation indicating their relict status.

Soil extractable Fe as a function of depth was similar to findings by Daniels et al. (1975) in Coastal Plain Paleaquults and Aquic Paleudults of North Carolina. The Fe_d increased with depth in the whole soil samples, while subtle changes were observed in Fe_o. An increase in whole soil active Fe (Fe_o) (in lower horizons that experienced increased saturation) was observed in the Washington County Plinthic Paleudult and Aquic Paleudult pedons.

The Fe_d in plinthite decreased in lower horizons where significant durational saturation was observed. Plinthite quantity was positively correlated with whole soil Fe_d ($r = 0.77$, $p = 0.003$), negatively correlated with the whole soil Fe_o/Fe_d ratio ($r = -0.53$, $p = 0.074$), and uncorrelated with Fe_o (Table 11). Regression analysis relating plinthite to whole soil properties indicated 60% of plinthite variability was explained by whole soil Fe_d (Fig. 13). This somewhat reflects what Daniels et al. (1975) found, where plinthite content was related to total Fe content in the parent material of some North Carolina Coastal Plain soils.

Active Fe increased with increasing C in whole soil samples, and to a lesser extent, in plinthite (Table 9 and 12). Surface soils contained the highest amount of both C and active Fe, which can be attributed to higher quantities of poorly crystalline, amorphous and in particular, organically bound Fe in the surface horizons. Whole soil C was related to Fe_o in all soils, with strongest relationship ($r^2 = 0.59$) was expressed in the Plinthic Paleudult of Washington County.

Similar relationships (to Fe) of extractable Al were observed between whole soil and plinthite (Table 11). Plinthite quantities were positively correlated with whole soil

Al_d and Al_o (r = 0.75, and r = 0.74 respectively), but not with the ratio of Al_o/Al_d (Table 11). Extractable Al in the whole soil increased with increased saturation and lower pH.

Particle Size

Significant differences for sand and clay concentrations were observed between plinthite and whole soil (Table 10). Higher sand quantities were found in whole soil than in the plinthite, and more clay was found in the plinthite relative to whole soil samples. Plinthite was negatively correlated with whole soil sand (p= 0.042) (Table 11). The higher extractable Fe and clay in plinthite is similar to findings by Aide et al. (2004), who found preferential Fe oxide precipitation in the clay fraction in soils of the Mississippi East Gulf Coastal Plain taxonomically similar to the soils in this study.

Water Table Data

An attempt was made to correlate plinthite quantities in these soils to water table metrics. No correlation was found between percent plinthite occurrences with any of the saturation metrics (Table 13). Saturation duration, % saturation, and NSE were much higher in horizons containing plinthite in the Aquic soil as compared to the Plinthic soils (Table 14). Horizons with plinthite ranged in saturation from 0% to 60% of the monitoring period. Horizons with plinthite and Fe depletions (chroma $\leq$ 3) in combination were saturated for greater durations than horizons with plinthite alone. These data collectively indicate that neither the presence nor amount of plinthite is related to contemporary saturation.

Conclusion

Carbon contents and C:N ratios were higher in plinthite nodules relative to whole soil. Organic carbon levels were found to be very low in these soils, and may retard hydromorphic feature development in these Alabama Coastal Plain soils. Although labile carbon concentrations were low, hydromorphic features were found in horizons with saturation durations similar to those found by previous researchers. This may suggest that in the warm humid soils of the Coastal Plain region of Alabama, less organic matter may be required to drive the Fe redox process and warrants further research.

We found plinthite had more clay and less sand relative to the surrounding soil, while silt remained similar between whole soil and plinthite. Plinthite had higher extractable Fe_d concentrations compared to the whole soil, and plinthite nodules were positively correlated with extractable Fe_d within the whole soil. Differences between extractable Fe_d within the soil relative to plinthite samples were larger in poorly drained Aquic soils than well drained Plinthic soils. Conversely, a decrease in the difference between poorly crystalline, amorphous and non crystalline Fe between the soil and plinthite samples was found in the poorly drained Aquic soil as compared to the well drained Plinthic soils. Active Fe in the soil, indicated by the ratio Fe_o/ Fe_d, was positively correlated to saturation. Further research in the active mineralogical form of the crystalline oxides present within plinthite will further distinguish the role of plinthite in hydromorphology assessment.

Plinthite in these soils occurred over a wide range of saturation durations, and its quantity was not correlated with any of the water table metrics, suggesting that its presence is not directly connected to seasonal saturation. Plinthite nodules found in combination with Fe depletions of chroma ≤ 3 suggest periods of prolonged saturation. Fe depletions of chroma ≤ 3 were more indicative of saturation durations than plinthite alone, and therefore warrant higher priority in SHWT assessment.

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Table 7. Pedon classification of three studied soils of the Alabama Coastal Plain containing plinthite.

Soil ID	Pedon	Data Logger(s)	Classification	Installation Date
1	S07AL-003-01	30637, 30736	Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult	11/19/2003
2	S07AL-129-01	30624, 30737	Coarse-loamy, siliceous, semiactive, thermic Plinthic Paleudult	11/18/2003
3	S07AL-129-02	30621, 30694	Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult	11/18/2003

Table 8. Weather station proximity to pedons, and monthly and annual comparison to thirty-year *normal* rainfall (as defined by Soil Taxonomy).

		2004			2005			2006			Closest	Approximate
Station	County	mo†	yr‡	Normal§	mo†	yr‡	Normal§	mo†	yr‡	Normal§	Pedons	Distance (km)
Bay Minette	Baldwin	8	yes	yes	9	yes	yes	10	yes	yes	S07AL-129-1	63
	Baldwin	8	yes	yes	9	yes	yes	10	yes	yes	S07AL-129-2	63
Fairhope	Baldwin	7	yes	no	7	no	no	9	no	no	S07AL-003-1	1

†mo=#of normal months (+/- 1 SD of 30 yr avg.).
‡yr=does annual total fall within+/-1 SD of 30 yr avg.
§Normal=does year meet Soil Taxonomy normal requirements.

Table 9. Whole soil extractable Fe and Al, percent plinthite, organic carbon concentration, and saturation duration, and hydromorphic feature occurrence for horizons of three soils containing plinthite in the Alabama Coastal Plain.

Pedon	Horizon	Lower Depth	Extractable Fe Fe_d†	Fe_o	Extractable Al Al_d	Al_o	Ratio Fe_o/Fe_d	Al_o/Al_d	Plinthite by volume	Frag >2mm‡	C	Saturation Duration
		(cm)	---------------mg kg^{-1}---------------						----%----		(g kg^{-1})	(days)
S07AL-003-1	Ap	32	3350	590	1094	559	0.18	0.51	0	2	6.87	0
	EB	43	8706	145	2701	560	0.02	0.21	0	1	3.61	0
	Btc	88	16561	210	4616	778	0.01	0.17	0	3	2.60	0
	Btv1	110	15355	210	3827	548	0.01	0.14	7	3	1.83	0
	Btv2	133	14864	248	3636	491	0.02	0.14	4	3	1.55	0
	Btv3	143	16212	240	4049	599	0.01	0.15	7	4	1.56	0
	Btv4	178	17955	367	4438	661	0.02	0.15	22	4	1.58	9
	2Btgv	200	25938	229	4511	925	0.01	0.21	20	1	1.43	47
S07AL-129-1	Ap	18	1605	828	577	597	0.52	1.03	0	0	6.94	0
	E1	41	2630	186	693	427	0.07	0.62	0	0	2.81	0
	E2	55	5422	137	995	229	0.03	0.23	1	0	1.75	1
	Btv1	88	14594	375	2585	610	0.03	0.24	1	0	1.70	5
	Btv2	120	9330	310	1813	459	0.03	0.25	5	0	1.35	11
	Btv3	151	5209	310	852	276	0.06	0.32	4	0	1.23	23
	Btv4	182	7320	376	1088	332	0.05	0.31	2	0	1.28	104
	CB	200	5135	439	764	342	0.09	0.45	0	0	1.30	107
S07AL-129-2	Ap	12	4703	1023	713	46	0.22	0.06	0	0	4.82	20
	E1	24	3558	715	575	0	0.20	0.00	0	0	2.05	46
	E2	44	2982	549	564	0	0.18	0.00	0	0	1.63	66
	BE	74	3820	506	651	49	0.13	0.08	1	0	1.58	94
	Btv1	90	4663	471	610	188	0.10	0.31	2	0	1.65	97
	Btv2	120	9747	601	1171	406	0.06	0.35	3	0	1.51	101
	2CBg	152	19589	927	1376	1222	0.05	0.89	4	0	1.50	nm§
	2Cg	200	18341	880	568	875	0.05	1.54	7	0	1.39	nm

† Fe_d = Iron extraction by dithionite citrate bicarbonate (DCB); Fe_o = Iron extraction by acid ammonium oxalate (AOX); Al_d = Aluminum extraction by dithionite citrate bicarbonate (DCB); Al_o = Aluminum extraction by acid ammonium oxalate (AOX); C = Total organic carbon.

‡ Ironstone and coarse fragments.

§ nm = Not measured due to piezometer installation depth.

Table 10. Paired T-tests comparing properties of whole soil (fraction < 2-mm) to plinthite for three Alabama Coastal Plain soils.

		Whole Soil		Plinthite		T Statistic	P Value
	n†	Mean	Std. Dev.	Mean	Std. Dev.		
			---------------(%)---------------				
Sand	12	60	12.4	54.9	10.2	-3.967	0.0022
Silt	12	22.5	11.6	23.1	11.2	0.254	0.8045
Clay	12	17.5	7.5	22	9.8	1.848	0.0916
			---------------(mg kg^{-1})---------------				
Fe_d‡	12	12083	6568	43367	11989	9.169	<0.0001
Fe_o	12	354	122	4883	1745	9.298	<0.0001
Fe_o/Fe_d	12	0.04	0.04	0.12	0.04	6.073	<0.0001
Al_d	12	2436	1571	5419	1529	10.443	<0.0001
Al_o	12	462	234	1614	696	7.17	<0.0001
Al_o/Al_d	12	0.22	0.09	0.29	0.08	1.885	0.0861
			---------------(g kg^{-1})---------------				
C	12	1.5	0.2	2	0.7	2.783	0.0178
N	12	0.3	0.0	0.4	0.1	1.543	0.151
C/N	12	4.959	0.927	5.424	1.526	1.855	0.0905

† n = Number of horizons.

‡ Fe_d = Iron extraction by dithionite citrate bicarbonate (DCB); Fe_o = Iron extraction by acid ammonium oxalate (AOX); Al_d = Aluminum extraction by dithionite citrate bicarbonate (DCB); Al_o = Aluminum extraction by acid ammonium oxalate (AOX); C = Total organic carbon; N = Total organic nitrogen.

Table 11. Pearson correlation coefficients (r) relating whole soil properties to plinthite (significant *p*-values in bold).

	wssand†	wssilt	wsclay	wsfed	wsfeo	wsfeofed	wsald	wsalo	wsaloald	wsn	wsc	wscn
plinth	-0.594	0.226	0.629	0.772	-0.389	-0.534	0.746	0.738	-0.296	-0.441	0.019	0.349
	0.042	0.480	**0.028**	**0.003**	0.212	**0.074**	**0.005**	**0.006**	0.351	0.151	0.953	0.267
plinsand	0.940	-0.932	-0.113	-0.542	-0.078	0.026	-0.440	-0.374	0.366	0.594	-0.512	-0.621
	<.001	**<.001**	0.726	**0.069**	0.810	0.935	0.153	0.231	0.242	**0.042**	**0.089**	**0.031**
plinsilt	-0.424	0.703	-0.384	-0.285	0.661	0.589	-0.273	-0.431	-0.121	-0.440	0.576	0.572
	0.170	**0.011**	0.218	0.370	**0.019**	**0.044**	0.391	0.161	0.709	0.152	**0.050**	**0.052**
plinclay	-0.496	0.167	0.559	0.893	-0.676	-0.703	0.773	0.886	-0.244	-0.115	-0.125	-0.007
	0.101	0.604	**0.059**	**<.001**	**0.016**	**0.011**	**0.003**	**<.001**	0.444	0.722	0.698	0.983
plinfed	-0.042	0.212	-0.257	0.288	0.127	0.007	0.108	0.288	-0.121	0.260	0.270	-0.064
	0.897	0.509	0.420	0.364	0.694	0.983	0.739	0.364	0.708	0.414	0.396	0.844
plinfeo	-0.018	0.111	-0.142	-0.226	0.497	0.462	-0.104	-0.327	-0.450	-0.180	0.351	0.353
	0.957	0.731	0.660	0.479	0.101	0.130	0.748	0.300	0.142	0.576	0.263	0.260
plinfeofed	-0.036	-0.020	0.090	-0.356	0.393	0.401	-0.116	-0.450	-0.364	-0.393	0.192	0.435
	0.912	0.952	0.781	0.256	0.207	0.196	0.720	0.142	0.245	0.207	0.549	0.157
plinald	-0.452	0.148	0.515	0.789	-0.557	-0.571	0.797	0.714	-0.589	-0.191	0.398	0.333
	0.141	0.646	**0.087**	**0.002**	**0.060**	**0.053**	**0.002**	**0.009**	**0.044**	0.553	0.200	0.290
plinalo	-0.548	-0.018	0.930	0.776	-0.671	-0.743	0.932	0.705	-0.624	-0.452	0.256	0.466
	0.065	0.955	**<.001**	**0.003**	**0.017**	**0.006**	**<.001**	**0.011**	**0.030**	0.140	0.422	0.127
plinaloald	-0.334	-0.216	0.882	0.421	-0.496	-0.609	0.622	0.408	-0.315	-0.411	-0.035	0.293
	0.289	0.500	**<.001**	0.173	0.101	**0.036**	**0.031**	0.188	0.319	0.184	0.913	0.355
pn	0.062	-0.107	0.062	0.355	-0.572	-0.212	0.324	0.339	-0.350	0.174	-0.010	-0.127
	0.848	0.740	0.848	0.258	**0.052**	0.508	0.305	0.281	0.265	0.589	0.975	0.695
pc	0.133	0.182	-0.498	-0.321	0.192	0.552	-0.262	-0.430	-0.402	0.056	0.462	0.188
	0.681	0.572	**0.099**	0.309	0.550	**0.063**	0.410	0.163	0.195	0.863	0.131	0.559
pcn	0.076	0.311	-0.604	-0.534	0.525	0.743	-0.465	-0.655	-0.257	-0.049	0.509	0.280
	0.813	0.325	**0.038**	**0.074**	**0.080**	**0.006**	0.128	**0.021**	0.420	0.880	**0.091**	0.378

† wssand = whole soil sand; wssilt = whole soil silt; wsclay = whole soil clay; wsfed = whole soil extracted iron (Fe_d) by dithionite citrate bicarbonate (DCB); wsfeo =whole soil extracted Fe_o by acid ammonium oxalate (AOX); wsfeofed = whole soil Fe_o/Fe_d ratio; wsald = whole soil extracted aluminum (Al_d) by DCB; wsalo = whole soil extracted Al_o by AOX; wsaloald = Whole soil Al_o/Al_d ratio; wsn = Whole soil nitrogen (N); wsc = whole soil carbon (C); wscn = whole soil C/N ratio; plinth = plinthite quantity (%) per horizon; plinsand = plinthite sand fraction (%); plinsilt = plinthite silt fraction (%); plinclay = plinthite clay fraction (%); plinfed = plinthite extracted Fe_d; plinfeo = plinthite extracted Fe_o; plinfeofed = plinthite Fe_o/Fe_d ratio; plinald = plinthite extracted Al_d; plinalo = plinthite extracted Al_o; plinaloald = plinthite Al_o/Al_d ratio; pn = plinthite N; pc = plinthite C; pcn = plinthite C/N.

Table 12. Extractable Fe and Al, and organic carbon concentration of plinthite, and percent plinthite, and percent saturation for horizons of three Alabama Coastal Plain soils.

Horizon	Lower Depth	Fe Oxides		Al Oxides		Oxide Ratio		Plinthite	Frag >2mm‡	C	Saturation
		Fe_d†	Fe_o	Al_d	Al_o	Fe_o/Fe_d	Al_o/Al_d	by volume			
	(cm)	-----------------mg kg^{-1}-----------------						---------%--------		g kg^{-1}	%
						S07AL-003-1					
Btv1	110	36052	3357	6210	1891	0.09	0.30	7	3	2.0	0
Btv2	133	35790	4331	5998	2341	0.12	0.39	4	3	1.9	0
Btv3	143	36137	5079	6232	2705	0.14	0.43	7	4	1.8	0
Btv4	178	43470	7686	6889	2690	0.18	0.39	22	4	1.7	8
2Btgv	200	54907	2729	7544	2066	0.05	0.27	20	1	1.6	19
						S07AL-129-1					
Btv1	88	74285	5995	7275	1471	0.08	0.20	1	0	2.9	2
Btv2	120	36921	4180	3918	1229	0.11	0.31	5	0	1.6	9
Btv3	151	30659	3132	3426	1096	0.10	0.32	4	0	1.5	20
Btv4	182	44615	3987	5492	1172	0.09	0.21	2	0	1.9	60
						S07AL-129-2					
BE	74	50588	8422	4915	985	0.17	0.20	1	0	3.3	51
Btv1	90	39035	5154	4119	848	0.13	0.21	2	0	2.7	62
Btv2	120	37944	4544	3010	869	0.12	0.29	3	0	1.0	67

† Fe_d = Iron extraction by dithionite citrate bicarbonate (DCB), Fe_o = Iron extraction by acid ammonium oxalate (AOX), Al_d = Aluminum extraction by dithionite citrate bicarbonate (DCB), Al_o = Aluminum extraction by acid ammonium oxalate (AOX), C = Total organic carbon.
‡ Ironstone and coarse fragments.

Table 13. Pearson correlation coefficients (r) relating saturation metrics to plinthite.

	saturation†	periodicity	durational	cumulative	21day	NSE
plinth	-0.373	-0.290	-0.325	-0.375	-0.377	-0.378
	0.233	0.361	0.302	0.230	0.227	0.226
plinfed	-0.059	-0.043	0.034	-0.058	-0.056	-0.009
	0.856	0.895	0.917	0.857	0.864	0.979
plinfeo	0.123	0.150	0.132	0.122	0.063	0.125
	0.703	0.642	0.682	0.707	0.845	0.698
plinfeofed	0.116	0.144	0.061	0.114	0.053	0.082
	0.720	0.656	0.851	0.724	0.871	0.799

† saturation = percent saturation for the monitoring period; periodicity = average annual frequency of saturation; durational = average longest saturated period; cumulative = average number of days experiencing saturation; 21 day = saturation events ≥ 21 durational days; NSE = number of saturation events ≥ 21 days of duration; plinth = plinthite quantity (%) per horizon; plinfed = plinthite extracted Fe_d by dithionite citrate bicarbonate (DCB); plinfeo = plinthite extracted Fe_o by acid ammonium oxalate (AOX); plinfeofed = plinthite Fe_o/Fe_d ratio.

Table 14. The relationship between hydromorphic features and water table metrics for *normal* years (as per Soil Taxonomy) occurring within the 2004-2006 monitoring period for three soil pedons of the Alabama Coastal Plain.

Hydromorphic Feature	n†	Saturation ‡					
		Cumulative	Durational	Periodicity	%	21 day	NSE
		-----(days)-----		(events)			
		All Soils					
Plinthite	7	81.1	41.1	4.3	22	1.0	2.5
Plinthite & Chroma ≤ 3	7	111.7	49.9	7.6	31	1.4	3.0
		Plinthic Paleudults					
Plinthite	4	2.3	1.8	1.3	1	0.0	0.0
Plinthite & Chroma ≤ 3	4	55.8	17.0	7.0	15	0.8	0.9
		Aquic Paleudult					
Plinthite	3	186.3	93.7	8.3	51	2.3	5.8
Plinthite & Chroma ≤ 3	3	186.3	93.7	8.3	51	2.3	5.8

† = number of horizons

‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; durational = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation; 21 day = saturation events ≥ 21 durational days; NSE = number of saturation events ≥ 21 days of duration.

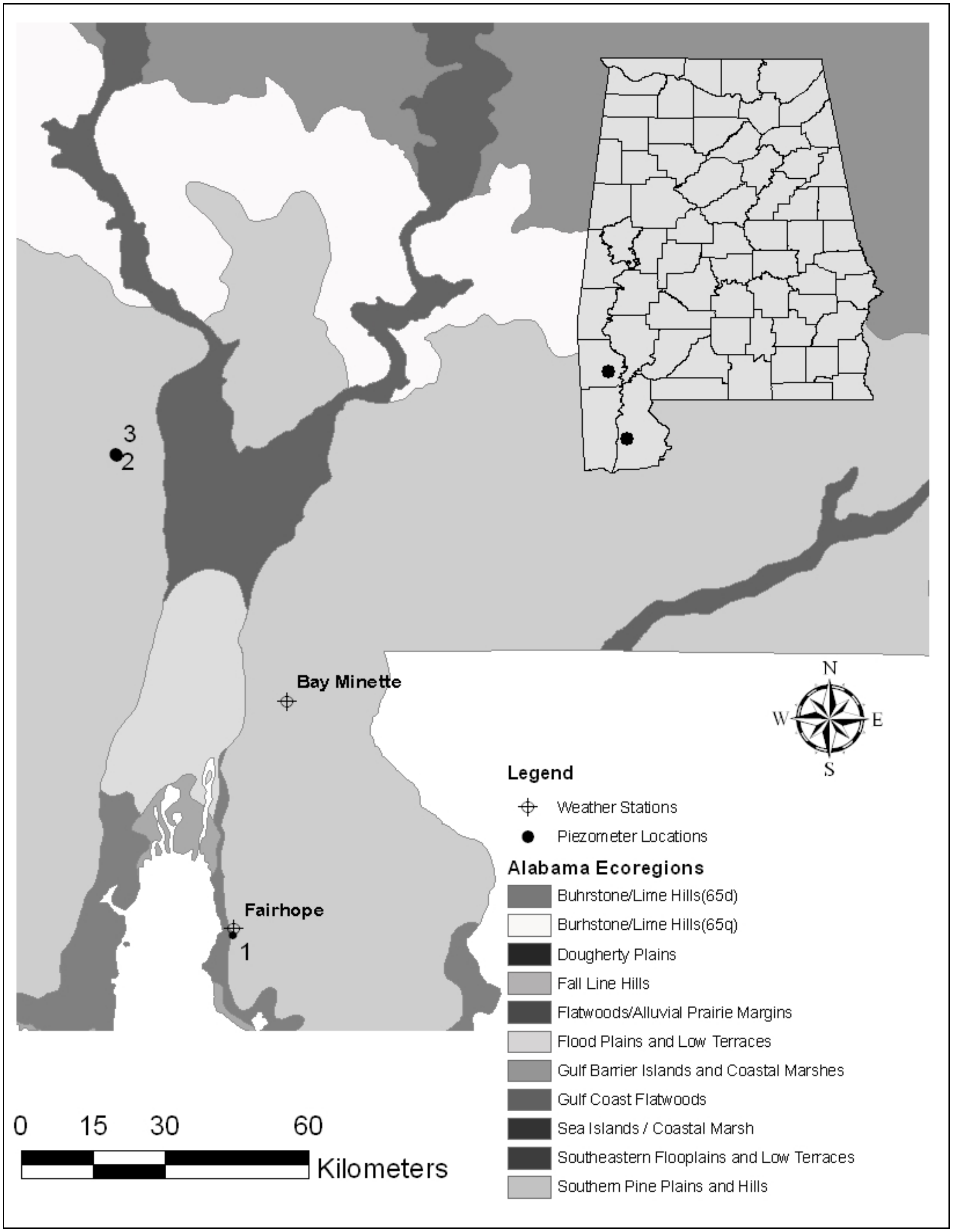

Fig. 10. Ecoregions of the Alabama Coastal Plain with pedon and weather monitoring station locations in a plinthite characterization study.

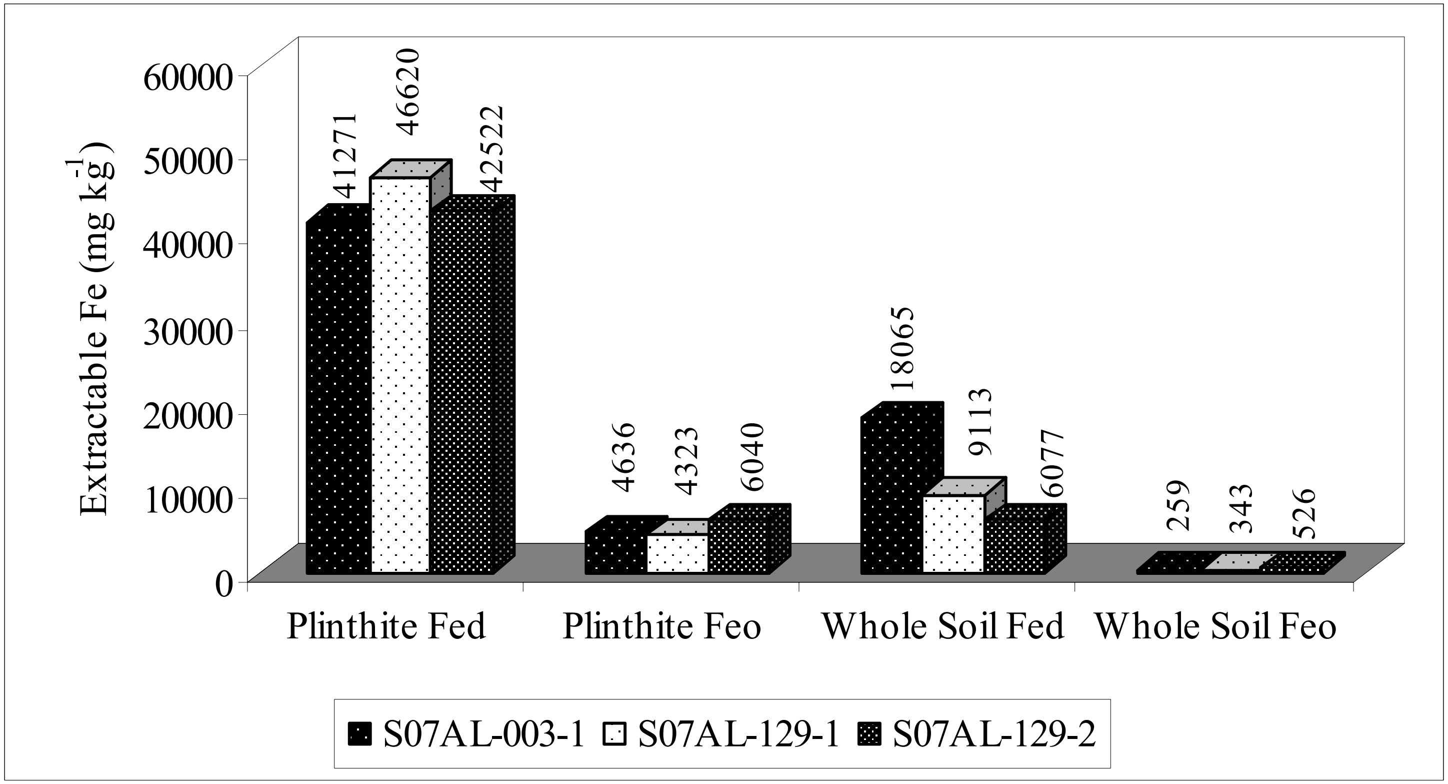

Fig. 11. Average dithionite (Fe_d) and oxalate (Fe_o) extractable Fe of plinthite nodules and whole soils (<2mm) in twelve horizons containing plinthite in some Alabama Coastal Plain soils.

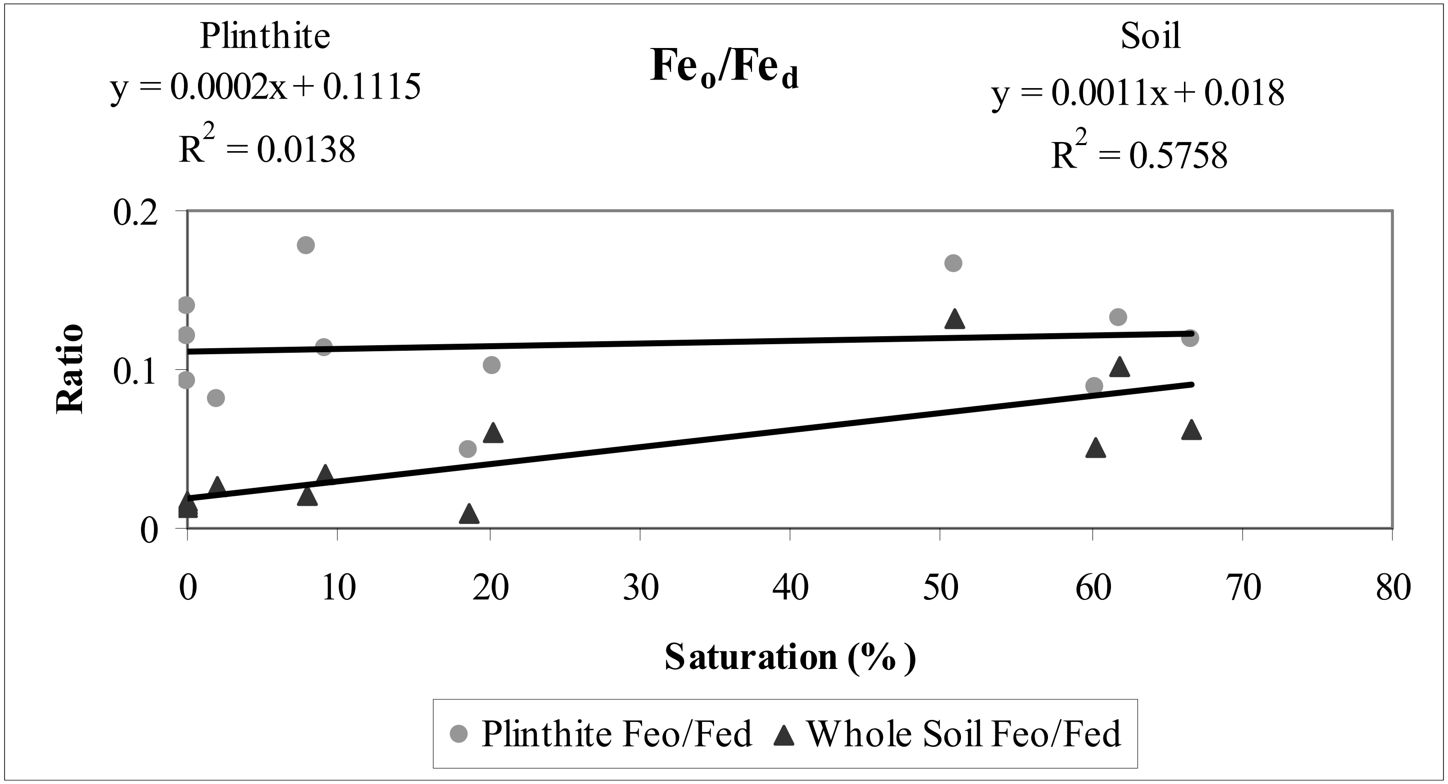

Fig. 12. Linear regression relating oxalate (Fe_o): dithionite (Fe_d) extractable Fe in plinthite and whole soil ratios to percent saturation for three Alabama Coastal Plain soils. Analysis conducted for *normal* precipitation years as per Soil Taxonomy.

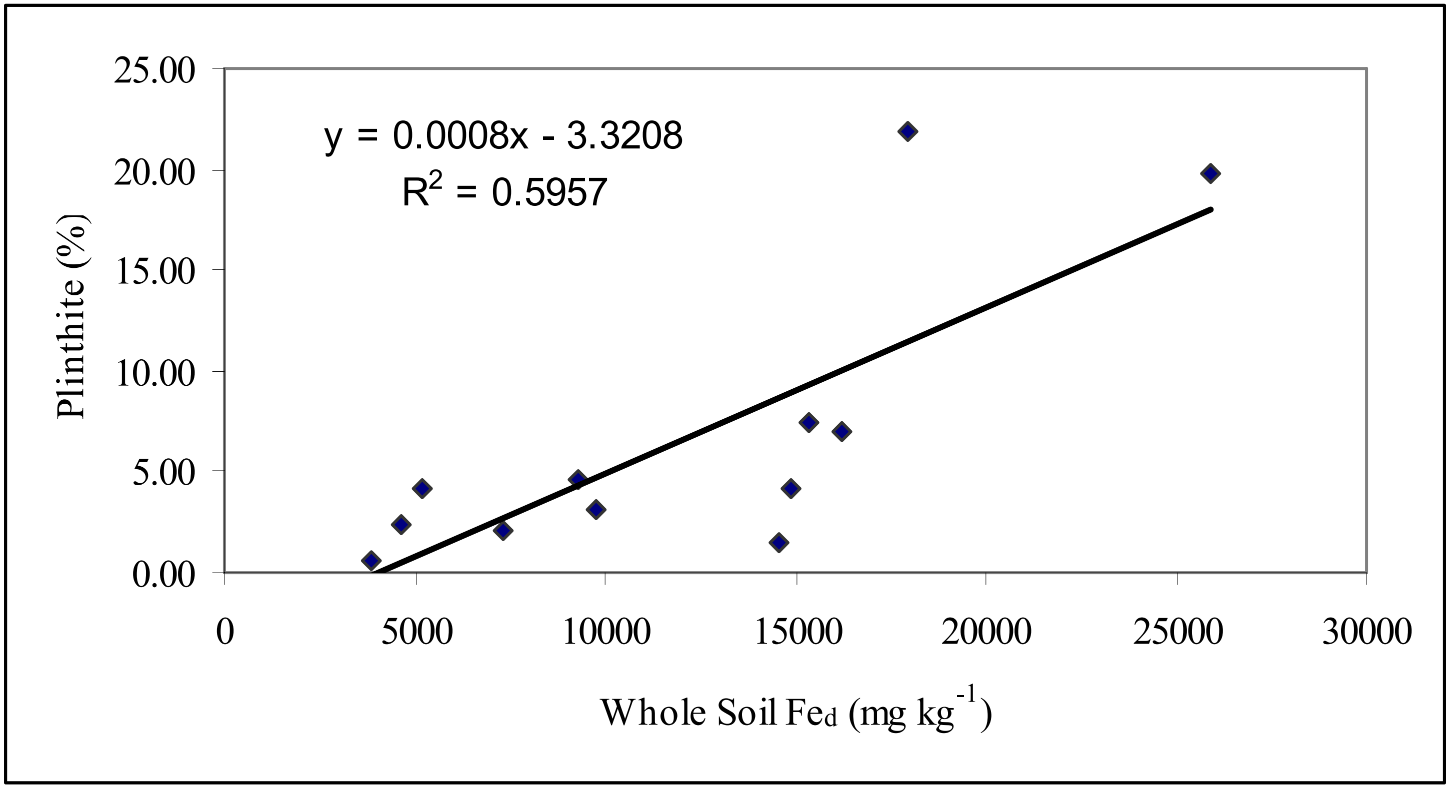

Fig. 13. Linear regression relating whole soil dithionite extractable Fe (Fe_d) to plinthite for horizons of some Alabama Coastal Plain soils ($\alpha = 0.15$).

APPENDIX I

GEOLOGICAL FORMATIONS OF RESEARCH SITES

SOIL DESCRIPTION AND CHARACTERIZATION

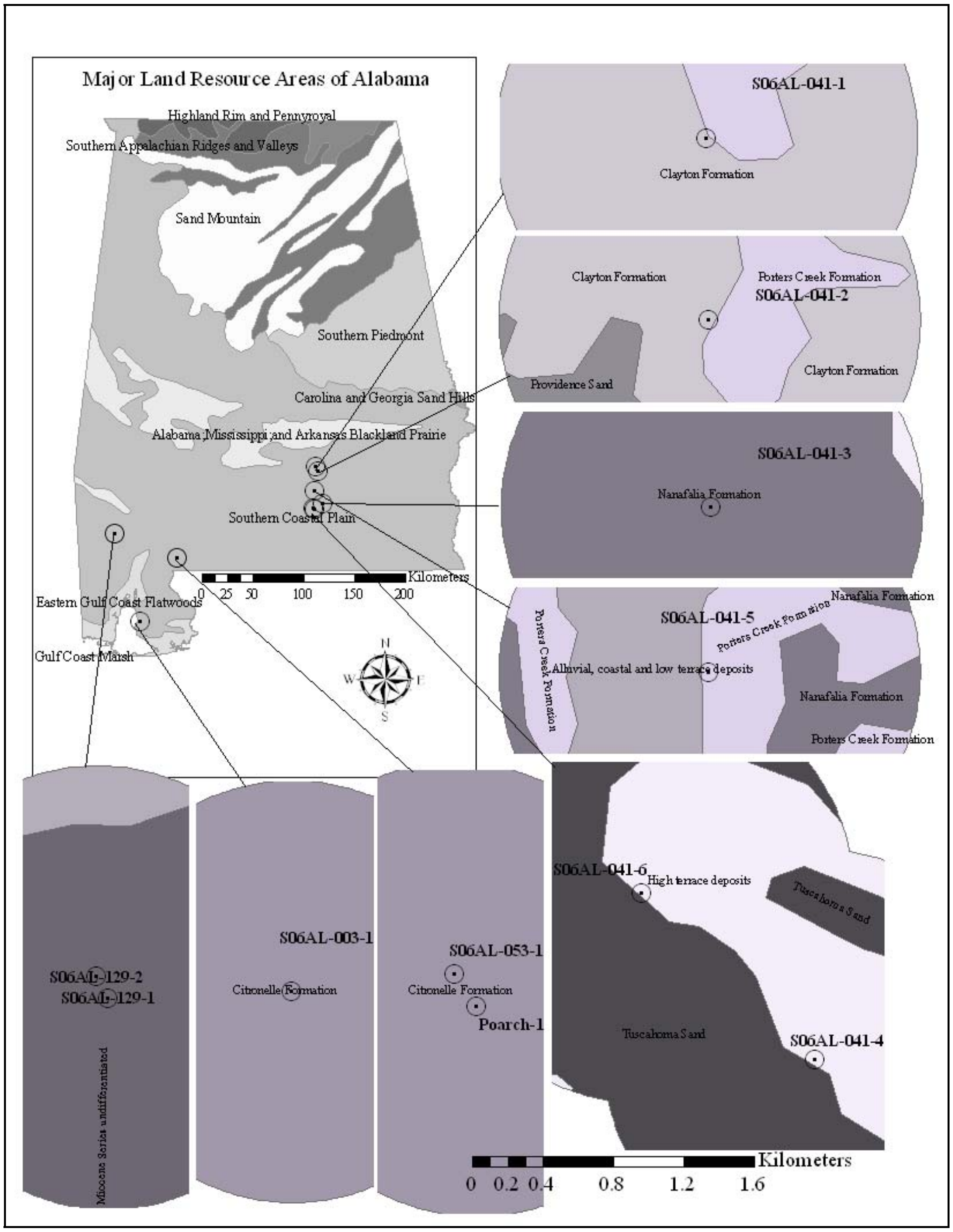

Fig. 14. Major Land Resource Areas (MLRA) and geological map of the piezometer locations.

Soil Description; S06AL-003-1, Fine-loamy, kaolinitic, thermic Plinthic Kandiudult. Data logger; 30637 and 30736, Baldwin County, Alabama, August 15, 2006.

Ap—0 to 30 cm; brown (10YR 4/3) fine sandy loam; weak fine granular structure; friable; common fine roots; few medium strong brown (7.5YR 5/8) ironstone nodules very strongly acid (pH 4.91).

Bt1—30 to 60 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; common medium strong brown (7.5YR 5/8) ironstone nodules; strongly acid (pH 5.17).

Bt2—60 to 113 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; common medium strong brown (7.5YR 5/8) ironstone nodules; strongly acid (pH 5.36).

Btv1—113 to 138 cm; yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; common medium yellowish red (5YR 5/8) ironstone nodules; 2 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium strong brown (7.5YR 5/8) soft masses of iron accumulation; extremely acid (pH 4.36).

Btv2—138 to 190 cm; brownish yellow (10YR 6/6) sandy clay; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; common medium yellowish red (5YR 5/8) ironstone nodules; 19 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium distinct red (2.5YR 4/6), and brownish yellow (10YR 6/8) soft masses of iron accumulation; common medium light gray (10YR 7/2) iron depletions; extremely acid (pH 4.38).

2Btg—190 to 215 cm; white (2.5Y 8/1) clay; moderate medium angular blocky structure; firm; common distinct clay films on faces of peds; 3 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium distinct brownish yellow (10YR 6/8) and yellowish red (5YR 5/8) soft masses of iron accumulation; extremely acid (pH 4.02).

Remarks: Soil Drainage Class 2, well drained soil. Soil color of chroma two or less begins at a depth of 138 cm. 2-3 percent plinthite was recorded per laboratory analysis in the Btv1 and Btv3 horizon, 19 percent in the Btv2.

Table 15. Standard characterization; S06AL-003-1, Fine-loamy, kaolinitic, thermic Plinthic Kandiudult.

Sample ID	Horizon	Lower	Particle Size Distribution			Sand Size Distribution					Base Saturation	pH	
		Depth	Sand	Silt	Clay	2-1	1-.5	.5-.25	.1-.25	.1-.05	NH4OAc	H2O	.01NCaCl
		(cm)	-----------------%-----------------									--------1:1--------	
S06AL-003-1-1	Ap	30	61.8	31.3	6.9	0.0	1.7	14.4	27.0	18.7	46.94	4.91	4.46
S06AL-003-1-2	Bt1	60	47.8	25.2	27.1	0.4	1.8	9.3	21.5	14.8	58.33	5.17	5.07
S06AL-003-1-3	Bt2	113	49.3	21.0	29.7	0.1	1.2	9.0	21.9	17.1	69.97	5.36	5.42
S06AL-003-1-4	Btv1	138	49.0	19.0	32.0	0.6	1.7	10.0	21.1	15.6	50.83	4.36	4.29
S06AL-003-1-5	Btv2	190	47.4	15.9	36.7	1.4	3.0	12.4	18.1	12.5	41.00	4.38	4.13
S06AL-003-1-6	2Btg	215	32.2	17.8	49.9	0.0	0.1	0.9	11.4	19.8	12.75	4.02	3.72

Sample ID	Horizon	Lower	Exchangeable Cations					Cation Exchange Capacity				Plinthite‡	Frag>2mm
		Depth	Ca†	Mg	K	Al	Na	CEC-7	ECEC	CEC-7	ECEC	by volume	
		(cm)	---------meq 100g soil^{-1}---------							---meq 100g clay^{-1}---		--------%--------	
S06AL-003-1-1	Ap	30	1.29	0.39	0.05	0.20	0.05	3.77	1.97	54.53	28.50	0	1
S06AL-003-1-2	Bt1	60	1.80	0.85	0.03	0.01	0.04	4.66	2.73	17.23	10.09	0	3
S06AL-003-1-3	Bt2	113	1.62	0.67	0.02	0.01	0.02	3.32	2.33	11.17	7.85	0	3
S06AL-003-1-4	Btv1	138	1.34	0.38	0.01	0.35	0.01	3.43	2.09	10.72	6.55	2	2
S06AL-003-1-5	Btv2	190	1.21	0.43	0.02	0.75	0.04	4.15	2.45	11.29	6.66	19	2
S06AL-003-1-6	2Btg	215	0.38	0.48	0.05	4.90	0.02	7.30	5.83	14.61	11.68	3	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-041-1, Loamy, kaolinitic, thermic Grossarenic Kandiudult. Data logger; 30742, Crenshaw County, Alabama, June 28, 2006.

Ap1—0 to 11 cm; brown (10YR 4/3) sand; weak fine granular structure; very friable; many fine roots and many coarse roots; very strongly acid (pH 4.78).

Ap2—11 to 27 cm; dark yellowish brown (10YR 4/4) sand; weak medium subangular blocky structure; very friable; common fine roots and many coarse roots; strongly acid (pH 5.08).

E1—27 to 82 cm; yellowish brown (10YR 5/6) loamy sand; weak medium subangular blocky structure; very friable; common fine roots and common medium roots; strongly acid (pH 5.21).

E2—82 to 139 cm; yellowish brown (10YR 5/6) loamy sand; weak medium subangular blocky structure; very friable; strongly acid (pH 5.22).

E3—139 to 156 cm yellowish brown (10YR 5/6), light yellowish brown (10YR 6/4) sand; weak medium subangular blocky structure; very friable; few medium strong brown (7.5YR 5/8) ironstone nodules; 1 percent medium yellowish red (5YR 5/8) plinthite nodules; very strongly acid (pH 4.99).

E4—156 to 169 cm; pale yellow (2.5Y 7/4) sand; weak medium subangular blocky structure; very friable; 1 percent medium yellowish red (5YR 5/8) plinthite nodules; very strongly acid (pH 4.78).

Bt1—169 to 190 cm; yellowish brown (10YR 5/6), yellowish brown (10YR 5/8) sandy loam; moderate medium subangular blocky structure; friable; common thin clay films on faces of peds; few fine strong brown (7.5YR 5/8) soft masses of iron accumulation; extremely acid (pH 4.16).

Bt2—190 to 211 cm; yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; friable; common thin clay films on faces of peds; common medium red (2.5YR 4/8) soft masses of iron accumulation; few fine light yellowish brown (10YR 6/4) iron depletions; extremely acid (pH 4.18).

Remarks: Soil Drainage Class 1, well drained soil. Plinthite per volume found during lab analysis was E1 (0.03%), E2 (0.06%), E3 (0.93%), E4 (0.62%), Bt1 (0.18%), Bt2 (0.02%). Ironstone analysis found E1 (0.09%) E2 (0.35%), E3 (0.49%), E4 (0.26%), Bt1 (0.25%), Bt2 (0.00%).

Table 16. Standard Characterization; S06AL-041-1, Loamy, kaolinitic, thermic Grossarenic Kandiudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	---					%			--	-------1:1	--------
S06AL-041-1-1	Ap1	11	89.9	7.2	2.9	1.0	10.6	65.4	12.1	0.9	67.32	4.78	4.68
S06AL-041-1-2	Ap2	27	91.8	5.8	2.4	0.4	10.2	68.8	11.5	0.8	63.47	5.08	4.70
S06AL-041-1-3	E1	82	86.9	9.5	3.7	0.2	6.1	60.0	17.5	3.1	43.87	5.21	4.79
S06AL-041-1-4	E2	139	86.6	7.8	5.7	0.0	6.6	60.6	16.9	2.5	47.93	5.22	4.78
S06AL-041-1-5	E3	156	92.1	4.8	3.2	0.2	8.4	65.8	15.4	2.3	29.24	4.99	4.41
S06AL-041-1-6	E4	169	95.1	2.6	2.3	0.1	6.8	72.2	15.2	0.9	44.16	4.78	4.73
S06AL-041-1-7	Bt1	190	74.9	7.1	18.0	0.2	6.4	55.8	11.4	1.0	26.12	4.16	3.82
S06AL-041-1-8	Bt2	211	68.1	3.9	28.0	0.1	8.8	49.1	9.4	0.7	24.04	4.18	3.76

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag>2mm
		(cm)	--------------------	meq 100g soil^{-1}				-----------------------		--meq 100g clay^{-1}--		---------%	--------
S06AL-041-1-1	Ap1	11	1.99	0.29	0.11	0.09	0.02	3.59	2.50	123.88	86.49	0	0
S06AL-041-1-2	Ap2	27	0.80	0.11	0.07	0.01	0.02	1.57	1.01	64.31	41.14	0	0
S06AL-041-1-3	E1	82	0.34	0.07	0.05	0.01	0.02	1.08	0.48	29.50	13.22	0	0
S06AL-041-1-4	E2	139	0.30	0.16	0.06	0.02	0.01	1.10	0.55	19.48	9.69	0	0
S06AL-041-1-5	E3	156	0.10	0.11	0.03	0.08	0.00	0.87	0.33	27.51	10.58	1	0
S06AL-041-1-6	E4	169	0.09	0.08	0.03	0.00	0.01	0.49	0.22	21.29	9.40	1	0
S06AL-041-1-7	Bt1	190	0.18	0.24	0.09	0.99	0.04	2.12	1.54	11.77	8.59	0	0
S06AL-041-1-8	Bt2	211	0.25	0.32	0.15	1.60	0.04	3.22	2.37	11.50	8.47	0	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-041-2, Loamy, kaolinitic, thermic Grossarenic Kandiudult. Data logger; 30715/30723, Crenshaw County, Alabama, June 28, 2006.

Ap—0 to 18 cm; dark grayish brown (10YR 4/2) loamy sand; weak fine granular structure; very friable; many fine roots and many coarse roots; strongly acid (pH 5.18).

AE—18 to 29 cm; brown (10YR 4/3) loamy sand; weak medium subangular blocky structure; very friable; common fine roots and many coarse roots; very strongly acid (pH 4.99).

E1—29 to 85 cm; light yellowish brown (2.5Y 6/4) loamy sand; weak medium subangular blocky structure; very friable; common fine roots and common medium roots; very strongly acid (pH 4.70).

E2—85 to 107 cm; yellowish brown (10YR 5/6) loamy sand; weak medium subangular blocky structure; very friable; very strongly acid (pH 4.67).

E3—107 to 142 cm yellowish brown (10YR 5/6) loamy sand; weak medium subangular blocky structure; very friable; few medium strong brown (7.5YR 5/8) ironstone nodules; extremely acid (pH 4.27).

B/E—142 to 156 cm; brownish yellow (10YR 6/6) sandy loam; weak medium subangular blocky structure; friable; light yellowish brown (2.5Y 6/4) loamy sand; weak medium subangular blocky structure; very friable; few medium strong brown (7.5YR 5/8) ironstone nodules; 4 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium yellowish red (5YR 4/6) soft masses of iron accumulation; extremely acid (pH 4.24).

Btv1—156 to 179 cm; strong brown (7.5YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; few medium strong brown (7.5YR 5/8) ironstone nodules; 17 percent medium yellowish red (5YR 5/8) plinthite nodules; many medium yellowish red (5YR 4/6) soft masses of iron accumulation; common medium pale yellow (2.5YR 7/3) iron depletions; extremely acid (pH 4.30).

Btv2—179 to 200 cm; strong brown (7.5YR 5/6) and yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; few medium strong brown (7.5YR 5/8) ironstone nodules; 10 percent medium yellowish red (5YR 5/8) plinthite nodules; many medium yellowish red (5YR 4/6) soft masses of iron accumulation; many medium light gray (10YR 7/1) iron depletions; extremely acid (pH 4.12).

Remarks: Soil Drainage Class 1, well drained soil. Soil color of chroma two or less begins at a depth of 179 cm. Lab data revealed Kandic requirements.

Plinthite analysis revealed 4% plinthite by volume in the B/E horizon, 17% within the Btv1, and 10% in the Btv2. Trace amounts per volume ironstone was found from analysis within the E3 (0.20%), B/E (0.59%), Btv1 (0.73%), and Btv2 (1.24%).

Table 17. Standard Characterization; S06AL-041-2, Loamy, kaolinitic, thermic Grossarenic Kandiudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	----------------	----------------	----------------	----------------	%	----------------	----------------	----------------	----------------	-------1:1	--------
S06AL-041-2-1	Ap	18	86.0	10.9	3.1	0.7	8.7	49.8	23.1	3.7	64.54	5.18	4.72
S06AL-041-2-2	AE	29	86.4	10.3	3.2	0.2	7.7	51.8	23.1	3.7	40.11	4.99	4.47
S06AL-041-2-3	E1	85	84.7	11.8	3.5	0.0	5.9	51.1	23.8	3.9	27.89	4.70	4.20
S06AL-041-2-4	E2	107	82.5	13.4	4.1	0.1	6.4	46.9	25.0	4.2	11.59	4.67	3.88
S06AL-041-2-5	E3	142	85.7	9.4	4.9	0.3	6.8	46.4	26.8	5.4	17.04	4.42	4.01
S06AL-041-2-6	B/E	156	77.2	10.5	12.4	0.2	4.8	39.7	27.4	5.1	10.85	4.24	3.84
S06AL-041-2-7	Btv1	179	71.2	10.4	18.4	3.2	7.3	35.3	21.2	4.2	17.88	4.50	4.06
S06AL-041-2-8	Btv2	200	65.3	6.6	28.1	2.3	5.7	33.6	20.7	3.0	7.28	4.12	3.73

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm by volume
		(cm)	----------------	----------------	meq 100g soil^{-1}	----------------	----------------	----------------	----------------	meq 100g clay^{-1}		----------%	---------
S06AL-041-2-1	Ap	18	1.68	0.28	0.11	0.04	0.02	3.23	2.12	104.67	68.86	0	0
S06AL-041-2-2	AE	29	0.48	0.09	0.04	0.07	0.02	1.59	0.71	49.01	21.81	0	0
S06AL-041-2-3	E1	85	0.08	0.05	0.02	0.10	0.09	0.85	0.34	24.32	9.66	0	0
S06AL-041-2-4	E2	107	0.05	0.03	0.02	0.26	0.00	0.89	0.36	21.56	8.80	0	0
S06AL-041-2-5	E3	142	0.06	0.04	0.02	0.01	0.02	0.81	0.15	16.47	3.01	0	0
S06AL-041-2-6	B/E	156	0.07	0.06	0.03	0.65	0.01	1.58	0.82	12.80	6.65	4	1
S06AL-041-2-7	Btv1	179	0.17	0.13	0.08	0.19	0.04	2.39	0.62	13.00	3.37	17	1
S06AL-041-2-8	Btv2	200	0.09	0.14	0.04	1.68	0.02	3.92	1.96	13.96	6.98	10	1

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-041-3, Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult. Data loggers; 30602 & 30627, Crenshaw County, Alabama, June 28, 2006.

Ap1—0 to 15 cm; dark grayish brown (2.5Y 4/2) fine sandy loam; weak fine granular structure; very friable; few fine yellowish red (5YR 4/6) oxidized root channels; strongly acid (pH 5.23).

Ap2—15 to 30 cm; dark grayish brown (2.5Y 4/2) fine sandy loam; weak medium subangular blocky structure; friable; few fine light yellowish brown (2.5Y 6/3) iron depletions; common medium strong brown (7.5YR 5/6) soft masses of iron accumulation; common medium brown (7.5YR 4/4) soft masses of iron accumulation; strongly acid (pH 5.34).

Bt—30 to 43 cm; light olive brown (2.5Y 5/6) sandy loam; weak medium subangular blocky structure; firm; few faint clay films on faces of peds; common medium light yellowish brown (2.5Y 6/3) iron depletions; few fine and medium strong brown (7.5YR 5/6) soft masses of iron accumulation; few medium yellowish brown (10YR 5/8) soft masses of iron accumulation; very strongly acid (pH 4.51).

Btv—43 to 68 cm; light olive brown (2.5Y 5/4) sandy loam; moderate medium subangular blocky structure; friable; few faint clay films on faces of peds; 3% medium strong brown (7.5YR 5/8) plinthite nodules; common medium yellowish brown (10YR 5/8) soft masses of iron accumulation; common medium light brownish gray (2.5Y 6/2) iron depletions; extremely acid (pH 4.16).

Btg—68 to 86 cm; light gray (2.5Y 7/1) and light brownish gray (2.5Y 6/2) sandy loam; moderate medium subangular blocky structure; friable; few faint clay films on faces of peds; few fine strong brown (7.5YR 5/8) soft masses of iron accumulation; extremely acid (pH 3.87).

B’t1—86 to 125 cm; yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; friable; common thin clay films on faces of peds; many common light gray (10YR 7/1) iron depletions; many medium strong brown (7.5YR 5/8) soft masses of iron accumulation; extremely acid (pH 3.95).

B’t2—125 to 167 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; common thin clay films on faces of peds; many fine and medium (5YR 5/8) soft masses of iron accumulation; few fine strong brown (7.5YR 5/8) soft masses of iron accumulation; common medium light gray (10YR 7/1) iron depletions; extremely acid (pH 3.77).

B’t3—167 to 187 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; common medium red (2.5YR 4/8) soft masses of iron accumulation; few medium yellowish brown (10YR 5/8) soft masses of iron accumulation; common medium light gray (10YR 7/1) iron depletions; extremely acid (pH 3.78).

Remarks: Soil Drainage Class 4, somewhat poorly drained soil. Soil color of chroma two or less begins at a depth of 43 cm. Characterization data and soil description provide evidence of a bi-sequel soil. Plinthite is less than 5% by volume within any horizon.

Table 18. Standard Characterization; S06AL-041-3, Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	---------------------				%				----------------------	------1:1-----	
S06AL-041-3-1	Ap1	15	75.8	19.1	5.2	0.8	5.7	13.8	39.8	15.7	66.16	5.23	4.83
S06AL-041-3-2	Ap2	30	76.9	18.2	5.0	0.9	7.5	15.0	38.9	14.6	74.26	5.37	5.07
S06AL-041-3-3	Bt	43	67.0	22.8	10.2	0.9	5.2	11.0	36.1	13.7	48.93	4.51	4.18
S06AL-041-3-4	Btv	68	67.9	22.3	9.8	1.1	5.0	11.3	36.6	13.9	35.18	4.16	3.82
S06AL-041-3-5	Btg	86	68.8	22.3	8.9	0.5	4.7	11.1	38.0	14.5	19.99	3.87	3.65
S06AL-041-3-6	B't1	125	64.1	19.3	16.6	0.5	4.0	10.7	36.0	13.0	12.11	3.95	3.58
S06AL-041-3-7	B't2	167	68.4	16.0	15.7	0.5	4.7	11.3	39.0	12.9	8.83	3.77	3.63
S06AL-041-3-8	B't3	187	69.4	12.5	18.1	0.8	4.9	11.4	39.3	13.0	13.93	3.78	3.64

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm
		(cm)	------------------	meq 100g $soil^{-1}$				--------------------	--meq 100g $clay^{-1}$--			--------%--------	
S06AL-041-3-1	Ap1	15	1.49	0.41	0.10	0.04	0.04	3.08	2.08	59.71	40.28	0	0
S06AL-041-3-2	Ap2	30	1.06	0.31	0.06	0.00	0.05	1.99	1.46	40.16	29.53	0	0
S06AL-041-3-3	Bt	43	0.80	0.37	0.04	0.44	0.03	2.54	1.68	24.89	16.50	1	0
S06AL-041-3-4	Btv	68	0.47	0.24	0.03	1.51	0.03	2.20	1.92	22.45	19.58	3	0
S06AL-041-3-5	Btg	86	0.21	0.11	0.03	1.11	0.04	1.93	1.50	21.65	16.80	0	0
S06AL-041-3-6	B't1	125	0.21	0.17	0.03	2.63	0.02	3.63	3.07	21.82	18.46	1	0
S06AL-041-3-7	B't2	167	0.12	0.13	0.02	2.42	0.02	3.29	2.71	21.04	17.35	0	0
S06AL-041-3-8	B't3	187	0.21	0.18	0.03	2.65	0.07	3.44	3.13	18.99	17.28	1	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-041-4, Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult. Data loggers; 30747, 47731, & 30606, Crenshaw County, Alabama, June 28, 2006.

Ap—0 to 25 cm; brown (10YR 4/3) loamy sand; weak fine granular structure; friable; common fine roots; strongly acid (pH 5.13).

BE—25 to 64 cm; yellowish brown (10YR 5/4) sandy loam; weak medium subangular blocky structure; friable; common fine roots; very strongly acid (pH 4.68).

Bt—64 to 101 cm; yellowish brown (10YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; few medium pale brown (10YR 6/3) iron depletions; extremely acid (pH 4.17).

Btv1—101 to 128 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; firm; common faint clay films on faces of peds; common medium strong brown (7.5YR 5/8) ironstone nodules; 1 percent medium yellowish red (5YR 5/8) plinthite nodules; common fine strong brown (7.5YR 5/8) soft masses of iron accumulation; few fine light yellowish brown (10YR 6/4) iron depletions; extremely acid (pH 4.16).

Btv2—128 to 155 cm; yellowish brown (10YR 5/6) sandy clay; moderate medium subangular blocky structure; firm; common faint clay films on faces of peds; common medium strong brown (7.5YR 5/8) ironstone nodules; 6 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium and coarse yellowish red (5YR 5/6), and many medium brownish yellow (10YR 6/8) soft masses of iron accumulation; many medium light gray (10YR 7/1) iron depletions; extremely acid (pH 4.27).

Btv3—155 to 186 cm; 40 percent yellowish brown (10YR 5/6) and 40 percent light gray (10YR 7/1) and 20 percent yellowish red (5YR 4/6) sandy clay; moderate medium subangular blocky structure; firm; common thin clay films on faces of peds; common medium strong brown (7.5YR 5/8) ironstone nodules; 2 percent medium yellowish red (5YR 5/8) plinthite nodules; extremely acid (pH 4.08).

BC—186 to 196 cm; 50 percent red (2.5YR 5/8) and 30 percent light gray (10YR 7/1) and 20 percent brownish yellow (10YR 6/8) sandy clay loam; weak medium subangular blocky structure; friable; common medium strong brown (7.5YR 5/8) ironstone nodules; 3 percent medium yellowish red (5YR 5/8) plinthite nodules. extremely acid (pH 4.11).

Remarks: Soil Drainage Class 2, well drained soil. Soil color of chroma two or less begins at a depth of 128 cm. 5 percent plinthite was recorded per laboratory analysis in the Btv2 horizon.

Table 19. Standard Characterization; S06AL-041-4, Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	---					%			---	-------1:1-------	
S06AL-041-4-1	Ap	25	76.3	20.5	3.2	1.1	5.4	18.3	39.3	12.2	55.29	5.13	4.76
S06AL-041-4-2	BE	64	67.1	26.4	6.5	0.7	3.6	14.6	36.5	11.8	35.93	4.68	4.13
S06AL-041-4-3	Bt	101	61.2	21.5	17.3	1.0	3.4	13.1	32.8	10.9	19.77	4.17	3.83
S06AL-041-4-4	Btv1	128	55.8	18.2	26.0	0.5	3.1	12.5	30.2	9.4	25.22	4.16	3.85
S06AL-041-4-5	Btv2	155	44.8	12.5	42.8	0.1	2.4	9.1	24.5	8.7	16.11	4.27	3.78
S06AL-041-4-6	Btv3	186	50.1	5.3	44.6	0.5	0.7	5.2	32.5	11.2	8.31	4.08	3.72
S06AL-041-4-7	BC	196	69.7	2.4	28.0	0.2	0.1	11.3	50.2	7.9	8.87	4.11	3.77

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm
		(cm)	----------------------meq 100g $soil^{-1}$----------------------							--meq 100g $clay^{-1}$--		------------%-----------	
S06AL-041-4-1	Ap	25	0.95	0.38	0.13	0.02	0.01	2.65	1.49	82.70	46.35	0	0
S06AL-041-4-2	BE	64	0.35	0.17	0.09	0.41	0.02	1.77	1.04	27.13	16.01	0	0
S06AL-041-4-3	Bt	101	0.30	0.18	0.13	1.77	0.01	3.13	2.38	18.13	13.81	0	0
S06AL-041-4-4	Btv1	128	0.70	0.32	0.15	2.20	0.01	4.67	3.38	17.98	13.01	1	10
S06AL-041-4-5	Btv2	155	0.91	0.31	0.23	4.31	0.03	9.12	5.78	21.96	13.92	6	1
S06AL-041-4-6	Btv3	186	0.37	0.18	0.10	4.44	0.03	8.13	5.11	18.73	11.79	2	0
S06AL-041-4-7	BC	196	0.19	0.10	0.05	2.06	0.02	4.06	2.42	15.19	9.07	3	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.
‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-041-5, Loamy, siliceous, subactive, thermic Grossarenic Paleudult. Data loggers; 30704 & 30732, Crenshaw County, Alabama, August 14, 2006.

Ap—0 to 8 cm; brown (10YR 4/3) loamy sand, weak fine granular structure; very friable; many fine roots; moderately acid (pH 5.83).

AE—8 to 30 cm; brown (10YR 5/3) loamy sand; weak medium subangular blocky structure; very friable; many fine roots; very strongly acid (pH 4.71).

E1—30 to 47 cm; brown (10YR 5/3) loamy sand; weak medium subangular blocky structure; very friable; common fine roots; very strongly acid (pH 4.82).

E2—47 to 72 cm; pale brown (10YR 6/3) loamy sand; weak medium subangular blocky structure; very friable; common fine roots; very strongly acid (pH 4.65).

E3—72 to 107 cm; pale brown (10YR 6/3) loamy sand; yellowish red (5YR 5/8) sandy loam; weak medium subangular blocky structure; very friable; few fine roots; extremely acid (pH 4.41).

E4—107 to 122 cm; pale brown (10YR 6/3) loamy sand; many medium faint pale yellow (2.5YR 7/3), and many medium distinct yellowish brown (10YR 5/6); weak medium subangular blocky structure; very friable; few fine roots; very strongly acid (pH 4.86).

Bt1—122 to 157 cm; yellowish brown (10YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; few faint clay films on faces of peds; very strongly acid (pH 4.84).

Bt2—157 to 174 cm; yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; friable; few faint clay films on faces of peds; common medium prominent red (2.5YR 4/8) soft masses of iron accumulation; few fine distinct light yellowish brown (10YR 6/4) and pale brown (10YR 6/3) iron depletions; extremely acid (pH 4.21).

Bt3—174 to 190 cm; yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; friable; few faint clay films on faces of peds; common medium faint brownish yellow (10YR 6/8) and common medium prominent red (2.5YR 4/8) and common medium distinct yellowish red (5YR 5/8) soft masses of iron accumulation; common medium distinct light gray (2.5Y 7/2) iron depletions; extremely acid (pH 3.96).

Bt4—190 to 220 cm; brownish yellow (10YR 6/6) sandy clay loam; moderate medium subangular blocky structure; friable; few faint clay films on faces of peds; common medium faint brownish yellow (10YR 6/8) and common medium prominent red (2.5YR 4/8) and common medium distinct yellowish red (5YR 5/8) soft masses of iron accumulation; common medium prominent light brownish gray (10YR 6/2), and common medium distinct light gray (2.5Y 7/2) iron depletions; extremely acid (pH 3.98).

Remarks: Soil Drainage Class 1, Somewhat excessively drained to well drained. Soil color of chroma two or less begins at a depth of 174 cm.

Table 20. Standard Characterization; S06AL-041-5, Loamy, siliceous, subactive, thermic Grossarenic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	--------------------------------------%--									-------1:1-------	
S06AL-041-5-1	Ap	8	78.7	16.4	4.9	1.0	5.9	19.7	36.4	15.7	31.75	5.83	4.13
S06AL-041-5-2	AE	30	78.6	17.0	4.5	0.6	6.2	19.6	36.5	15.7	20.73	4.71	4.14
S06AL-041-5-3	E1	47	76.8	18.3	4.9	0.3	3.7	15.0	38.5	19.3	30.67	4.82	4.41
S06AL-041-5-4	E2	72	77.6	19.0	3.4	0.6	4.4	14.4	39.9	18.3	18.10	4.65	4.18
S06AL-041-5-5	E3	107	76.3	19.3	4.3	1.2	5.3	14.5	34.7	20.7	40.55	4.41	4.07
S06AL-041-5-6	E4	122	80.7	15.2	4.1	0.8	4.2	13.0	42.9	19.8	54.88	4.86	4.51
S06AL-041-5-7	Bt1	157	67.6	12.9	19.6	0.5	2.4	8.9	35.9	19.9	68.87	4.84	4.64
S06AL-041-5-8	Bt2	174	63.3	9.1	27.6	0.4	1.7	7.7	36.4	17.1	38.77	4.21	3.95
S06AL-041-5-9	Bt3	190	65.0	6.8	28.2	0.1	1.6	6.5	38.9	18.0	24.81	3.96	3.77
S06AL-041-5-10	Bt4	220	68.3	6.8	25.0	0.1	1.0	5.2	41.9	20.0	17.94	3.98	3.59

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡	Frag >2mm by volume
		(cm)	----------------------meq 100g soil^{-1}--------------------							--meq 100g clay^{-1}--		-----------%---------	
S06AL-041-5-1	Ap	8	0.50	0.21	0.09	0.43	0.00	2.53	1.23	51.41	25.10	0	0
S06AL-041-5-2	AE	30	0.26	0.08	0.06	0.42	0.00	1.97	0.83	44.41	18.68	0	0
S06AL-041-5-3	E1	47	0.32	0.06	0.05	0.23	0.00	1.38	0.65	28.08	13.29	0	0
S06AL-041-5-4	E2	72	0.09	0.02	0.03	0.24	0.00	0.78	0.38	23.15	11.33	0	0
S06AL-041-5-5	E3	107	0.24	0.09	0.03	0.35	0.00	0.88	0.70	10.57	8.47	0	0
S06AL-041-5-6	E4	122	0.29	0.11	0.03	0.02	0.00	0.79	0.45	19.16	11.01	0	0
S06AL-041-5-7	Bt1	157	2.22	0.34	0.03	0.09	0.00	3.77	2.69	19.27	13.73	0	0
S06AL-041-5-8	Bt2	174	1.70	0.42	0.02	2.69	0.01	5.54	4.84	20.09	17.54	0	0
S06AL-041-5-9	Bt3	190	1.13	0.33	0.03	3.97	0.01	6.05	5.47	21.49	19.44	0	0
S06AL-041-5-10	Bt4	220	0.79	0.24	0.03	4.04	0.00	5.96	5.10	23.86	20.44	0	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-041-6, Loamy, kaolinitic, thermic Arenic Plinthic Kandiudult. Data loggers; 30748 & 30634, Crenshaw County, Alabama, August 14, 2006.

Ap—0 to 18 cm; brown (10YR 4/3) loamy sand; weak fine granular structure; very friable; common fine roots; few medium strong brown (7.5YR 5/8) ironstone nodules; moderately acid (pH 5.61).

E1—18 to 37 cm; yellowish brown (10YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; common fine roots; few medium strong brown (7.5YR 5/8) ironstone nodules; strongly acid (pH 5.53).

E2—37 to 61 cm; light yellowish brown (10YR 6/4)loamy sand; weak medium subangular blocky structure; very friable; common medium strong brown (7.5YR 5/8) ironstone nodules; moderately acid (pH 5.72).

Btv1—61 to 97 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; few medium strong brown (7.5YR 5/8) ironstone nodules; 4 percent medium strong brown (7.5YR 5/8) plinthite nodules; few medium faint yellowish brown (10YR 5/8) soft masses of iron accumulation; few medium faint pale brown (10YR 6/3) iron depletions; very strongly acid (pH 4.69).

Btv2—97 to 124 cm; yellowish brown (10YR 5/6) sandy clay; weak medium angular blocky structure; firm; common distinct clay films on faces of peds; 5 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium prominent red (2.5YR 4/8), and common medium brownish yellow (10YR 6/8) soft masses of iron accumulation; few medium distinct light yellowish brown (2.5Y 6/4) iron depletions; extremely acid (pH 4.34).

Bt—124 to 152 cm; red (2.5YR 4/8) sandy clay; weak medium angular blocky structure; firm; common distinct clay films on faces of peds; 1 percent medium red (2.5YR 4/8) plinthite nodules; common medium prominent brownish yellow (10YR 6/6) soft masses of iron accumulation; common medium prominent light yellowish brown (2.5Y 6/4) iron depletions; extremely acid (pH 4.37).

BC—152 to 200 cm; red (2.5YR 4/8) sandy clay; weak medium subangular blocky structure; friable; common distinct clay films on faces of peds; many medium and coarse prominent brownish yellow (10YR 6/8) soft masses of iron accumulation; many medium prominent light yellowish brown (2.5Y 6/3) iron depletions; extremely acid (4.36).

Remarks: Soil Drainage Class 1, well drained soil. Soil color of chroma three begins at a depth of 61 cm. 5 percent plinthite was recorded per laboratory analysis in the Btv2 horizon.

Table 21. Standard Characterization; S06AL-041-6, Loamy, kaolinitic, thermic Arenic Plinthic Kandiudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	--%---									--------1:1--------	
S06AL-041-6-1	Ap	18	82.2	14.3	3.5	0.4	3.4	16.8	54.4	7.2	70.64	5.61	4.65
S06AL-041-6-2	E1	37	80.5	15.3	4.2	0.8	4.1	15.9	51.1	8.6	56.95	5.53	5.17
S06AL-041-6-3	E2	61	79.3	15.5	5.2	2.0	4.8	15.0	48.6	8.8	69.23	5.72	5.35
S06AL-041-6-4	Btv1	97	65.8	12.0	22.2	5.1	5.2	12.4	36.9	6.1	62.12	4.69	4.54
S06AL-041-6-5	Btv2	124	52.1	8.7	39.3	0.8	3.1	9.7	33.6	4.9	30.46	4.34	4.00
S06AL-041-6-6	Bt	152	50.2	2.3	47.5	0.2	0.5	6.6	41.5	1.4	27.14	4.37	3.95
S06AL-041-6-7	BC	200	54.3	1.7	44.0	0.1	0.4	6.8	45.7	1.3	16.65	4.36	3.89

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm
		(cm)	---------------------meq 100g soil^{-1}------------------------							--meq 100g clay^{-1}--		----------%--------	
S06AL-041-6-1	Ap	18	1.12	0.30	0.11	0.01	0.01	2.19	1.56	62.00	44.08	0	1
S06AL-041-6-2	E1	37	0.78	0.26	0.03	0.02	0.02	1.91	1.11	45.11	26.17	0	1
S06AL-041-6-3	E2	61	0.33	0.27	0.04	0.02	0.01	0.94	0.67	18.16	12.96	0	3
S06AL-041-6-4	Btv1	97	0.75	0.95	0.12	0.09	0.02	2.94	1.92	13.27	8.65	4	1
S06AL-041-6-5	Btv2	124	0.96	0.95	0.12	1.78	0.01	6.70	3.82	17.06	9.74	5	0
S06AL-041-6-6	Bt	152	0.55	0.82	0.08	1.96	0.02	5.41	3.42	11.37	7.20	1	0
S06AL-041-6-7	BC	200	0.21	0.49	0.05	2.34	0.01	4.60	3.11	10.47	7.07	0	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7;
ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-053-1, Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult. Data loggers; 30733, 30662/30611, Escambia County, Alabama, August 14, 2006.

Ap—0 to 25 cm; dark grayish brown (2.5Y 4/2) fine sandy loam; weak fine granular structure; very friable; common fine roots; very strongly acid (pH 4.65).

E—25 to 38 cm; light olive brown (2.5Y 5/3) fine sandy loam; weak medium subangular blocky structure; very friable; common fine roots; very strongly acid (pH 4.64).

Bt—38 to 60 cm; light yellowish brown (2.5Y 6/4) fine sandy loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; common medium yellowish red (5YR 5/8) ironstone nodules; many fine and medium distinct yellowish brown (10YR 5/6) soft masses of iron accumulation; common fine light brownish gray (2.5Y 6/2) iron depletions; extremely acid (pH 4.37).

Btvg1—60 to 90 cm; gray (2.5Y 6/1) loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; common medium yellowish red (5YR 5/8) ironstone nodules; 3 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium brownish yellow (10YR 6/6) soft masses of iron accumulation; extremely acid (pH 3.88).

Btvg2—90 to 114 cm; light brownish gray (2.5Y 6/2) sandy loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; common medium strong brown (7.5YR 5/8) ironstone nodules; 1 percent medium yellowish red (5YR 5/8) plinthite nodules; many medium distinct yellowish brown (10YR 5/8) soft masses of iron accumulation; extremely acid (pH 4.16).

Btvg3—114 to 140 cm; light gray (2.5Y 7/2) loam; moderate medium subangular blocky structure; firm; common thin clay films on faces of peds; common medium strong brown (7.5YR 5/8) ironstone nodules; 8 percent medium yellowish red (5YR 5/8) plinthite nodules; many medium distinct yellowish brown (10YR 5/6) and many medium prominent dark reddish brown (2.5YR3/4) and red (2.5YR 5/8) soft masses of iron accumulation: common medium faint light brownish gray (2.5Y 6/2) iron depletions; extremely acid (pH 3.99).

Btv—140 to 151 cm; yellowish red (5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; firm; common medium strong brown (7.5YR 5/8) ironstone nodules; 6 percent medium yellowish red (5YR 5/8) plinthite nodules; many medium prominent red (2.5YR 4/6) soft masses of iron accumulation; many medium prominent gray (2.5Y 6/1) iron depletions; extremely acid (pH 3.96).

Remarks: Soil Drainage Class 4, somewhat poorly drained. Soil color of chroma two or less begins at a depth of 38 cm. 8 percent plinthite was recorded per laboratory analysis in the Btvg3 and 6 percent within the Btv horizons.

Table 22. Standard Characterization; S06AL-053-1, Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	----------	----------	----------	----------	----------	%	----------	----------	----------	----------	--------1:1	--------
S06AL-053-1-1	Ap	25	56.3	35.5	8.3	0.0	1.1	5.4	27.8	22.0	36.54	4.65	4.17
S06AL-053-1-2	E	38	55.9	35.5	8.6	0.4	1.0	4.4	26.5	23.6	39.49	4.64	4.27
S06AL-053-1-3	Bt	60	54.2	34.8	11.0	0.6	1.0	4.2	25.9	22.5	31.38	4.37	3.98
S06AL-053-1-4	Btvg1	90	51.4	35.5	13.1	0.3	0.7	4.1	24.7	21.6	27.33	4.30	3.88
S06AL-053-1-5	Btvg2	114	53.4	27.1	19.5	0.4	0.8	5.5	25.6	21.1	16.29	4.16	3.82
S06AL-053-1-6	Btvg3	140	46.0	30.8	23.2	0.4	1.0	3.8	21.7	19.1	8.52	3.99	3.74
S06AL-053-1-7	Btv	151	44.0	27.0	29.0	1.9	2.0	4.4	20.0	15.6	6.35	3.96	3.76

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm by volume
		(cm)	----------	----------	meq 100g soil^{-1}	----------	----------	----------	----------	--meq 100g clay^{-1}--		----------%	---------
S06AL-053-1-1	Ap	25	0.97	0.35	0.19	0.58	0.03	4.20	2.11	50.84	25.59	0	3
S06AL-053-1-2	E	38	0.96	0.27	0.08	0.55	0.02	3.39	1.89	39.32	21.90	0	3
S06AL-053-1-3	Bt	60	0.59	0.22	0.11	1.06	0.02	2.98	1.99	26.97	18.07	0	6
S06AL-053-1-4	Btvg1	90	0.46	0.26	0.19	1.44	0.00	3.35	2.36	25.68	18.10	3	6
S06AL-053-1-5	Btvg2	114	0.26	0.20	0.16	2.17	0.01	3.82	2.79	19.56	14.30	1	8
S06AL-053-1-6	Btvg3	140	0.15	0.13	0.12	3.37	0.01	4.83	3.78	20.78	16.27	6	8
S06AL-053-1-7	Btv	151	0.14	0.15	0.14	4.00	0.00	6.65	4.43	22.90	15.25	6	16

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; Poarch-1, Coarse-loamy, siliceous, semiactive, thermic Plinthic Paleudult. Data loggers; 30661, 30698, Escambia County, Alabama, described by P. G. Martin on November 19, 2003.

Ap—0 to 23 cm; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; very friable; many fine and very fine roots; less than 2 percent fine, rounded ironstone concretions; strongly acid (pH 5.5).

Bt1—23 to 43 cm; yellowish brown (10YR 5/6) fine sandy loam; weak medium subangular blocky structure; friable; common fine and very fine roots; few faint clay films on faces of peds; less than 2 percent fine, rounded ironstone concretions; very strongly acid (pH 4.5).

Bt2—43 to 75 cm; brownish yellow (10YR 6/6) fine sandy loam; weak medium subangular blocky structure; friable; few fine and very fine roots; common faint clay films on faces of peds; less than 2 percent fine, rounded ironstone concretions; few medium distinct yellowish brown (10YR 5/8) soft masses of iron accumulation; few medium distinct light yellowish brown (10YR 6/4) iron depletions; very strongly acid (pH 4.5).

Bt3—75 to 93 cm; yellowish brown (10YR 5/6) loam; weak medium subangular blocky structure; friable; common faint clay films on faces of peds; about 2 percent nodular plinthite; less than 2 percent fine, rounded ironstone concretions; few medium faint yellowish brown (10YR 5/8) soft masses of iron accumulation; few fine faint grayish brown (10YR 5/2) and common medium distinct light yellowish brown (10YR 6/4) iron depletions; very strongly acid (pH 4.5).

Btv1—93 to 108 cm; yellowish brown (10YR 5/6) loam; moderate medium subangular blocky structure; friable; few fine roots; common faint clay films on faces of peds; about 5 percent nodular plinthite and fine, rounded ironstone concretions; many medium faint yellowish brown (10YR 5/8) soft masses of iron accumulation; few fine faint grayish brown (10YR 5/2) and common medium distinct light yellowish brown (10YR 6/4) iron depletions; very strongly acid (pH 4.5).

Btv2—108 to 143 cm; strong brown (7.5YR 5/6) loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; about 10 percent nodular plinthite and fine coarse, rounded ironstone concretions; common medium prominent red (2.5YR 4/8) soft masses of iron accumulation; common medium prominent light brownish gray (10YR 6/2) iron depletions; very strongly acid (pH 4.5).

Btv3—143 to 158 cm; strong brown (7.5YR 5/8) loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; about 10 percent nodular plinthite and fine to coarse, rounded ironstone concretions; many coarse prominent red (2.5YR 4/8) soft masses of iron accumulation; common medium prominent light gray (10YR 7/2) iron depletions; very strongly acid (pH 4.5).

Btv4—158 to 183 cm; yellowish brown (10YR 5/8) clay loam; weak coarse subangular blocky structure; friable; common faint clay films on faces of peds; about 15 percent nodular plinthite and 10 percent fine to coarse, rounded ironstone nodules; common medium prominent red (10R 4/6) and common coarse distinct strong brown (7.5YR 5/6) soft masses of iron accumulation; many medium prominent light gray (10YR 7/2) iron depletions; very strongly acid (pH 4.5).

Remarks: Soil Drainage Class 3, moderately well drained. Soil color of chroma two or less begins at a depth of 75 cm. 5 percent, or greater, plinthite was recorded per field analysis in the Btv1, Btv2, Btv3 and Btv4 horizons.

Soil Description; S06AL-129-1, Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult. Data loggers; 30621, 30694, Washington County, Alabama, August 15, 2006.

Ap—0 to 10 cm; brown (10YR 4/3) fine sandy loam; weak fine granular structure; very friable; common fine roots; common medium strong brown (7.5YR 5/8) ironstone nodules; extremely acid (pH 4.01).

AE—10 to 23 cm; light olive brown (2.5Y 5/3) fine sandy loam; weak fine subangular blocky structure; very friable; common fine roots; few medium strong brown (7.5YR 5/8) ironstone nodules; common fine faint strong brown (7.5YR 5/8) soft masses of iron accumulation; extremely acid (pH 4.35).

E—23 to 71 cm; light yellowish brown (2.5Y 6/3) fine sandy loam; weak medium subangular blocky structure; very friable; few medium strong brown (7.5YR 5/8) ironstone nodules; common fine and medium faint strong brown (7.5YR 5/8) soft masses of iron accumulation; common medium faint gray (2.5Y 6/1) iron depletions; extremely acid (pH 4.27).

Btv1—71 to 90 cm; light yellowish brown (2.5Y 6/3) sandy loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; few medium yellowish red (5YR 5/8) ironstone nodules; 5 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium distinct red (2.5YR 4/6) and yellowish red (5YR 5/8) soft masses of iron accumulation; common medium distinct gray (2.5Y 6/1) iron depletions; extremely acid (pH 4.26).

Btv2—90 to 110 cm; light yellowish brown (2.5Y 6/3) loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; few medium yellowish red (5YR 5/8) ironstone nodules; 3 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium distinct red (2.5YR 4/8) soft masses of iron accumulation; common medium distinct gray (2.5Y 6/1) iron depletions; extremely acid (pH 4.27).

Btv3—110 to 129 cm; dark red (2.5YR 3/6) silty clay; moderate medium angular blocky structure; firm; common distinct clay films on faces of peds; few medium yellowish red (5YR 5/8) ironstone nodules; 5 percent medium yellowish red (5YR 5/8) plinthite nodules; common medium distinct brownish yellow (10YR 6/8) soft masses of iron accumulation: common medium distinct light brownish gray (2.5Y 6/2) iron depletions; extremely acid (pH 4.20).

Btg—129 to 183 cm; gray (2.5Y 6/1) silty clay; moderate medium angular blocky structure; firm; many medium distinct red (2.5YR 4/6) soft masses of iron accumulation; many medium distinct gray (2.5Y 6/1) iron depletions; extremely acid (pH 4.08).

Remarks: Soil Drainage Class 5, poorly drained to somewhat poorly drained. Soil color of chroma two or less begins at a depth of 23 cm. 5 percent plinthite was recorded per laboratory analysis in the Btv1, Btv3 and 3 percent within the Btv2 horizons.

Table 23. Standard Characterization; S06AL-129-1, Coarse-loamy, siliceous, semiactive, thermic Plinthaquic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	pH .01NCaCl
		(cm)	-----	-----	-----	-----	-----	%	-----	-----	-----	--------1:1	--------
S06AL-129-1-1	Ap	10	64.6	32.5	2.9	0.8	0.4	7.8	32.3	23.3	6.91	4.01	3.49
S06AL-129-1-2	AE	23	62.8	33.9	3.3	4.0	0.7	4.9	30.2	23.1	11.60	4.35	3.80
S06AL-129-1-3	E	71	64.2	31.4	4.4	1.1	0.6	6.1	33.1	23.4	8.69	4.27	3.80
S06AL-129-1-4	Btv1	90	56.4	33.6	10.0	1.5	0.7	4.3	27.6	22.3	9.63	4.26	3.74
S06AL-129-1-5	Btv2	110	50.7	35.3	14.0	1.8	0.7	4.2	25.5	18.4	12.90	4.27	3.73
S06AL-129-1-6	Btv3	129	13.6	43.1	43.3	1.4	1.3	1.8	5.3	3.8	21.36	4.20	3.63
S06AL-129-1-7	Btg	183	11.7	46.7	41.7	0.0	0.2	0.4	4.3	6.8	32.84	4.08	3.49

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm by volume
		(cm)	-----	-----	meq 100g soil^{-1}	-----	-----	-----	-----	--meq 100g clay^{-1}--		-----------%	----------
S06AL-129-1-1	Ap	10	0.06	0.04	0.04	1.03	0.04	2.51	1.20	86.86	41.66	0	3
S06AL-129-1-2	AE	23	0.06	0.04	0.03	0.51	0.07	1.63	0.70	49.70	21.32	0	1
S06AL-129-1-3	E	71	0.03	0.04	0.02	0.65	0.04	1.44	0.78	33.02	17.81	0	1
S06AL-129-1-4	Btv1	90	0.05	0.19	0.02	1.99	0.04	3.19	2.29	31.98	23.02	5	1
S06AL-129-1-5	Btv2	110	0.10	0.37	0.03	2.41	0.04	4.16	2.94	29.78	21.05	3	2
S06AL-129-1-6	Btv3	129	0.62	2.52	0.13	9.99	0.08	15.68	13.34	36.21	30.81	5	2
S06AL-129-1-7	Btg	183	0.94	3.19	0.20	7.91	0.13	13.58	12.37	31.98	29.15	0	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7;
ECEC = Effective cation exchange capacity.
‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

Soil Description; S06AL-129-2, Fine-loamy, siliceous, semiactive, thermic Oxyaquic Paleudult. Data loggers; 30624, 30737, Washington County, Alabama, August 15, 2006.

Ap—0 to 10 cm; brown (10YR 4/3) loamy fine sand; weak fine granular structure; very friable; many fine and very fine roots; extremely acid (pH 4.21).

E1—10 to 34 cm; light yellowish brown (2.5Y 6/4) and light olive brown (2.5Y 5/4) fine sandy loam; weak medium subangular blocky structure; friable; common fine and very fine roots; less than 2 percent ironstone nodules; extremely acid (pH 4.47).

E2—34 to 60 cm; light yellowish brown (2.5Y 6/4) fine sandy loam; weak medium subangular blocky structure; friable; few fine roots; about 2 percent yellowish red (5YR 5/8) plinthite nodules; 9 percent fine and medium, rounded ironstone concretions; few medium distinct brownish yellow (10YR 6/8) soft masses of iron accumulation; extremely acid (pH 4.43).

Btv1—60 to 94 cm; yellowish brown (10YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; 13 percent yellowish red (5YR 5/8) nodular plinthite; less than 2 percent fine, rounded ironstone concretions; common medium distinct dark red (2.5YR 3/6) soft masses of iron accumulation; extremely acid (pH 4.05).

Btv2—94 to 121 cm; yellowish brown (10YR 5/6) sandy loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; 7 percent yellowish red (5YR 5/8) nodular plinthite; common medium distinct red (2.5YR 4/8) soft masses of iron accumulation; few fine faint light brownish gray (2.5Y 6/2) iron depletions; extremely acid (pH 4.28).

Btv3—121 to 152 cm; olive yellow (2.5Y 6/6) sandy clay loam; moderate medium subangular blocky structure; friable; common faint clay films on faces of peds; 3 percent red (2.5YR 4/8) nodular plinthite; common medium distinct yellowish red (5YR 5/8) soft masses of iron accumulation; common medium distinct light gray (10YR 7/1) iron depletions; extremely acid (pH 4.15).

Btg—152 to 190 cm; light gray (2.5Y 7/2) sandy clay loam; moderate medium subangular and angular blocky structure; firm; common distinct clay films on faces of peds; 3 percent red (2.5YR 4/8) nodular plinthite; common medium distinct yellowish red (5YR 5/8) and brownish yellow (10YR 6/8) and few fine faint olive yellow (2.5Y 6/6) soft masses of iron accumulation; extremely acid (pH 4.15).

Remarks: Soil Drainage Class 3, moderately well drained. Soil color of chroma two or less begins at a depth of 94 cm. 5 percent, or greater, plinthite was recorded per field analysis in the Btv1, and Btv2 horizons.

Table 24. Standard Characterization; S06AL-129-2, Fine-loamy, siliceous, semiactive, thermic Oxyaquic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH_4OAc	pH H_2O	.01NCaCl
		(cm)	----------	----------	----------	----------	----------	%	----------	----------	----------	--------1:1	-------
S06AL-129-2-1	Ap	10	72.4	23.5	4.1	0.3	2.5	20.1	36.5	13.0	7.04	4.21	3.68
S06AL-129-2-2	E1	34	71.3	23.8	4.9	0.1	1.0	15.7	40.0	14.6	3.56	4.47	4.00
S06AL-129-2-3	E2	60	71.6	23.6	4.8	0.0	0.6	11.3	41.2	18.5	6.34	4.43	3.93
S06AL-129-2-4	Btv1	94	62.2	20.3	17.5	1.8	1.6	7.5	36.0	15.2	6.47	4.05	3.65
S06AL-129-2-5	Btv2	121	66.3	14.3	19.5	0.5	0.9	5.7	44.5	14.6	4.99	4.28	3.64
S06AL-129-2-6	Btv3	152	60.1	14.0	25.9	0.0	0.3	4.6	40.0	15.2	5.57	4.15	3.58
S06AL-129-2-7	Btg	190	64.9	11.0	24.2	0.0	0.3	4.2	42.6	17.7	5.93	4.15	3.54

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡	Frag >2mm by volume
		(cm)	----------	----------	meq 100g soil^{-1}	----------	----------	----------	----------	--meq 100g clay^{-1}--		----------%	----------
S06AL-129-2-1	Ap	10	0.11	0.05	0.05	1.13	0.01	3.09	1.35	75.61	32.91	0	0
S06AL-129-2-2	E1	34	0.02	0.01	0.02	0.53	0.00	1.50	0.58	30.62	11.82	0	1
S06AL-129-2-3	E2	60	0.02	0.02	0.02	0.50	0.02	1.27	0.58	26.22	12.04	2	9
S06AL-129-2-4	Btv1	94	0.12	0.08	0.03	2.75	0.06	4.53	3.05	25.88	17.41	13	2
S06AL-129-2-5	Btv2	121	0.08	0.13	0.03	3.33	0.02	5.03	3.58	25.87	18.39	7	0
S06AL-129-2-6	Btv3	152	0.08	0.24	0.04	5.09	0.05	7.37	5.50	28.46	21.22	3	0
S06AL-129-2-7	Btg	190	0.08	0.23	0.05	5.88	0.05	6.99	6.29	28.92	26.05	3	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

S07AL-003-1-(1-8) Data loggers; 30637, 30736 Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult, Baldwin County, Alabama, March 24, 2007.

Ap—0 to 32 cm; brown (10YR 4/3) fine sandy loam; moderate medium granular and platy structure; very friable; many fine and very fine roots; few ironstone nodules; abrupt smooth boundary; very strongly acid (pH 5.02).

EB—32 to 43 cm; yellowish brown (10YR 5/4) loam; weak medium subangular blocky structure; friable; common fine and very fine roots; few medium ironstone nodules; clear wavy boundary; strongly acid (pH 5.14).

Btc—43 to 88 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; friable; few fine roots; few thin clay films on faces of peds; common medium ironstone nodules; clear wavy boundary; strongly acid (pH 5.54).

Btv1—88 to 110 cm; yellowish brown (10YR 5/6) sandy clay loam; moderate medium subangular blocky structure; firm; common thin clay films on faces of peds; 7 percent yellowish red (5YR 5/8) plinthite nodules; common medium ironstone nodules; common medium distinct yellowish red (5YR 5/8) soft masses of iron accumulation; clear wavy boundary; strongly acid (pH 5.36).

Btv2—110 to 133 cm; yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; firm; common medium clay films on faces of peds; 4 percent strong brown (7.5YR 5/8) plinthite nodules; common medium ironstone nodules; common medium distinct strong brown (7.5YR 5/8) soft masses of iron accumulation; common medium distinct light yellowish brown (10YR 6/4) iron depletions; clear smooth boundary; very strongly acid (pH 4.81).

Btv3—133 to 143 cm; 30 percent yellowish brown (10YR 5/8) sandy clay loam; moderate medium subangular blocky structure; firm; common medium clay films on faces of peds; 7 percent red (2.5YR 4/8) plinthite nodules; common medium ironstone nodules; common medium red (2.5YR 4/8) soft masses of iron accumulation; many medium distinct pale brown (10YR 6/3) iron depletions; clear wavy boundary; extremely acid (pH 4.49).

Btv4—143 to 178 cm; 35 percent light gray (10YR 7/2), 25 percent yellowish red (5YR 5/8), 25 percent strong brown (7.5YR 5/8) sandy clay loam; moderate medium subangular blocky structure; firm; common medium clay films on faces of peds; 22 percent yellowish red (5YR 5/8) plinthite nodules; common medium ironstone nodules; abrupt smooth boundary; extremely acid (pH 4.47).

2Btgv—178 to 200 cm; 50 percent light gray (10YR 7/1), 30 percent red (2.5YR 4/6), 20 percent yellowish brown (10YR 5/6) loam; moderate medium angular blocky structure; very friable; 20 percent yellowish red (5YR 5/8) plinthite nodules; extremely acid (pH 4.31).

Remarks: Soil Drainage Class 2, well drained. Soil color of chroma two or less begins at a depth of 143 cm. 5 percent, or greater, plinthite was recorded per field analysis in the Btv1, Btv3, Btv4 and 2Btgv horizons.

Table 25. Standard Characterization; S07AL-003-1, Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH4OAc	pH H2O	.01NCaCl
		(cm)	--%--									--------1:1--------	
S07AL-003-1-1	Ap	32	63.4	25.3	11.4	0.3	1.9	12.1	28.9	20.2	43.89	5.02	4.39
S07AL-003-1-2	EB	43	51.5	32.6	16.0	0.4	1.4	10.0	23.5	16.2	57.13	5.14	5.02
S07AL-003-1-3	Btc	88	48.9	27.4	23.7	0.8	1.7	8.8	20.7	16.9	60.29	5.54	5.48
S07AL-003-1-4	Btv1	110	52.1	26.1	21.8	0.3	1.3	9.1	23.1	18.3	57.60	5.36	5.40
S07AL-003-1-5	Btv2	133	53.6	20.9	25.6	0.3	1.3	9.9	23.8	18.3	46.77	4.81	4.67
S07AL-003-1-6	Btv3	143	51.8	20.4	27.8	0.2	1.6	10.6	22.8	16.6	39.75	4.49	4.22
S07AL-003-1-7	Btv4	178	52.5	18.0	29.5	0.8	2.0	11.3	22.0	16.4	39.62	4.47	4.21
S07AL-003-1-8	2Btgv	200	38.7	42.0	19.3	2.3	3.5	7.1	11.9	13.9	18.90	4.31	3.88

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm
		(cm)	---------------------meq 100g soil^{-1}-----------------------							--meq 100g clay^{-1}--		----------%----------	
S07AL-003-1-1	Ap	32	1.38	0.39	0.07	0.32	0.10	4.39	2.25	38.65	19.76	0	2
S07AL-003-1-2	EB	43	1.65	0.94	0.04	0.04	0.09	4.76	2.76	29.85	17.30	0	1
S07AL-003-1-3	Btc	88	1.98	1.22	0.03	0.45	0.05	5.45	3.74	22.98	15.75	0	3
S07AL-003-1-4	Btv1	110	1.50	0.91	0.01	0.04	0.08	4.35	2.55	19.98	11.69	7	3
S07AL-003-1-5	Btv2	133	1.12	0.61	0.02	0.27	0.08	3.89	2.09	15.24	8.18	4	3
S07AL-003-1-6	Btv3	143	1.14	0.53	0.02	0.60	0.14	4.61	2.43	16.56	8.73	7	4
S07AL-003-1-7	Btv4	178	1.22	0.50	0.02	0.59	0.08	4.59	2.40	15.57	8.16	22	4
S07AL-003-1-8	2Btgv	200	0.60	0.46	0.03	2.69	0.05	6.02	3.83	31.24	19.85	20	1

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

S07AL-129-1-(1-8) Data loggers; 30624, 30737 Coarse-loamy, siliceous, semiactive, thermic Plinthic Paleudult, Washington County, Alabama, March 23, 2007.

Ap—0 to 18 cm; brown (10YR 4/3) loamy fine sand; moderate medium granular structure; very friable; many fine and very fine roots; clear wavy boundary; extremely acid (pH 4.04).

E1—18 to 41 cm; light yellowish brown (10YR 6/4) fine sandy loam; weak medium subangular blocky structure; very friable; common fine and very fine roots; few medium ironstone nodules; few fine distinct strong brown (7.5YR 5/6) soft masses of iron accumulation; clear wavy boundary; extremely acid (pH 4.23).

E2—41 to 55 cm; brownish yellow (10YR 6/6) with light yellowish brown (10YR 6/4) stripping; fine sandy loam; weak medium subangular blocky structure; very friable; few fine roots; 1 percent dark red (2.5YR 3/6) plinthite nodules; few medium distinct reddish yellow (7.5YR 6/8) soft masses of iron accumulation; clear wavy boundary; extremely acid (pH 4.35).

Btv1—55 to 88 cm; yellowish brown (10YR 5/8) sandy loam; moderate medium subangular blocky structure; friable; few thin clay films on faces of peds; 2 percent dark red (2.5YR 3/6) plinthite nodules; few medium distinct red (2.5YR 4/8) soft masses of iron accumulation; clear wavy boundary; extremely acid (pH 4.26).

Btv2—88 to 120 cm; yellowish brown (10YR 5/8) sandy loam; moderate medium subangular blocky structure; firm; few thin clay films on faces of peds; 5 percent yellowish red (5YR 5/6) plinthite nodules; few medium prominent yellowish red (5YR 5/8) soft masses of iron accumulation; common medium distinct light yellowish brown (10YR 6/4) iron depletions; clear wavy boundary; extremely acid (pH 4.20).

Btv3—120 to 151 cm; 30 percent yellowish brown (10YR 5/8), 30 percent light brownish gray (10YR 6/2), 25 percent red (2.5YR 4/8), 15 percent red (2.5YR 4/6) sandy loam; moderate medium subangular blocky structure; firm; common thin clay films on faces of peds; 4 percent red (2.5YR 4/8) plinthite nodules; gradual wavy boundary; extremely acid (pH 4.21).

Btv4—151 to 182 cm; 50 percent yellowish brown (10YR 5/6), 40 percent light gray (10YR 7/1), 10 percent red (10R 4/8) sandy loam; moderate medium subangular blocky structure; firm; common thin clay films on faces of peds; 2 percent strong brown (7.5YR 5/6) plinthite nodules; clear wavy boundary; extremely acid (pH 4.19).

CB—182 to 200 cm; yellowish red (5YR 5/6) sandy loam; weak medium subangular blocky structure; friable; common medium distinct yellowish brown (10YR 5/6) soft masses of iron accumulation; common medium distinct light brownish gray (10YR 6/2) iron depletions; extremely acid (pH 4.27).

Remarks: Soil Drainage Class 2, well drained. Soil color of chroma two or less begins at a depth of 120 cm. 5 percent, or greater, plinthite was recorded per field analysis in the Btv2 horizon.

Table 26. Standard Characterization; S07AL-129-1, Coarse-loamy, siliceous, semiactive, thermic Plinthic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH4OAc	pH H2O	.01NCaCl
		(cm)	--%---									-------1:1-------	
S07AL-129-1-1	Ap	18	73.5	23.4	3.1	0.8	1.3	17.6	40.5	13.3	5.22	4.04	3.91
S07AL-129-1-2	E1	41	69.8	27.1	3.2	0.2	1.0	16.0	39.8	12.7	6.79	4.23	4.02
S07AL-129-1-3	E2	55	69.2	20.5	10.3	1.5	1.6	12.7	38.9	14.5	11.27	4.35	3.92
S07AL-129-1-4	Btv1	88	68.1	17.9	14.0	1.7	1.8	12.2	40.5	12.0	8.46	4.26	3.80
S07AL-129-1-5	Btv2	120	73.8	10.8	15.4	0.0	0.5	8.4	52.0	12.9	11.57	4.20	3.73
S07AL-129-1-6	Btv3	151	77.9	5.9	16.2	0.0	0.2	5.1	56.2	16.4	10.31	4.21	3.70
S07AL-129-1-7	Btv4	182	79.4	6.8	13.8	0.2	0.3	6.5	56.8	15.6	9.63	4.19	3.74
S07AL-129-1-8	CB	200	81.8	3.1	15.1	0.0	0.2	15.9	58.2	7.4	12.43	4.27	3.73

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm by volume
		(cm)	-------------------meq 100g soil^{-1}---------------------							--meq 100g clay^{-1}--		----------%----------	
S07AL-129-1-1	Ap	18	0.02	0.02	0.03	1.35	0.06	2.47	1.48	78.85	47.38	0	0
S07AL-129-1-2	E1	41	0.01	0.00	0.03	0.76	0.08	1.78	0.88	56.30	27.87	0	0
S07AL-129-1-3	E2	55	0.04	0.01	0.03	1.14	0.06	1.18	1.28	11.52	12.43	1	0
S07AL-129-1-4	Btv1	88	0.17	0.07	0.04	2.09	0.08	4.18	2.45	29.88	17.49	1	0
S07AL-129-1-5	Btv2	120	0.21	0.14	0.03	2.15	0.06	3.68	2.58	23.89	16.71	5	0
S07AL-129-1-6	Btv3	151	0.16	0.14	0.02	2.33	0.10	4.13	2.75	25.50	16.98	4	0
S07AL-129-1-7	Btv4	182	0.08	0.15	0.02	2.16	0.07	3.28	2.47	23.74	17.88	2	0
S07AL-129-1-8	CB	200	0.11	0.18	0.02	2.11	0.12	3.46	2.54	22.90	16.79	0	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7;
ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

S07AL-129-2-(1-8) Data loggers; 30621, 30694 Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult, Washington County, Alabama, March 23, 2007.

Ap—0 to 12 cm; brown (10YR 4/3) fine sandy loam; weak medium granular structure; very friable; many fine and very fine roots; clear wavy boundary; extremely acid (pH 4.02).

E1—12 to 24 cm; light yellowish brown (10YR 6/4) fine sandy loam; weak medium subangular blocky structure; very friable; common fine and very fine roots; common medium distinct strong brown (7.5YR 5/8) and common medium distinct red (2.5YR 4/6) soft masses of iron accumulation; common fine yellowish red (5YR 4/6) oxidized rhizomes; clear wavy boundary; extremely acid (pH 4.18).

E2—24 to 44 cm; yellowish brown (10YR 5/4) fine sandy loam; weak medium subangular blocky structure; very friable; few fine roots; common medium distinct strong brown (7.5YR 5/8) soft masses of iron accumulation; many medium distinct light gray (10YR 7/2) iron depletions; clear wavy boundary; extremely acid (pH 4.20).

BE—44 to 74 cm; yellowish brown (10YR 5/4) fine sandy loam; weak medium subangular blocky structure; friable; few thin clay films on faces of peds; 1 percent yellowish red (5YR 4/6) plinthite nodules; common medium distinct strong brown (7.5YR 5/8) soft masses of iron accumulation; common medium distinct light gray (10YR 7/2) iron depletions; clear wavy boundary; extremely acid (pH 4.26).

Btv1—74 to 90 cm; light yellowish brown (10YR 6/4) fine sandy loam; moderate medium subangular blocky structure; friable; common thin clay films on faces of peds; 2 percent yellowish red (5YR 4/6) plinthite nodules; common medium prominent strong brown (7.5YR 5/8) soft masses of iron accumulation; many medium distinct light gray (10YR 7/1) iron depletions; clear wavy boundary; extremely acid (pH 4.16).

Btv2—90 to 120 cm; yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) loam; moderate medium subangular blocky structure; friable; common thin clay films on faces of peds; 3 percent yellowish red (5YR 5/8) plinthite nodules; common medium distinct strong brown (7.5YR 5/8) soft masses of iron accumulation; many medium distinct light gray (10YR 7/1) iron depletions; gradual wavy boundary; extremely acid (pH 4.26).

2CBg—120 to 152 cm; light gray (10YR 7/1) silty clay loam; weak coarse subangular blocky and massive structure; very firm; common thin clay films on faces of peds; 4 percent dark red (2.5YR 3/6) plinthite nodules; many medium dark red (2.5YR 3/6) and common medium brownish yellow (10YR 6/8) soft masses of iron accumulation; clear wavy boundary; extremely acid (pH 3.85).

2Cg—152 to 200 cm; light gray (10YR 7/1) silty clay loam; massive structure; very firm; 7 percent dark red (2.5YR 3/6) plinthite nodules; many medium dark red (2.5YR 3/6) and common medium brownish yellow (10YR 6/8) soft masses of iron accumulation; extremely acid (pH 3.83).

Remarks: Soil Drainage Class 5, poorly drained. Soil color of chroma two or less begins at a depth of 24 cm. 5 percent, or greater, plinthite was recorded per field analysis in the 2Cg horizon greater than 150 cm which did not meet the minimum for a Plinthaquic subgroup. Per MO14 – General Guide to Natural (Agricultural) Drainage Classes, this soil falls within the somewhat poorly drained soils determination.

Table 27. Standard Characterization; S07AL-129-2, Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult.

Sample ID	Horizon	Lower Depth	Particle Size Distribution Sand	Silt	Clay	Sand Size Distribution 2-1	1-.5	.5-.25	.1-.25	.1-.05	Base Saturation NH4OAc	pH H2O	.01NCaCl
		(cm)	---%---									-------1:1-------	
S07AL-129-2-1	Ap	12	66.3	28.1	5.6	3.0	1.0	5.5	32.6	24.3	10.09	4.02	3.71
S07AL-129-2-2	E1	24	65.3	28.0	6.7	0.9	0.6	4.6	33.0	26.1	30.04	4.02	3.71
S07AL-129-2-3	E2	44	67.4	27.0	5.6	2.0	0.5	4.1	32.1	28.7	11.09	4.02	3.71
S07AL-129-2-4	BE	74	60.4	29.7	10.0	1.2	0.5	4.9	30.5	23.3	17.55	4.26	3.80
S07AL-129-2-5	Btv1	90	58.3	28.8	12.9	0.8	0.5	4.6	29.3	23.0	9.15	4.16	3.76
S07AL-129-2-6	Btv2	120	52.9	29.0	18.1	0.9	0.6	3.9	25.7	21.8	20.40	4.26	3.68
S07AL-129-2-7	2CBg	152	14.1	48.6	37.3	1.0	0.8	0.9	5.1	6.2	27.73	3.85	3.57
S07AL-129-2-8	2Cg	200	17.6	45.7	36.6	5.1	2.6	1.3	3.6	5.1	35.19	4.02	3.71

Sample ID	Horizon	Lower Depth	Exchangeable Cations Ca†	Mg	K	Al	Na	Cation Exchange Capacity CEC-7	ECEC	CEC-7	ECEC	Plinthite‡ by volume	Frag >2mm by volume
		(cm)	---------------------meq 100g soil^{-1}-----------------------							--meq 100g clay^{-1}--		----------%----------	
S07AL-129-2-1	Ap	12	0.05	0.04	0.02	1.05	0.11	2.16	1.27	38.82	22.73	0	0
S07AL-129-2-2	E1	24	0.02	0.01	0.01	0.85	0.05	0.32	0.95	4.76	14.06	0	0
S07AL-129-2-3	E2	44	0.02	0.04	0.01	1.12	0.07	1.28	1.26	23.02	22.61	0	0
S07AL-129-2-4	BE	74	0.07	0.10	0.02	1.83	0.10	1.67	2.13	16.81	21.36	1	0
S07AL-129-2-5	Btv1	90	0.05	0.18	0.02	1.71	0.03	2.99	1.99	23.18	15.39	2	0
S07AL-129-2-6	Btv2	120	0.17	0.64	0.03	2.67	0.15	4.83	3.66	26.65	20.16	3	0
S07AL-129-2-7	2CBg	152	0.88	2.82	0.18	8.95	0.15	14.56	12.99	38.99	34.78	4	0
S07AL-129-2-8	2Cg	200	1.08	3.66	0.18	7.14	0.15	14.42	12.21	39.38	33.34	7	0

† Ca = Calcium; Mg = Magnesium; K = Potassium; Al = Aluminum; Na = Sodium; CEC-7 = Cation Exchange Capacity at pH 7; ECEC = Effective cation exchange capacity.

‡ Plinthite and coarse fragments (Frag>2mm) determined by slaking procedures as described in chapter.

APPENDIX II

WATER TABLE ACTIVITY

Table 28. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-003-1. The 2006 monitoring period had *normal* monthly precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
	Plinthite	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	0.0	0.0	0.0	0	0.0	0.0
2006	Chroma ≤ 2	1	68.0	47.0	4.0	19	1.0	2.2
	Depleted Matrix	1	68.0	47.0	4.0	19	1.0	2.2
	Soft Fe Acc. & Chroma ≤ 3	1	68.0	47.0	4.0	19	1.0	2.2
	Plinthite & Chroma ≤ 3	1	68.0	47.0	4.0	19	1.0	2.2

† = number of horizons.
‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

Table 29. Hydromorphic features associated with saturation, duration, and periodicity for pedon S06AL-041-1. The 2004-2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2004	Plinthite	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	2.0	2.0	1.0	1	0.0	0.0
2005	Plinthite	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	0.0	0.0	0.0	0	0.0	0.0
2006	Plinthite	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	0.0	0.0	0.0	0	0.0	0.0
2004-2006	Plinthite	3	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	3	0.7	0.7	0.3	0	0.0	0.0

† = number of horizons.
‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

Table 30. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-041-2. The 2004-2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2004	Plinthite	1	63.0	61.0	2.0	37	1.0	2.9
	Soft Fe Acc.	1	63.0	61.0	2.0	37	1.0	2.9
	Chroma 3	1	77.0	66.0	2.0	45	1.0	3.1
	Chroma ≤ 2	1	77.0	66.0	2.0	45	1.0	3.1
	Soft Fe Acc. & Chroma ≤ 3	1	77.0	66.0	2.0	45	1.0	3.1
	Plinthite & Chroma ≤ 3	1	77.0	66.0	2.0	45	1.0	3.1
2005	Plinthite	1	112.0	57.0	5.0	61	2.0	3.7
	Soft Fe Acc.	1	112.0	57.0	5.0	61	2.0	3.7
	Chroma 3	1	151.0	61.0	5.0	82	3.0	4.9
	Chroma ≤ 2	1	151.0	61.0	5.0	82	3.0	4.9
	Soft Fe Acc. & Chroma ≤ 3	1	151.0	61.0	5.0	82	3.0	4.9
	Plinthite & Chroma ≤ 3	1	151.0	61.0	5.0	82	3.0	4.9
2006	Plinthite	1	83.0	71.0	2.0	23	1.0	3.4
	Soft Fe Acc.	1	83.0	71.0	2.0	23	1.0	3.4
	Chroma 3	1	157.0	78.0	3.0	44	2.0	4.7
	Chroma ≤ 2	1	157.0	78.0	3.0	44	2.0	4.7
	Soft Fe Acc. & Chroma ≤ 3	1	157.0	78.0	3.0	44	2.0	4.7
	Plinthite & Chroma ≤ 3	1	157.0	78.0	3.0	44	2.0	4.7
2004-2006	Plinthite	3	86.0	63.0	3.0	40	1.3	3.3
	Soft Fe Acc.	3	86.0	63.0	3.0	40	1.3	3.3
	Chroma 3	3	128.3	68.3	3.3	57	2.0	4.3
	Chroma ≤ 2	3	128.3	68.3	3.3	57	2.0	4.3
	Soft Fe Acc. & Chroma ≤ 3	3	128.3	68.3	3.3	57	2.0	4.3
	Plinthite & Chroma ≤ 3	3	128.3	68.3	3.3	57	2.0	4.3

† number of horizons.

‡ saturation metrics calculated for 30-yr *normal* precipitation where: cumulative=avg. number of days experiencing saturation; longest duration=average longest saturated period; periodicity=average annual frequency of saturation; %=average percent of annual saturation.

Table 31. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-041-3. The 2004-2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
	Chroma 3	1	63.0	30.0	7.0	22	1.0	1.4
	Soft Fe Acc.	1	63.0	30.0	7.0	22	1.0	1.4
	Soft Fe Acc. & Chroma ≤ 3	1	63.0	30.0	7.0	22	1.0	1.4
2004	Chroma ≤ 2	1	130.0	73.0	7.0	45	2.0	4.4
	Plinthite	1	130.0	73.0	7.0	45	2.0	4.4
	Plinthite & Chroma ≤ 3	1	130.0	73.0	7.0	45	2.0	4.4
	Depleted Matrix	1	197.0	73.0	8.0	68	3.0	5.5
	Chroma 3	1	99.0	20.0	17.0	27	0.0	0.0
	Soft Fe Acc.	1	99.0	20.0	17.0	27	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	99.0	20.0	17.0	27	0.0	0.0
2005	Chroma ≤ 2	1	247.0	131.0	7.0	68	4.0	9.2
	Plinthite	1	247.0	131.0	7.0	68	4.0	9.2
	Plinthite & Chroma ≤ 3	1	247.0	131.0	7.0	68	4.0	9.2
	Depleted Matrix	1	287.0	139.0	7.0	79	4.0	9.6
	Chroma 3	1	28.0	9.0	9.0	8	0.0	0.0
	Soft Fe Acc.	1	28.0	9.0	9.0	8	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	28.0	9.0	9.0	8	0.0	0.0
2006	Chroma ≤ 2	1	80.0	80.0	1.0	22	1.0	3.8
	Plinthite	1	80.0	80.0	1.0	22	1.0	3.8
	Plinthite & Chroma ≤ 3	1	80.0	80.0	1.0	22	1.0	3.8
	Depleted Matrix	1	188.0	93.0	19.0	52	2.0	5.0
	Chroma 3	3	63.3	19.7	11.0	19	0.3	0.5
	Soft Fe Acc.	3	63.3	19.7	11.0	19	0.3	0.5
	Soft Fe Acc. & Chroma ≤ 3	3	63.3	19.7	11.0	19	0.3	0.5
2004-2006	Chroma ≤ 2	3	152.3	94.7	5.0	45	2.3	5.8
	Plinthite	3	152.3	94.7	5.0	45	2.3	5.8
	Plinthite & Chroma ≤ 3	3	152.3	94.7	5.0	45	2.3	5.8
	Depleted Matrix	3	224.0	101.7	11.3	66	3.0	6.7

† number of horizons; ‡ Saturation metrics calculated for 30-yr normal precipitation, where cumulative=average number of days experiencing saturation; longest duration=average longest saturated period; periodicity=average annual frequency of saturation; %=average percent of annual saturation.

Table 32. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-041-4. The 2004-2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2004	Chroma 3	1	9.0	6.0	3.0	2	0.0	0.0
	Chroma ≤ 2	1	18.0	9.0	4.0	5	0.0	0.0
	Plinthite	1	18.0	9.0	4.0	5	0.0	0.0
	Soft Fe Acc.	1	18.0	9.0	4.0	5	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	18.0	9.0	4.0	5	0.0	0.0
	Plinthite & Chroma ≤ 3	1	18.0	9.0	4.0	5	0.0	0.0
2005	Chroma 3	1	16.0	6.0	4.0	4	0.0	0.0
	Chroma ≤ 2	1	24.0	13.0	3.0	7	0.0	0.0
	Plinthite	1	24.0	13.0	3.0	7	0.0	0.0
	Soft Fe Acc.	1	24.0	13.0	3.0	7	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	24.0	13.0	3.0	7	0.0	0.0
	Plinthite & Chroma ≤ 3	1	24.0	13.0	3.0	7	0.0	0.0
2006	Chroma 3	1	0.0	0.0	0.0	0	0.0	0.0
	Plinthite	1	1.0	1.0	1.0	0	0.0	0.0
	Soft Fe Acc.	1	1.0	1.0	1.0	0	0.0	0.0
	Chroma ≤ 2	1	9.0	3.0	5.0	4	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	9.0	3.0	5.0	4	0.0	0.0
	Plinthite & Chroma ≤ 3	1	9.0	3.0	5.0	4	0.0	0.0
2004-2006	Chroma 3	3	8.3	4.0	2.3	2	0.0	0.0
	Plinthite	3	14.3	7.7	2.7	4	0.0	0.0
	Soft Fe Acc.	3	14.3	7.7	2.7	4	0.0	0.0
	Chroma ≤ 2	3	17.0	8.3	4.0	5	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	3	17.0	8.3	4.0	5	0.0	0.0
	Plinthite & Chroma ≤ 3	3	17.0	8.3	4.0	5	0.0	0.0

† number of horizons.

‡ Saturation metrics calculated for 30-yr normal precipitation, where cumulative=average number of days experiencing saturation; longest duration=average longest saturated period; periodicity=average annual frequency of saturation; % = average percent of annual saturation.

Table 33. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-041-5. The 2004-2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2004	Chroma 3	1	0.0	0.0	0.0	0	0.0	0.0
	Chroma ≤ 2	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	0.0	0.0	0.0	0	0.0	0.0
2005	Chroma 3	1	0.0	0.0	0.0	0	0.0	0.0
	Chroma ≤ 2	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	0.0	0.0	0.0	0	0.0	0.0
2006	Chroma 3	1	1.0	1.0	1.0	3	0.0	0.0
	Chroma ≤ 2	1	1.0	1.0	1.0	3	0.0	0.0
	Soft Fe Acc.	1	1.0	1.0	1.0	3	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	1.0	1.0	1.0	3	0.0	0.0
2004-2006	Chroma 3	3	0.3	0.3	0.3	1	0.0	0.0
	Chroma ≤ 2	3	0.3	0.3	0.3	1	0.0	0.0
	Soft Fe Acc.	3	0.3	0.3	0.3	1	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	3	0.3	0.3	0.3	1	0.0	0.0

† = number of horizons.
‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

Table 34. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-041-6. The 2004-2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2004	Chroma 3	1	0.0	0.0	0.0	0	0.0	0.0
	Plinthite	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	0.0	0.0	0.0	0	0.0	0.0
	Plinthite & Chroma ≤ 3	1	0.0	0.0	0.0	0	0.0	0.0
2005	Chroma 3	1	4.0	2.0	2.0	1	0.0	0.0
	Plinthite	1	4.0	2.0	2.0	1	0.0	0.0
	Soft Fe Acc.	1	4.0	2.0	2.0	1	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	4.0	2.0	2.0	1	0.0	0.0
	Plinthite & Chroma ≤ 3	1	4.0	2.0	2.0	1	0.0	0.0
2006	Chroma 3	1	0.0	0.0	0.0	0	0.0	0.0
	Plinthite	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc.	1	0.0	0.0	0.0	0	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	0.0	0.0	0.0	0	0.0	0.0
	Plinthite & Chroma ≤ 3	1	0.0	0.0	0.0	0	0.0	0.0
2004-2006	Chroma 3	3	1.3	0.7	0.7	0	0.0	0.0
	Plinthite	3	1.3	0.7	0.7	0	0.0	0.0
	Soft Fe Acc.	3	1.3	0.7	0.7	0	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	3	1.3	0.7	0.7	0	0.0	0.0
	Plinthite & Chroma ≤ 3	3	1.3	0.7	0.7	0	0.0	0.0

† = number of horizons.
‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

Table 35. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-053-1. The 2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2006	Chroma ≤ 2	1	16.0	7.0	7.0	4	0.0	0.0
	Soft Fe Acc.	1	16.0	7.0	7.0	4	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	16.0	7.0	7.0	4	0.0	0.0
	Plinthite	1	42.0	10.0	8.0	12	0.0	0.0
	Depleted Matrix	1	42.0	10.0	8.0	12	0.0	0.0
	Plinthite & Chroma ≤ 3	1	42.0	10.0	8.0	12	0.0	0.0

† = number of horizons.

‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

Table 36. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon Poarch 1. The 2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2006	Soft Fe Acc.	1	10.0	2.0	7.0	3	0.0	0.0
	Chroma ≤ 2	1	19.0	3.0	11.0	5	0.0	0.0
	Plinthite	1	19.0	3.0	11.0	5	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	19.0	3.0	11.0	5	0.0	0.0
	Plinthite & Chroma ≤ 3	1	19.0	3.0	11.0	5	0.0	0.0

† = number of horizons.
‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

Table 37. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-129-1. The 2004-2006 monitoring period had *normal* precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2004	Soft Fe Acc.	1	159.0	70.0	14.0	43	2.0	4.3
	Chroma ≤ 2	1	210.0	78.0	9.0	57	3.0	5.7
	Soft Fe Acc. & Chroma ≤ 3	1	210.0	78.0	9.0	57	3.0	5.7
	Plinthite	1	227.0	81.0	11.0	62	3.0	5.9
	Plinthite & Chroma ≤ 3	1	227.0	81.0	11.0	62	3.0	5.9
	Depleted Matrix	1	251.0	85.0	11.0	69	3.0	6.0
2005	Soft Fe Acc.	1	127.0	32.0	14.0	35	2.0	2.5
	Chroma ≤ 2	1	194.0	128.0	11.0	53	2.0	7.1
	Soft Fe Acc. & Chroma ≤ 3	1	194.0	128.0	11.0	53	2.0	7.1
	Plinthite	1	214.0	130.0	11.0	59	2.0	7.2
	Plinthite & Chroma ≤ 3	1	214.0	130.0	11.0	59	2.0	7.2
	Depleted Matrix	1	244.0	133.0	11.0	67	3.0	8.3
2006	Soft Fe Acc.	1	84.0	35.0	9.0	23	1.0	1.7
	Chroma ≤ 2	1	145.0	74.0	5.0	40	2.0	4.5
	Soft Fe Acc. & Chroma ≤ 3	1	145.0	74.0	5.0	40	2.0	4.5
	Plinthite	1	236.0	80.0	6.0	65	3.0	5.8
	Depleted Matrix	1	236.0	85.0	6.0	65	3.0	5.8
	Plinthite & Chroma ≤ 3	1	236.0	80.0	6.0	65	3.0	5.8
2004-2006	Soft Fe Acc.	3	123.3	45.7	12.3	34	1.7	2.8
	Chroma ≤ 2	3	183.0	93.3	8.3	50	2.3	5.8
	Soft Fe Acc. & Chroma ≤ 3	3	183.0	93.3	8.3	50	2.3	5.8
	Plinthite	3	225.7	97.0	9.3	62	2.7	6.3
	Plinthite & Chroma ≤ 3	3	225.7	97.0	9.3	62	2.7	6.3
	Depleted Matrix	3	243.7	101.0	9.3	67	3.0	6.7

† = number of horizons.
‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

Table 38. Hydromorphic features associated with annual saturation, duration, and periodicity for pedon S06AL-129-2. The 2004-2006 monitoring period had normal precipitation (as per Soil Taxonomy).

Year	Hydromorphic Feature	n†	Saturation‡				21 day	NSE
			Cumulative	Durational	Periodicity	%		
			(days)		(events)			
2004	Plinthite	1	3.0	3.0	1.0	1	0.0	0.0
	Soft Fe Acc.	1	3.0	3.0	1.0	1	0.0	0.0
	Chroma ≤ 2	1	42.0	13.0	7.0	11	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	42.0	13.0	7.0	11	0.0	0.0
	Plinthite & Chroma ≤ 3	1	42.0	13.0	7.0	11	0.0	0.0
	Depleted Matrix	1	269.0	100.0	4.0	73	3.0	6.8
2005	Plinthite	1	5.0	3.0	3.0	1	0.0	0.0
	Soft Fe Acc.	1	5.0	3.0	3.0	1	0.0	0.0
	Chroma ≤ 2	1	40.0	10.0	8.0	11	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	40.0	10.0	8.0	11	0.0	0.0
	Plinthite & Chroma ≤ 3	1	40.0	10.0	8.0	11	0.0	0.0
	Depleted Matrix	1	249.0	142.0	6.0	68	3.0	8.8
2006	Plinthite	1	5.0	4.0	3.0	1	0.0	0.0
	Soft Fe Acc.	1	5.0	4.0	3.0	1	0.0	0.0
	Chroma ≤ 2	1	19.0	10.0	3.0	5	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	1	19.0	10.0	3.0	5	0.0	0.0
	Plinthite & Chroma ≤ 3	1	19.0	10.0	3.0	5	0.0	0.0
	Depleted Matrix	1	165.0	80.0	4.0	45	2.0	4.8
2004-2006	Plinthite	3	4.3	3.3	2.3	1	0.0	0.0
	Soft Fe Acc.	3	4.3	3.3	2.3	1	0.0	0.0
	Chroma ≤ 2	3	33.7	11.0	6.0	9	0.0	0.0
	Soft Fe Acc. & Chroma ≤ 3	3	33.7	11.0	6.0	9	0.0	0.0
	Plinthite & Chroma ≤ 3	3	33.7	11.0	6.0	9	0.0	0.0
	Depleted Matrix	3	227.7	107.3	4.7	62	2.7	6.8

† = number of horizons.
‡ = Saturation metrics calculated for 30-yr normal precipitation, where cumulative = average number of days experiencing saturation; longest duration = average longest saturated period; periodicity = average annual frequency of saturation; % = average percent of annual saturation.

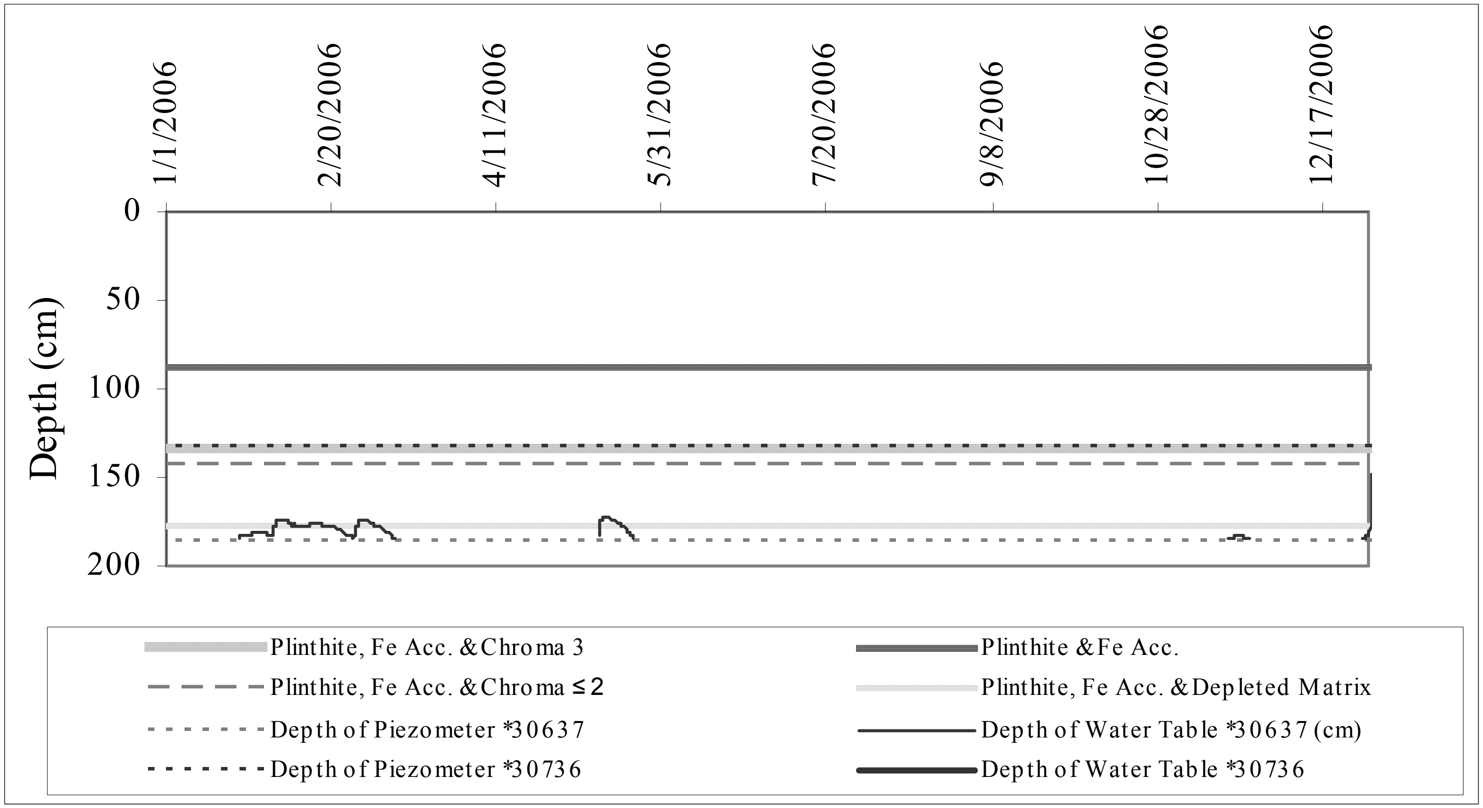

Fig. 15. Water-table depth in relation to hydromorphic feature occurrence in Baldwin County pedon S07AL-003-1 (Fine-loamy, siliceous, subactive, thermic Plinthic Paleudult). The 2006 monitoring period had *normal* precipitation as defined by Soil Taxonomy.

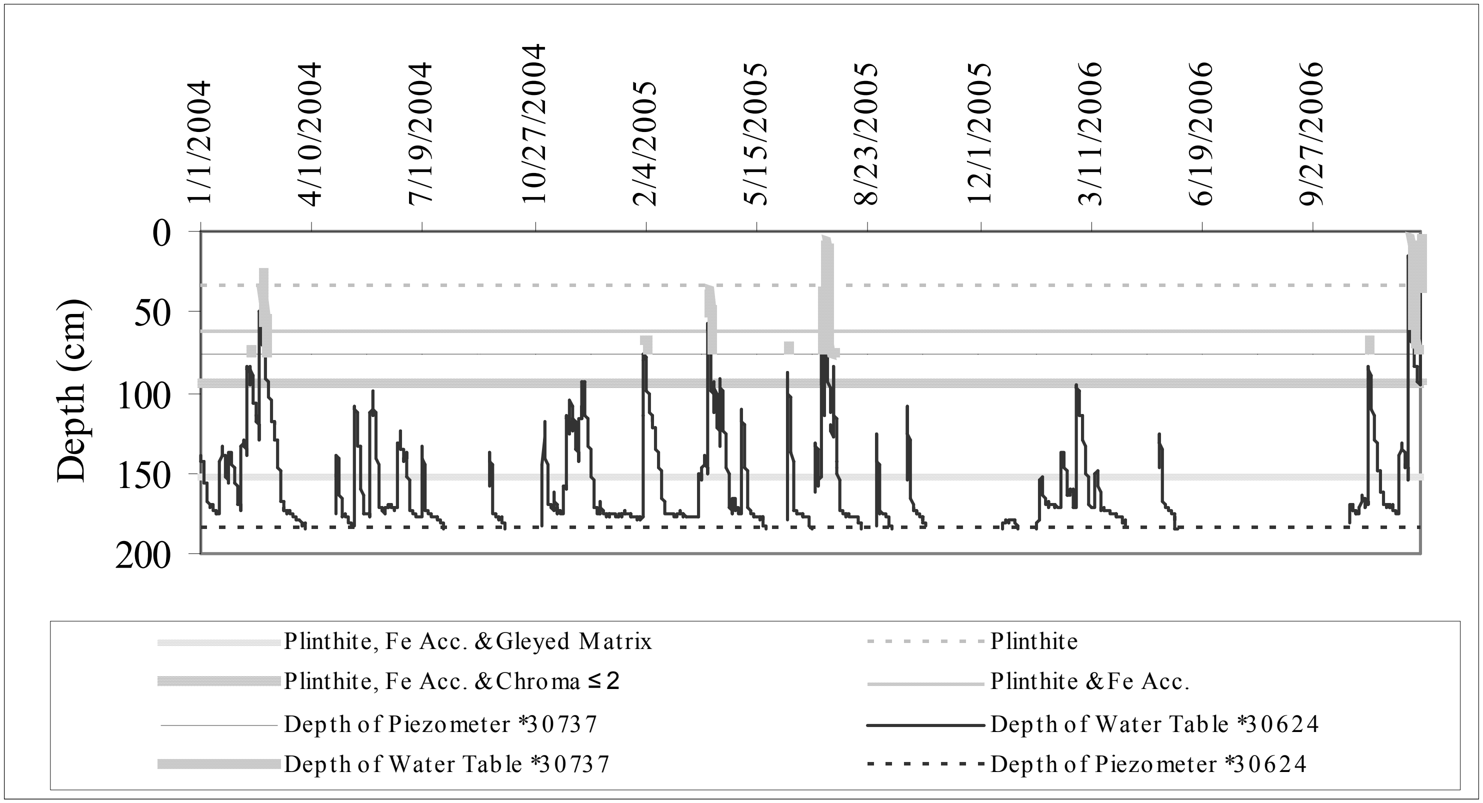

Fig. 16. Water-table depth in relation to hydromorphic feature occurrence in Washington County pedon S07AL-129-1 (Coarse-loamy, siliceous, semiactive, thermic Plinthic Paleudult). The 2004 - 2006 monitoring period had *normal* precipitation as defined by Soil Taxonomy

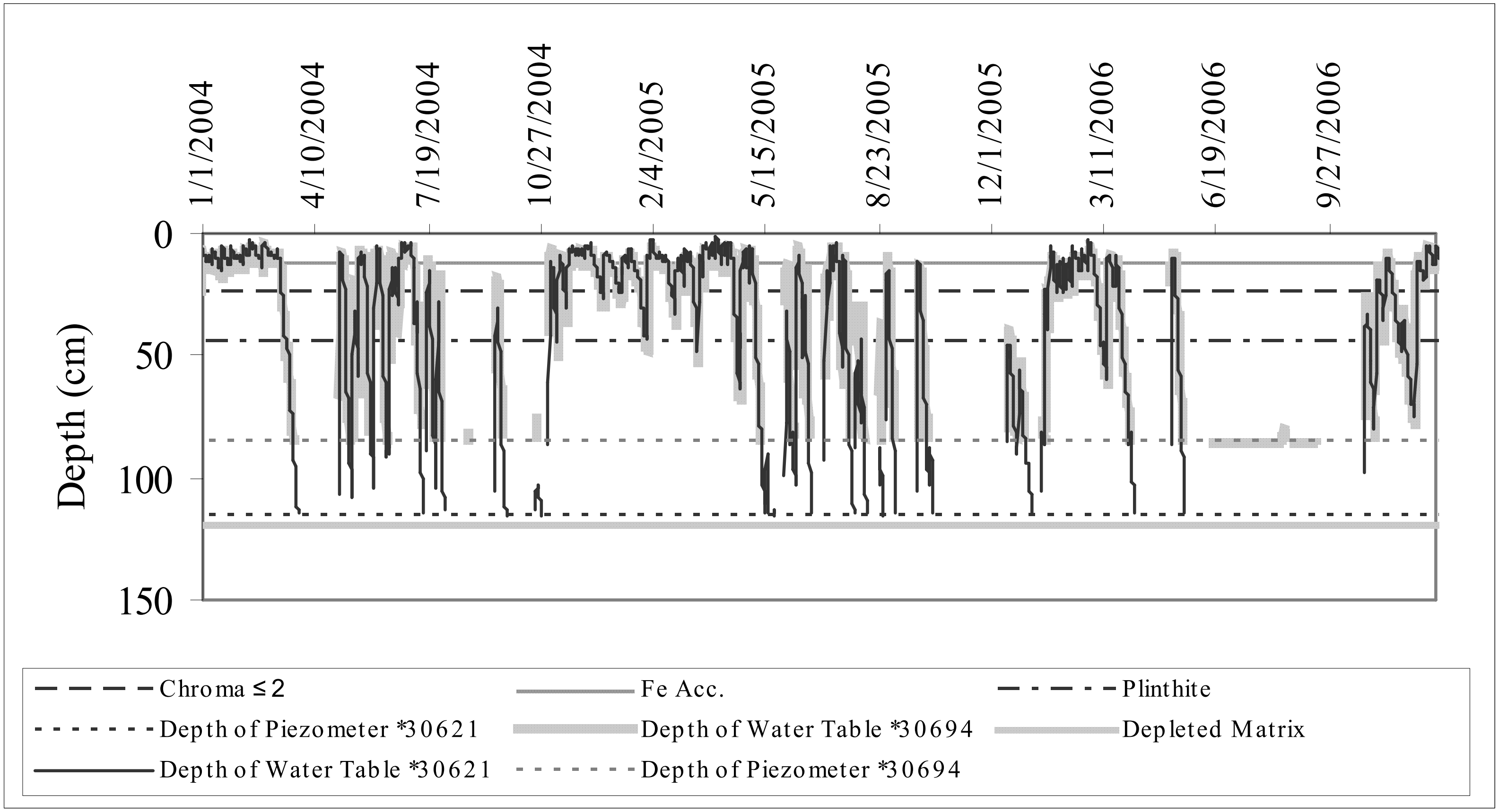

Fig. 17. Water-table depth in relation to hydromorphic feature occurrence in Washington County pedon S07AL-129-2 (Coarse-loamy, siliceous, subactive, thermic Aquic Paleudult). The 2004 - 2006 monitoring period had *normal* precipitation as defined by Soil Taxonomy.