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Progress Report On Chronostratigraphic And Paleoclimatic Studies, Middle Mississippi River Valley, Eastern Arkansas And Western Tennessee

by

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INTRODUCTION
H.W. Markewich

Previous Work and Available Data

Pliocene and Pleistocene deposits of the Mississippi River Valley and the emergent part of the delta in Mississippi and Louisiana(fig. 1) have been studied by a host of researchers with different objectives and with vastly different points of view. Several of these studies are considered "classics" and established the bases of later research - particularly Fisk's 1944 summary of the Lower Mississippi Valley alluvium, Krinitzsky's 1949 investigations of gravel deposits in the Lower Mississippi Valley and on adjacent uplands, Krinitzsky and Turnbull's 1967 paper on loess deposits of Mississippi, Russell's 1944 summary of loess deposits in the Lower Mississippi River Valley, and the analysis by Leighton and Willman (1950) of loess throughout the length of the Mississippi Valley. Although the plethora of studies since the nineteen forties include detailed work from relatively small geographic areas (such as, West and others, 1980; Grisinger and others, 1982; Rutledge, West, and Guccione, 1985; Rutledge, West, and Omakupt, 1985; Autin, and others, 1985, 1986), the majority of studies have been regional in scope (Potter, 1955; Saucier, 1964, 1967, 1968, 1974, 1987; Snowden and Priddy, 1968; Saucier and Fleetwood, 1970; Delcourt and others, 1980; Miller and others, 1985; Saucier and Snead, 1989) Some of these publications include data on the chemistry, mineralogy, fossil content and internal structure of specific alluvial and (or) loessial units (Hajic and others, 1991), but only a few provide data on local stratigraphic relations such as type of contact (accretionary, unconformable, disconformable, etc.), time represented by unconformities, or the climates during and between depositional periods .

In referring to geologic investigations of the Mississippi River Valley alluvium, Autin and others (1991, p. 547 and 549) stated it well:

> The stratigraphy and chronology of the alluvial valley...have been intensely explored but still are not well understood. Few undisputed radiocarbon dates exist for any Holocene or Pleistocene alluvial sequences, and there have been no specific regional chronostratigraphy studies during the last several decades. The principal contributions have been incidental to engineering geologic and geomorphic studies and have not been comprehensive or systematic.
> This synthesis...demonstrates substantial progress in understanding the late Pleistocene and Holocene history but...It is no exaggeration that virtually nothing can be stated with confidence about the middle and early Pleistocene history of any part of the Lower Mississippi Valley.

The level of knowledge described by Autin and others (1991) is where this investigation starts. The first task is to describe and analyze the composition and sequence stratigraphy of the Mississippi River Valley alluvium. The second is to determine the age(s) of that alluvium. The third is to determine the relations between alluvium and associated terraces. Although many other aspects of the alluvium could be investigated, study of these three will provide the data needed to suggest a model for time and mode of deposition - data needed to establish chrono- and litho-stratigraphic frameworks..

Investigations of the Mississippi Valley loess have provided relatively more site specific data than have studies of the alluvium. A few studies have provided soil chemistry or trace element chemistry of specific loesses (Miller and others, 1986; Pye and

Johnson, 1988) and age data for individual loesses (Pye and Johnson, 1988; Clark and others, 1989, 1990; Forman and others, 1992; Mirecki and Skinner, 1991). Most reports, however, include data only on the number of loesses and particle size distribution, color, texture, and structure of the loesses and their associated paleosols (McCraw and Autin, 1989; Guccione and Rutledge, 1990; Hajic and others, 1991). Few data are available on (1) internal structures or bedforms within a loess unit; (2) contacts or bounding unconformities within or between loesses; (3) range of ages within a loess unit at a particular locality, from East to West across the Valley, or from North to South along the axis of the Valley; or (4) local and regional stratigraphic relations. Even fewer studies have tried to relate the alluvial and loessial stratigraphies within any part of the valley.

Some reliable chronostratigraphic and lithostratigraphic data are available for Quaternary deposits in parts of the Mississippi River Valley, largely from areas of adequate natural or man-made exposures. However, throughout much of the Mississippi River Valley south of southeastern Missouri, exposures are few and distant from any research center. As a result, there are large areas of the Mississippi River Valley for which chronostratigraphic and lithostratigraphic data are few or nonexistent. The incomplete data base has made North to South or down-valley correlation of individual loesses, alluvial units, and (or) terraces difficult.

Very few age data, and only some stratigraphic data, are available for the area from southeastern Missouri to west-central Mississippi, an area that is here referred to as the Middle Mississippi River Valley (MMV) and is part of the Lower Mississippi Valley as used by Autin and others (1991). A few studies have focused on, or included data for, the ages of alluvium and loess in the MMV, but data from this region as a whole is sparse. (The reader is referred to Guccione and Rutledge [1990] for a relatively complete review of the available literature in this area). The importance of the MMV is that it lies between the relatively well studied lower Mississippi River delta and tri-junction area of the Ohio, Missouri, and Mississippi Rivers. Well-established chrono- and litho-stratigraphic frameworks for the loessial and alluvial sections in the MMV would (1) allow the down-valley correlation of loesses, (2) facilitate paleogeographic reconstructions of loess sheets, (3) provide much needed data for down-valley climate variations during and between periods of loess deposition, and (4) settle some disputes on the age(s) of alluvium in the Western Lowlands part of the MMV (fig. 2), thereby providing data on the migrational history of the Mississippi River through the late Pleistocene and Holocene.

Purpose, Scope, and Methods of Study

This report contains the initial (first year) results of a U.S. Geological Survey (USGS) and U.S. Department of Agriculture Soil Conservation Service (SCS) cooperative effort to establish a lithostratigraphic and a chronostratigraphic framework for Pliocene(?), Pleistocene, and Holocene eolian and alluvial sediments and their associated paleosols in parts of the MMV. This area of the Mississippi River valley includes parts of the St. Francis basin (fig. 2) (also referred to as the Eastern Lowlands [fig. 3]) and the Western Lowlands (figs. 2 and 3) in Arkansas, which, along with the Mississippi River bluffs of western Tennessee, have been targeted for study. Outcrop and core localities have been selected for detailed description and analyses in order to develop local and regional stratigraphic frameworks. The following techniques and (or) methods are being emphasized:

<u>Field Investigations</u>

-Detailed descriptions of loess units and associated soil and weathering profiles from selected outcrop and core localities
-Detailed description of alluvium from core and sand and gravel borrow pits

Compositional Analyses
-Clay mineralogy by X-ray diffraction (XRD); selected samples by differential thermal analysis (DTA)
-Silt and sand mineralogy by petrographic techniques
-Soil characterization data by standardized techniques of the National Soil Survey Laboratories

Paleontological Analyses
-pollen
-leaves, seeds, and nuts
-ostracodes
-molluscs
-phytoliths

Age Determining Irradiation Techniques:
-thermoluminescence (TL)
-optically stimulated luminescence (OSL)
-infrared stimulated luminescence (IRSL)

Age Determining Isotopic Methods:
-Beryllium-10 isotopic age determination (Be-10)
-Carbon -14 age determination (C-14)

Paleomagnetics for correlation and age estimation
-natural remanent magnetism (NRM)
-magnetic polarity

All appropriate techniques will be applied to each unit at specific "benchmark" localities in the study area. Data from other sites will be correlated with data from the benchmark localities. A geologic map of Pliocene and Quaternary deposits in the Memphis West 1:100,000 quadrangle will be constructed from all available subsurface and outcrop data.

During the first year of study, exposures near Helena, Arkansas (Phillips Bayou, site 1, fig. 3) and about 36 km north northeast of Memphis, Tennessee (Old River section, site 3, fig. 3) were selected to be the benchmark localities for loess studies. Some data on the loesses were collected from three other key localities (Wittsburg quarry, site 2 and Meeman Shelby, site 4, fig. 3) (Markewich and others, 1992). Three transects were selected for core of the valley alluvium; two long (43 and 53 m) and two short (8 and 15 m) cores were obtained. The benchmark exposures and core localities were selected to provide the most information possible on the stratigraphy of the region. The loess localities are the least eroded, most complete sections in the area. The alluvial transects cross all alluvial units and associated terraces. The two cores acquired this past year are from the second oldest (Pinetree, site 6, fig. 3) and second youngest (Wapanocca, site 5, fig. 3) of the terraces. Datable materials were obtained from the Wapanocca (site 5) core, and from well cuttings from two localities not shown on figure 3. Materials submitted for C-14 analysis include wood, leaf, shell, and disseminated carbon.

REGIONAL GEOLOGY AND STRATIGRAPHIC FRAMEWORK

H.W. Markewich

Regional Geology

The MMV is part of the unglaciated alluvial Mississippi River valley. Physiographically, the MMV includes the Yazoo Basin, the Grand Prairie, the Western Lowlands, the St. Francis basin, Crowleys Ridge, Sikeston Ridge and the Holocene and modern Mississippi River flood plain. The study area includes parts of the Western Lowlands, the St. Francis basin, Crowleys Ridge, the Mississippi River floodplain, and the highlands east of the Mississippi River in southwestern Tennessee (figs. 1 and 2). Although indirectly affected by Quaternary deposition in the deltaic plain of the Mississippi River (fig. 1), alluvial fill in the MMV has no deltaic components. Valley alluvium is primarily sand and gravel - a series of fining upward sequences contained within larger fining upward sequences. Alluvium thickness ranges from 4 to 7m near the valley sides, to a maximum of 67m in the center of the main channels, one on either side of Crowleys Ridge (Broom and Lyford, 1981) (fig. 2). The upper 5 to 6 m of alluvium is commonly fine-sand. Fine-grained (<63 micron) alluvium is generally swamp or back-levee deposits. In the main channels, 10-12 cm diameter cobbles are common in the basal 2 m of alluvium. Paleomeanders can been identified from aerial photographs and (or) maps (Saucier, 1974; U.S. Army Corps of Engineers, 1983a, b). The meanders become increasingly less pronounced with increasing age, distance from present river, and thickness of overlying eolian deposits. Quaternary deposits of eolian sand and silt (loess?) are present on some of the recognized fluvial terraces. The silt is more extensive than the eolian sand. Five to forty meter thick deposits of loess (eolian silt) are present on Crowleys Ridge and on the highlands east of the modern Mississippi River (fig. 2).

Loess and Sand Dune Stratigraphy

Four identifiable loesses are present in the study area (Wascher and others, 1948; Krinitzsky and Turnbull, 1967; Snowden and Priddy, 1968; West and others, 1980; Rutledge, West and Guccione, 1985; Rutledge, West, and Omakupt, 1985; McKay and Follmer, 1985). A fifth loess has been identified in the study area near Wynne, Arkansas (Rutledge and others, 1990) and in northern Louisiana (Miller and Day, 1985). This fifth loess, informally called the Marianna loess, has not been recognized in outcrop or in core described during the first year of this study. From oldest to youngest, the four recognized loesses are the Crowley's Ridge Silt, the Loveland loess (usage of Daniels and Handy, 1959), the Roxana Silt, and the Peoria Loess. Locally, contacts between loesses are manifest as angular unconformities (resulting from deposition on paleo erosion surfaces), but in most exposures, loess to loess contacts are disconformable or accretionary.

Some loesses are thicker and (or) more extensive than others. For example, the youngest loess, the Peoria, is commonly 1 to 20 m thick, whereas the thickness of the underlying Roxana Silt varies from 1 to 7 m. Despite the fact that it is thinner, the Roxana Silt is reported to extend much farther east from the Mississippi River than does the Peoria Loess (Buntley and others, 1977).

Surface soils and buried paleosols developed in the loesses vary in thickness, color, structure, texture, and to some extent, mineralogy. Surface soils developed in the Peoria Loess generally have fragic properties (pedogenetically developed firmness, brittleness, or high bulk density). Fragic properties are also associated with surface soils developed in the Roxana Silt in western Tennessee and Kentucky, where it is the surface unit or within a meter of the surface (Buntley and others, 1977). Paleosol development varies from the dark gray Inceptisol (the Farmdale paleosol) which typifies the surface soil of the Roxana Silt to the well-developed strikingly red, clay-rich Alfisol (probably the Sangamon paleosol) developed in the Loveland or Third loess, to the strongly developed Crowley's Ridge paleosol (Alfisol or Ultisol) developed in the Crowley's Ridge Silt.

The Crowley's Ridge paleosol is highly variable. Where thickness of the A (surface) horizon is 0.5 m or greater, contact with the Loveland loess is accretionary. Locally, the Loveland loess/Crowley's Ridge Silt contact is unconformable. At these localities it is common for the A horizon to be missing or very thin. In exposures at Wittsburg quarry (site 2, fig. 3), and in core from localities on Crowleys Ridge near Wynne, the Crowley's Ridge paleosol is the most strongly developed of all the paleosols. The A horizon is thin; the argillic horizon thickness is 1.5 to 1.7 m; and clay content in the argillic horizons ranges from 35 to 40 percent (Porter and Bishop, 1990; Rutledge and others, 1990).

Saucier (1978) cites the presence of 1025 km^2 of sand dunes in the Western Lowlands and Upper St. Francis basin. He suggests that there are two sets of dunes and that both sets are late Wisconsin in age. Based on the glacial/interglacial model of the Midwest, Saucier suggests an optimal time of dune formation between 18,000 and 22,000 years ago, during the glacial maximum, and that the complete dune-forming episode probably lasted from 30,000 to 12,000 years ago. The planned 1993 sampling of the dune sand along the White River near Augusta, Arkansas for OSL and TL age determinations will provide real-time data for dunes in the region.

Alluvial Stratigraphy

Autin and others (1991, p. 55) review published concepts or models of alluvial stratigraphy in the Mississippi River Valley, and the reader is referred to that paper for a discussion of the models. The lack of adequate chronostratigraphic data disallows certainty as to the depositional history of the alluvium. The lack of data is due in part to a lack of suitable datable material from core, in part to the small number of available core, and in part to the fact that most studies of the valley alluvium have been concerned with ground water resources or engineering requirements, not acquisition of chronostratigraphic data. Acquisition of real-time data is necessary to resolve stratigraphic problems and to develop better depositional models.

Saucier and Snead (1989) (plate 6 in Autin and others, 1991) recognized four levels of early Wisconsin valley train deposits in the Western Lowlands of eastern Arkansas., west of Crowleys Ridge. In this area, they also recognized the Prairie complex which they considered to be Sangamon and early Wisconsin in age. In the St. Francis basin, to the east of Crowleys Ridge, they mapped remanents of levels 3 and 4 of the early Wisconsin valley train deposits, two levels of late Wisconsin valley train deposits, and five Holocene meander belts of the Mississippi River.

The lack of real-time ages on the alluvium, makes it difficult to verify any depositional model or to corroborate Saucier and Snead's (1989) assignment of ages to alluvial terraces in the study area. And as mentioned in Autin and others (1990), one chronostratigraphic problem is the age(s) of alluvium in the Western Lowlands. Saucier and Snead (1989) suggest that the oldest alluvium in the Western Lowlands is Wisconsin to Sangamon in age. Rutledge, West, and Omakupt (1985) recognized a veneer of Loveland and Peoria loesses on the third level of Saucier and Snead's early Wisconsin valley train deposits. Their identification of two loesses was based on the presence of an intervening paleosol which they correlated with the Sangamon paleosol seen in outcrop on Crowleys Ridge. Since published age estimates of the Loveland loess are greater than 100 ka, Rutledge, West, and Omakupt (1985) suggested that the third and possibly the fourth terrace, and the associated alluvium, in the Western Lowlands are pre Wisconsin in age. (If the Roxana is present on these terraces, it is too thin to be recognized).

Age and paleosol data for the silt-covered terraces identified in the Western Lowlands are necessary to determine whether the model of Saucier and Snead (1989) or that of Rutledge, West, and Omakupt (1985) is valid. Data acquired from these investigations (and from another ongoing SCS investigation) will be used to evaluate the two models.

For the first year of USGS investigations in the Memphis West, Arkansas-Tennessee, 1:100,000 quadrangle, 2 core localities were selected - one to the east and one to the west of Crowleys Ridge (sites 5 and 6 on fig. 3). As mapped by Saucier and Snead (1989), alluvium at site 5 (Memphis West #1 core and #2 core; NW1/4, NW1/4, sec. 35, T9N, R8E; Jericho, Arkansas 7.5 min. quadrangle; 68.6 m surface altitude; Wapanocca National Wildlife Refuge) is Holocene in age. They show the alluvial terrace at site 6, (University of Arkansas Pinetree Agricultural Experiment Station, Pinetree, Arkansas; Memphis West #3 and #4); NE1/4, SW1/4, sec. 19, T6N, R2E; Hamlin, Arkansas 7.5 min. quadrangle; 65 m surface altitude) to be early Wisconsin in age. The Memphis West #3 and #4 cores at site 6 show a 5-m-thick loess cap on the alluvium. Based upon the core from these two localities, Mississippi River Valley alluvium can be described as a series of fining upward sequences that contain smaller fining upward sequences. Each younger sequence is finer than the one previous. Datable materials were obtained at three depths from the alluvium in the Memphis West #2 core. Organic materials were also collected from the Memphis West #4 core (actual location is 0.6 km SW of Memphis West #3). All datable materials were submitted to the USGS C-14 laboratories in Reston, Virginia for age determination. The material from the Memphis West #4 core is scant and has a low carbon content. This material will be processed only if no other suitable material is obtained from core to be taken in fiscal year 1993.

W.L. Prior of the Arkansas Geological Commission supplied shells and wood from two drilled wells located 80 and 126 km south of the Memphis West 1:100,000 quadrangle (34°32'56" N. Lat., 90°50'37" W. Long.; Lexa, Arkansas 7.5 min. quadrangle; 56.6 m surface altitude; and 33°41'40" N. Lat., 91°29'06" W. Long.; McGeehee, Arkansas 7.5 min. quadrangle; 47 m surface altitude) (locations not shown in figures). The shells in the core near Lexa, Arkansas are from the basal meter of a 11 to 13-m-thick loess cap - the "confining unit" for the alluvial aquifer. Wood from alluvium in the same core is from 23 m depth. Wood from alluvium in the second core(near McGeehee, Arkansas) is from a depth of 14 m. The shell and wood from these wells have also been submitted to the USGS C-14 laboratories.

AGE DETERMINATIONS OF MMV LOESS AND ALLUVIUM

Carbon-14

Meyer Rubin, J.P. McGeehin, and H.W. Markewich

Twelve samples from the MMV have been submitted to the USGS Radiocarbon Laboratory in Reston, Virginia for age determinations as part of the study of Pliocene and Quaternary deposits of the that area. Six samples are from Mississippi River alluvium; three are from the Farmdale paleosol near the top of the Roxana Silt; two are from the basal Peoria Loess; and one is from Loosahatchie River alluvium underlying the Hatchie? terrace as identified by Saucier (1987). Age determinations are available from four of the samples.

The wood from the Loosahatchie River alluvium (USGS Radiocarbon Laboratory No. W-6341) near Arlington, Tennessee (site 8, fig. 3) was a straight forward conventional gas run with full pre-treatment. The age was 11,200±180 yrs. B.P.

The 62-85 cm depth (USGS Radiocarbon Laboratory No. W-6437) interval of the Farmdale paleosol at Phillips Bayou (site 1, fig. 3) was very low in carbon. Six hundred forty grams were required to provide the 2 liters of acetylene gas needed for the conventional proportional gas counting technique. The soil was pre-treated in a standard acid-base-acid technique, but the hot base treatment was abbreviated to prevent loss of the entire sample. The age of 28,980±800 yrs B.P. does not take into account the possibility of contamination, either in the form of younger or older carbon. This is mentioned here particularly because of the low percentage of carbon in the soil and the influence small amounts of foreign carbon can have on the results.

The sample of clay and silt with charcoal flecks from the upper 15 cm of the Farmdale paleosol (USGS Radiocarbon Laboratory No. WW-48) at the Old River section along the bluffs of the Mississippi River west of Millington, Tennessee (site 3, fig. 3) was given only an acid pre-treatment for fear of dissolving all of the charcoal. In Reston, the sample was converted to graphite in the graphitizer line, pressed into a target, and shipped to the Center for Accelerator Mass Spectrometry, at the Lawrence Livermore National Laboratory. It was dated by the AMS method (with their number CAMS-3278). The age of 26,490±270 is computed using an assumed value of delta C-13 of -25, and a Libby half-life of 5568, as is also the case for gas runs made in Reston.

The C-14 ages for the Farmdale paleosol from the Old River section (site 3, fig. 3) and from the Phillips Bayou section (site 1, fig. 3) are in reasonable agreement with each other and with the 28 ka TL value for the Farmdale (Roxana) at Wittsburg Quarry (site 2, fig. 3).

Three samples of gastropod shells, from the lower part of the Peoria Loess at Phillips Bayou (site 1, fig. 3), an interval 4-7 m above the top of the Farmdale paleosol (fig. 7), were combined to form a composite sample for C-14 age determination. The shells were first cleaned ultrasonically in a light HCl solution to remove carbonaceous silt. They were then reduced in volume approximately 20 percent by soaking in a strong HCl bath to remove possible surface contamination due to atmospheric exchange of carbon. The sample was converted to graphite, sent to Lawrence Livermore National Laboratory and dated by AMS. The 21,070±230 yrs B.P. (USGS Radiocarbon Laboratory No. WW-102, Lawrence Livermore No. CAMS-4942) age is in agreement with the 22 ka TL determination for the lower part of the Peoria at Wittsburg quarry (site 2, fig. 3) and is in reasonable agreement with C-14 ages for the lower Peoria at the Hornbeak locality in northwestern Tennessee (fig. 7).

Our experience with the Lawrence Livermore Laboratory suggests that AMS dates are as accurate as conventional gas counting.

Beryllium-10
M.J. Pavich

Beryllium-10 is a radioactive isotope ($t1/2 = 1.5 \times 10^6$ years) that is produced in the atmosphere by cosmic ray spallation of nitrogen and oxygen nuclei. It is delivered to the land surface mainly by precipitation with a nominal delivery flux of 1.3×10^6 atom/cm^2/yr for areas of 100 cm/yr rainfall. Residence time on vegetation and the soil surface is short, but residence times in clay-rich soil B-horizons can exceed 100,000 years.

Studies of soil chronosequences, soils developed on loess, and residual soils overlying saprolite demonstrate that at pH 5 Be-10 is retained in the soil clay/iron oxyhydroxide complex and that the inventory of Be-10 atoms/cm^2 can be used to estimate the minimum residence time of the soil. In this study we are measuring the Be-10 of the soils developed on loess deposits. We assume that the Be-10 retained in each soil profile accumulated prior to burial by an overlying unit or prior to erosion. We will compare the soil residence times determined by this method with the ages of the loess units determined by radiocarbon and irradiated techniques, and by difference, the unconformities separating periods of loess deposition.

The various dating methods can be used to provide boundary dates at the tops or bottoms of units or cumulative time over which a loess unit was exposed to pedogenic alteration. We have evidence from field descriptions, clay mineralogy, and magnetic susceptibility that each of the loess units was exposed to some period of subaerial weathering and pedogenesis after deposition. Be-10 can be used to measure the minimum time of exposure to atmospheric precipitation.

For example, we measured the Be-10 inventories (in atoms per cm^2) in the Crowley's Ridge paleosol at both the Wittsburg quarry locality, on the east side of Crowleys Ridge, and at the Old River section, on the bluffs east of the Mississippi River northeast of Memphis. For each locality, the inventory is about 1.6×10^{11} atom/cm^2. This translates into a minimum exposure time of about 120 ka for the Crowley's Ridge Silt.

Using the ages of the overlying stratigraphic units (loesses) we estimate that the base of the Crowley's Ridge Silt is <450 ka and possibly <250 ka.

TL, OSL, and IRSL Dating Techniques

H.T. Millard, Jr. and P.B. Maat

In order to acquire age estimates by irradiated techniques, it was decided to establish a laboratory at the USGS facilities on the Federal Center in Denver, Colorado. Funding and staffing considerations dictated a strategy whereby we concentrated on collecting samples and establishing the thermoluminescence (TL) method during FY 1992 and began running samples by TL and establishing the optically stimulated luminescence (OSL) method in FY 1993.

Numerous steps are required to establish a radiation exposure dating laboratory for TL, OSL, and infra-red stimulated luminescence (IRSL). Most of these are common to all the techniques and those completed include: (1) acquisition of beta/alpha irradiator; (2) set up of a gamma irradiation facility, (3) set up and calibration of a preheat hot plate, (4) acquisition and calibration of a portable gamma spectrometer (for K, eU, and Th), (5) calibration of an existing laboratory gamma spectrometer (for K, eU, and Th), (6) set up of a delayed neutron counting (for U and Th), (7) establishment of procedures to determine moisture content, and (8) writing a computer program for modeling the radiation environments seen by the samples.

The beta irradiator and gamma irradiation facility will be calibrated by March 1993. The X-ray fluorescence (XRF) instrument (for K) is also scheduled to be calibrated in the spring of 1993. The computer program for modeling the radiation environment should be debugged sometime in the spring of 1993.

Instrumentation for TL was purchased, as well as an adapter to perform IRSL. An OSL instrument was designed and fabricated. The OSL instrument still requires assembly and computer programs must be written for operation. Sample collection procedures (employing an auger, sample tubes, and a drive tube), the preparation of a dark laboratory (including filtered lighting), size and mineral separation procedures, and disk preparation procedures have all been worked out and exercised.

The sample collection strategy was designed to sample well-dated localities in order to establish confidence in our procedures and credibility in our results in the outside scientific community. For loess (TL), we sampled three areas in Alaska (above the Arctic Circle, in the Fairbanks area, and in the Nenana River valley), four loesses (the Crowley's Ridge Silt, the Loveland or Third loess, the Roxana Silt, and the Peoria Loess) at three localities in the MMV from exposures near Helena, Arkansas (Phillips Bayou; site 1, fig. 3); near Wynne, Arkansas (Wittsburg quarry; site 2, fig. 3); and near Millington, Tennessee (Old River section; site 3, fig. 3).

For sand, (OSL and TL) we sampled eolian deposits at four localities in the Nebraska Sand Hills; numerous localities in northeastern Colorado, in the Southern High Plains region of Texas (near Lubbock); and in the Atlantic Coastal Plain of southeastern Georgia.

Preliminary age determinations for four MMV loess samples were anticipated in the fall of 1992. Problems with computers and in acquiring adequate calibration standards resulted in obtaining only very preliminary values for the Peoria (22 ka), Roxana (28 ka), Sangamon paleosol (>100 ka), and Loveland (>100 ka) from the Wittsburg quarry locality (site 2, fig. 3). Computer and calibration problems are being resolved, and work is progressing.

If funds are available, sometime in FY1993 we will sample the sand dunes along the White River in the Western Lowlands of Arkansas for TL and OSL age determinations.

DETAILED LOESS AND PALEOSOL STRATIGRAPHY
L.B. Ward, E.M. Rutledge, and D.A. Wysocki

The USGS and the SCS are cooperating as equal partners in the study of loess units and associated paleosols in the MMV. The interest of the SCS is as much related to ongoing regional projects as to establishment of chrono- and litho- loess stratigraphies. The National Cooperative Soil Survey has begun to update soil surveys on a Major Land Resource Area (MLRA) concept. This approach requires that soils information be coordinated and developed from regional perspectives. The understanding of the number, age, and regional distribution of loess deposits in the MMV is limited. This cooperative study will provide fundamental information on the stratigraphy, sedimentation and distribution of the loess units. The information is basic to make meaningful separations between soil series in MLRA 131 and MLRA 134.

The soil survey update of MLRA 131 and 134 will use the existing terrace interpretations of Saucier (1964, 1974, 1978, and 1987), Saucier and Fleetwood (1970), and Saucier and Snead (1989). These studies give a basic framework, but little field verification has been done to confirm the published interpretations. Existing soil patterns suggest that in some parts of the region the age and (or) composition of the parent may be different than indicated in these studies. These problems must be resolved for the update.

The most complete loess stratigraphy occurs near the source areas (bluffs along the Mississippi River and on Crowleys Ridge). Knowledge of the loess stratigraphy obtained in this study is an essential building block for understanding the age and parent material relations of the entire terrace system of the lower Mississippi River Valley.

Two complete sections of the Roxana, Loveland, and Crowley's Ridge loesses and an underlying fluvial unit have been described and sampled for characterization, and for mineralogic, and micromorphologic analyses. The first locality, referred to herein as the Phillips Bayou section, is a northeast facing, 30-m-high exposure on the east side of Crowleys Ridge about 11.2 km north of Helena, Arkansas (34°38'12" N. Lat., 90°38'05" W. Long.; site 1, fig. 3). Although originally oversteepened by a meander of the St. Francis River, the exposure was enhanced by a presently inactive gravel mining operation. Atop Crowleys Ridge, directly upslope from the exposure, a complete section of the Peoria Loess was sampled from a Giddings Rig core (referred to as the Helena #2). These samples have also been submitted for analyses. The second locality, known as the Old River section, is in the headwall of a northwest-facing ravine or gully on the east side of the Mississippi River some 29 km northeast of Memphis, Tennessee (35°25' N. Lat., 89°59' W. Long.; site 3, fig. 3).

A field description of the Phillips Bayou section follows. Age data from specific intervals are given after the field description of that interval. The field description of the Old River section is presently being transcribed and revised. XRD traces of glycolated clay fraction of the Roxana Silt, the Loveland loess and the Crowley's Ridge Silt, and the underlying unnamed fluvial unit from the Old River section are shown in figure 6. To date there are no characterization data or data on the mineralogies of the sand and silt fractions. Most analyses are being performed by personnel of the National Soil Survey Laboratories in Lincoln, Nebraska or USGS personnel in Reston, Virginia, Atlanta, Georgia, and Denver, Colorado. However, some samples of the Roxana Silt have been sent to J.B. Dixon at Texas A&M University in order to identify the composition and mode of occurrence (grain coatings or pores) of the mineral(s) that give the Roxana Silt its characteristic purple to chocolate-brown color.

Phillips Bayou Loess Section
Description of core and a north-northeast facing exposure (Draft)
May 29-June 5, 1992

Location: SE1/4SE1/4NW1/4, sec. 1, T. 1 S., R. 4 E., (34°38'12"N. Lat., 90°38'05"W. Long.), Phillips County, Arkansas
Land Surface Elevation at Helena #2 core locality: 325.7 ft. (99.3 m); elevations for Phillips Bayou section surveyed from benchmark located at road intersection at Phillips Bayou store, about 1.6 km north of borrow pit.
Description By: E. M. Rutledge, L. B. Ward, and D.A. Wysocki.
Pedon Number: 92PH04

Notes: Horizon nomenclature and texture subject to revision. Surface has mat of decayed hardwood leaves and other litter about 1 cm thick not described or sampled. The upper 200 cm described from four 2 inch diameter cores. Pedon description from 200 to 722 cm described from two 2 inch diameter cores and below 722 cm described from one 2 inch core. Topography of horizon boundaries not described. Colors are given for broken, moist peds. Soil matrix becomes calcareous below 722 cm.

Peoria

A--0 to 10 cm; dark grayish brown (10YR 4/2) silt loam; moderate medium granular structure; very friable; common fine roots; clear boundary

BA--10 to 40 cm; dark brown (7.5YR 3/4, 4/4) silt loam; weak medium subangular blocky structure; very friable; many very fine, many fine and few medium pores; common very fine and few fine roots; few (<1%) fine (1-2 mm) soft black (Mn) irregular shaped masses; gradual boundary.

Bw1--40 to 67 cm; dark brown (7.5YR 4/4) silt loam; few medium faint brown (7.5YR 5/4) mottles; moderate medium subangular blocky structure; very friable; few prominent very pale brown (10YR 7/3) uncoated silt grains on faces of peds that disappear upon wetting; many very fine, many fine and common medium pores; few fine and few very fine roots; few (<1%) fine and medium (1-3 mm) soft brown-black (Fe-Mn) irregular shaped masses; clear boundary.

Bw2--67 to 92 cm; brown (7.5YR 5/4) silt loam; common medium faint light brown (7.5YR 6/4) mottles; moderate medium subangular blocky structure; friable; common prominent very pale brown (10YR 7/3) uncoated silt grains on faces of peds that disappear upon wetting; few prominent black (10YR 2/1) mangans on faces of some peds; many very fine, many fine and common medium pores; few fine and few very fine roots; few (2%) fine and medium (1-5 mm) soft brown-black (Fe-Mn) irregular shaped masses; clear boundary.

E/B--92 to 110 cm; about 60% light gray (10YR 7/2) silt (E); structureless; very friable; about 40% yellowish brown (10YR 5/4) silt loam (Bw); weak fine and medium subangular blocky structure; friable; many very fine, many fine and common medium pores throughout; few very fine roots throughout; few (2%) fine and medium (1-5 mm) soft brown-black (Fe-Mn) irregular shaped masses throughout; clear boundary.

Bt1—110 to 175 cm; dark brown (7.5YR 4/4) silt loam; common medium and coarse distinct light yellowish brown (10YR 6/4) mottles; moderate coarse and very coarse prismatic structure parting to moderate medium subangular blocky structure; firm, some peds slightly brittle; few faint clay films on faces of peds; many prominent light gray (10YR 7/2) uncoated silt grains on faces of prisms and covering some clay films; common very fine, common fine and few medium pores; few very fine, few fine and occasional medium roots between faces of prisms; few (<1%) fine (1-2 mm) soft brown-black (Fe-Mn) irregular shaped masses; gradual boundary. Subsampled: 110-148 cm; 148-175 cm

Bt2—175 to 200 cm; brown (7.5YR 5/4) silt loam; few medium distinct light yellowish brown (10YR 6/4) mottles; moderate coarse and very coarse prismatic structure parting to moderate medium subangular blocky structure; firm, some peds slightly brittle; few faint dark brown (7.5YR 4/4) clay films on faces of peds; many prominent light gray (10YR 7/2) uncoated silt grains on faces of prisms and covering some clay films; common very fine, common fine and few medium pores; few very fine and occasional medium roots between faces of prisms; few (<1%) fine (1 mm) soft brown-black (Fe-Mn) irregular shaped masses; gradual boundary.

Bt3—200 to 300 cm; brown (7.5YR 5/4) silt loam; few fine distinct light yellowish brown (10YR 6/4) mottles; moderate coarse and very coarse prismatic structure parting to weak medium subangular blocky structure; firm; few faint dark brown (7.5YR 4/4) clay films on faces of peds and lining a few pores; many prominent light gray (10YR 7/2) uncoated silt grains on faces of prisms; many prominent black (10YR 2/1) mangans on faces of prisms and lining some pores, uncoated silt grains are over mangans in some places; common very fine, common fine and few medium pores; few very fine roots between faces of prisms; gradual boundary.
Subsampled: 200-233 cm; 233-266 cm; 266-300 cm.

BC1—300 to 349 cm; dark brown (7.5YR 4/4) silt loam; few fine distinct light brown (7.5YR 6/4) mottles; weak coarse and very coarse prismatic structure parting to weak medium subangular blocky structure; friable; few prominent light gray (10YR 7/2) uncoated silt grains on faces of prisms; few prominent black (10YR 2/1) mangans on faces of prisms and peds and lining some pores; many very fine, common fine and few medium pores; few medium roots between faces of prisms; few (<1%) fine (1 mm) soft brown-black (Fe-Mn) irregular shaped masses; clear boundary.
Subsampled: 300-325 cm; 325-349 cm.

BC2—349 to 421 cm; brown (7.5YR 5/4) silt loam; few medium distinct light yellowish brown (10YR 6/4) mottles; weak medium and coarse subangular blocky structure; friable; few prominent black (10YR 2/1) mangans on faces of peds and lining some pores; common very fine and common fine pores; few fine roots; few (<1%) fine (1 mm) soft brown-black (Fe-Mn) irregular shaped masses; gradual boundary.
Subsampled: 349-385 cm; 385-421 cm.

C1—421 to 489 cm; about 60% light gray (10YR 7/2), 35% light yellowish brown (10YR 6/4) and 15% yellowish brown (10YR 5/6) silt; structureless, massive; friable; common prominent black (10YR 2/1) mangans on fracture faces and lining some pores; common very fine, common fine and few medium pores; few fine roots; few (<1%) fine (1-2 mm) soft black (Mn) irregular shaped masses and few (1%) fine and medium (1-4 mm) yellowish brown (Fe) irregular shaped masses; clear boundary. Subsampled: 421-455 cm; 455-489 cm.

C2—489 to 513 cm; brown (10YR 4/3) silt; common fine distinct light brownish gray (10YR 6/2), common fine distinct strong brown (7.5YR 4/6) and few fine distinct light yellowish brown (10YR 6/4) mottles; structureless, massive; friable; common prominent black (10YR 2/1) mangans on fracture faces and lining larger pores; common very fine, common fine and few medium pores; few fine black (Mn) irregular shaped masses and few fine (1-2 mm) and medium (1-5 mm) strong brown (Fe) irregular shaped masses; clear boundary.

C3—513 to 555 cm; grayish brown (10YR 5/2) silt; common medium distinct yellowish brown (10YR 5/6) mottles; structureless, massive; friable; common very fine and few fine pores, some have oxidized walls; one continuous horizontal yellowish brown (10YR 5/4) oxidation band 3 cm wide, about 5 cm down from upper boundary; few (2%) fine, medium and coarse (1-20 mm) soft strong brown (Fe) irregular shaped masses; abrupt boundary.

C4—555 to 663 cm; grayish brown (2.5Y 5/2) silt; common medium distinct yellowish brown (10YR 5/6) and few fine prominent red (2.5YR 4/6) mottles; structureless, massive; friable; common very fine, common fine and common medium pores, some have oxidized walls; some pores are lined with prominent black (10YR 2/1) mangans; one continuous horizontal yellowish brown (10YR 5/4) oxidation band 10 cm wide beginning at 640 cm; few (2%) fine and medium (1-4 mm) soft strong brown (Fe) irregular shaped masses; clear boundary. Subsampled: 555-582 cm; 582-609 cm; 609-636 cm; 636-663 cm.

C5—663 to 703 cm; gray (10YR 5/2) silt; structureless, massive; friable; common very fine and common fine pores, some have oxidized walls; one continuous horizontal yellowish brown (10YR 5/4) oxidation band 11 cm wide beginning at 688 cm; few fine and medium (1-4 mm) soft strong brown (Fe) irregular shaped masses; abrupt boundary.

C6—703 to 722 cm; yellowish brown (10YR 5/4) silt; common medium distinct grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/6) mottles; structureless, massive; friable; common very fine and common fine pores, some have oxidized walls; few fine (1-2 mm) soft black (Mn) irregular shaped masses; clear boundary.

C7—722 to 744 cm; pale brown (10YR 6/3) silt; few medium distinct brownish yellow (10YR 6/6) mottles; structureless, massive; very friable; few very fine, few fine and few medium pores, most have strong brown (7.5YR 4/6) oxidized walls and a few are lined with black mangans; common fine and medium (1-5 mm) soft dark yellowish brown (10YR 4/4) (Mn) irregular shaped masses; strongly effervescent, but slowly reactive to cold 1N HCL; clear boundary.

C8—744 to 781 cm; very pale brown (10YR 7/3) silt; few medium distinct light yellowish brown (10YR 6/4), few medium distinct brown (10YR 5/3) and common coarse yellowish brown (10YR 6/6, 6/8) mottles; structureless, massive; very friable; few fine and few medium pores, most have strong brown (7.5YR 4/6) or yellowish red (5YR 4/6) oxidized walls; a few medium pores are lined with black mangans; common fine (1-2 mm) soft dark yellowish brown (10YR 4/4) (Mn) irregular shaped masses; strongly effervescent, but slowly reactive to cold 1N HCL; gradual boundary.

C9—781 to 808 cm; pale brown (10YR 6/3) silt; few medium distinct yellowish brown (10YR 6/6) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have strong brown (7.5YR 4/6) or yellowish red (5YR 4/6) oxidized walls; common fine (1-2 mm) soft dark yellowish brown (10YR 4/4) (Mn) irregular shaped masses; one old root channel about 14 mm in diameter filled with soft dark yellowish brown (10YR 3/4) (Mn) masses; strongly effervescent, but slowly reactive to cold 1N HCL; gradual boundary.

C10--808 to 834 cm; pale brown (10YR 6/3) silt; common coarse faint light yellowish brown (10YR 6/4) mottles; structureless, massive; very friable; few (<1%) fine and few medium pores, most have dark brown (7.5YR 4/4), strong brown (7.5YR 4/6) or yellowish red (5YR 4/6) oxidized walls; strongly effervescent, but slowly reactive to cold 1N HCL; clear boundary.

C11--834 to 874 cm; light brownish gray (10YR 6/2) silt; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have brownish yellow (10YR 6/8) or dark yellowish brown (10YR 4/6) oxidized walls; strongly effervescent, but slowly reactive to cold 1N HCL; clear boundary.

C12--874 to 942 cm; light yellowish brown (10YR 6/4) silt; common coarse distinct light brownish gray (10YR 6/2) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) oxidized walls and a few are lined with black mangans; common fine (1-2 mm) dark yellowish brown (10YR 4/4) soft masses throughout; slightly effervescent, but slowly reactive to cold 1N HCL; clear boundary.
Subsampled: 874-908 cm; 908-942 cm.

C13--942 to 969 cm; pale brown (10YR 6/3) silt; structureless, massive; friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) oxidized walls; common fine (1-2 mm) dark brown (10YR 4/3) soft masses throughout; slightly effervescent, but slowly reactive to cold 1N HCL; gradual boundary.

C14--969 to 1033 cm; light yellowish brown (10YR 6/4) silt; many coarse faint pale brown (10YR 6/3) mottles; structureless, massive; friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) oxidized walls; few fine dark brown (10YR 4/3) masses throughout; one continuous, horizontal brownish yellow (10YR 6/6) oxidation band 9 cm thick (1024-1033 cm); slightly effervescent, but slowly reactive to cold 1N HCL; clear boundary. Subsampled: 969-1001 cm; 1001-1033 cm.

C15--1033 to 1060 cm; light brownish gray (10YR 6/2) silt; few coarse faint pale brownish (10YR 6/3) mottles; structureless, massive; friable; few (<1%) very fine and few fine pores; common fine (1 mm) dark brown (10YR 4/3) soft masses throughout; slightly effervescent, but slowly reactive to cold 1N HCL; clear boundary.

C16--1060 to 1079 cm; light yellowish brown (10YR 6/4) silt; few medium distinct light brownish gray (10YR 6/2) mottles throughout and few medium distinct dark yellowish brown (10YR 4/4) in the upper part of horizon; structureless, massive; very friable; few (<1%) very fine and few fine pores; common fine (1-2 mm) dark brown (10YR 4/3) soft masses throughout; slightly effervescent, but slowly reactive to cold 1N HCL; clear boundary.

C17--1079 to 1124 cm; pale brown (10YR 6/3) silt; many coarse faint light yellowish brown (10YR 6/4) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, some have strong brown (7.5YR 4/6) oxidized walls;

common (3-4%) fine (1 mm) dark brown (10YR 4/3) soft masses throughout; few (<1%) hard gray coarse (13 cm) irregular shaped CaCO3 concretions; slightly effervescent, but slowly reactive to cold 1N HCL; clear boundary.

C18—1124 to 1172 cm; pale brown (10YR 6/3) silt; common coarse faint light yellowish brown (10YR 6/4) and common coarse distinct brownish yellow (10YR 6/6, 6/8) mottles; structureless, massive; friable; few (<1%) very fine and few fine pores, some have dark yellowish brown (10YR 4/4) oxidized walls; one light gray (10YR 7/2) skeletan about 2 mm wide in upper 5 cm of horizon; common (3-4%) fine (1 mm), few medium (2-5 mm) dark brown (10YR 4/3) soft masses and few coarse (5-10 mm) dark yellowish brown (10YR 3/4) soft masses throughout; slightly effervescent, but slowly reactive to cold 1N HCL; gradual boundary.

C19—1172 to 1210 cm; very pale brown (10YR 7/3) silt; few medium faint very pale brown (10YR 7/4) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, some have dark yellowish brown (10YR 4/4) oxidized walls; few (1%) fine, medium and coarse (1-15 mm) dark yellowish brown (10YR 4/4) soft masses throughout; slightly effervescent, but slowly reactive to cold 1N HCL; gradual boundary.

C20—1210 to 1256 cm; pale brown (10YR 6/3) silt; few coarse faint light yellowish brown (10YR 6/4) and few fine and medium distinct light gray (10YR 7/2) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) oxidized walls; few (1%) fine (1 mm) dark yellowish brown (10YR 4/4) soft masses throughout; slightly effervescent, but slowly reactive to cold 1N HCL; gradual boundary.

C21—1256 to 1276 cm; very pale brown (10YR 7/3) silt; structureless, massive; very friable; continuous horizontal brownish yellow (10YR 6/6, 6/8) oxidation band 7 cm wide at top of horizon; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) oxidized walls; slightly effervescent, but slowly reactive to cold 1N HCL; abrupt boundary.

C22—1276 to 1311 cm; pale brown (10YR 6/3) silt; few medium distinct brownish yellow (10YR 6/6) mottles; structureless, massive; very friable; few (<1%) fine and few medium pores, most have strong brown (7.5YR 4/6) and yellowish brown (10YR 5/6) oxidized walls; a few pores are lined with black mangans; few fine (<1 mm) dark yellowish brown (10YR 4/4) soft masses; strongly effervescent, but slowly reactive to cold 1N HCL; clear boundary.

C23—1311 to 1383 cm; light yellowish brown (10YR 6/4) silt; few fine distinct light brownish gray (10YR 6/2) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have brownish yellow (10YR 6/6) or strong brown (7.5YR 4/6) oxidized walls; common fine dark yellowish brown (10YR 4/4) soft masses throughout; strongly effervescent, but slowly reactive to cold 1N HCL; clear boundary.
Subsampled: 1311-1347 cm; 1347-1383 cm.

C24—1383 to 1434 cm; yellowish brown (10YR 5/8) silt; common coarse distinct very pale brown (10YR 7/3) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most are lined with dark yellowish brown (10YR 4/4) mangans; common fine dark yellowish brown (10YR 4/4) soft masses throughout; strongly effervescent with cold 1N HCL; clear boundary.
Subsampled: 1383-1408 cm; 1408-1434 cm.

C25—1434 to 1501 cm; pale brown (10YR 6/3) silt; few medium distinct brownish yellow (10YR 6/6) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) or strong brown (7.5YR 4/6) oxidized walls; few fine dark yellowish brown (10YR 4/4) soft masses throughout; strongly effervescent with cold 1N HCL; gradual boundary.
Subsampled: 1434-1467 cm; 1467-1501 cm.

C26—1501 to 1540 cm; light yellowish brown (10YR 6/4) silt; common coarse distinct yellowish brown (10YR 5/6) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) or strong brown (7.5YR 4/6) oxidized walls; few fine dark yellowish brown (10YR 4/4) soft masses throughout; strongly effervescent with cold 1N HCL; gradual boundary.

Note: Horizons below 1540 cm were saturated when described. Some minor distortion in depth measurements possible due to compaction in sampling tube.

C27—1540 to 1589 cm; pale brown (10YR 6/3) silt; few medium faint light yellowish brown (10YR 6/4) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/4) or strong brown (7.5YR 4/6) oxidized walls; violently effervescent with cold 1N HCL; gradual boundary.

C28—1589 to 1682 cm; pale brown (10YR 6/3) silt; many coarse distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; structureless, massive; very friable; few (<1%) very fine and few fine pores, most have dark yellowish brown (10YR 4/6)oxidized walls; common fine dark yellowish brown (10YR 4/4) soft masses throughout; violently effervescent with cold 1N HCL; gradual boundary.
Subsampled: 1589-1635 cm; 1635-1682 cm.

Peoria/Roxana contact
C29—1682 to 1752 cm; light yellowish brown (2.5Y 6/4) silt; common medium faint olive yellow (2.5Y 6/6) mottles, few medium distinct light yellowish brown (10YR 6/4) and yellowish brown (10YR 5/6) mottles and few medium distinct light brownish gray (10YR 6/2) mottles; structureless, massive; very friable; few very fine and fine pores, most have dark yellowish brown (10YR 4/6) oxidized walls; few fine, medium and coarse (1-15 mm) strong brown (7.5YR 4/6) and dark brown (10YR 4/3) soft irregular shaped masses; few fine soft very dark gray (10YR 3/1) masses; few thread-like very dark gray (10YR 3/1) to black (10YR 2/1) mangans throughout; slightly effervescent, but slowly reactive with cold 1N HCL; gradual boundary.
Subsampled: 1682-1717 cm; 1717-1752 cm.

C30—1752 to 1993 cm; light olive brown (2.5Y 5/4) silt; common coarse distinct yellowish brown (10YR 5/6) mottles, few medium distinct dark yellowish brown (10YR 4/6) mottles and common medium distinct light brownish gray (10YR 6/2) mottles; structureless, massive; very friable; few very fine and fine pores, most have dark yellowish brown (10YR 4/6) oxidized walls; few fine dark yellowish brown (10YR 4/4) soft irregular shaped masses; occasional soft weathered gastropod shells throughout; slightly effervescent, but slowly reactive with cold 1N HCL; gradual boundary.
Subsampled: 1752-1792 cm; 1792-1832 cm; 1832-1872 cm; 1872-1912 cm; 1912-1951 cm; 1951-1993 cm.

C31--1993 to 2035 cm; olive gray (5Y 5/2) silt; common medium distinct light yellowish brown (2.5Y 6/4) mottles; structureless, massive; very friable; few very fine and fine pores, most have dark yellowish brown (10YR 4/6) oxidized walls; few fine dark yellowish brown (10YR 4/4) soft irregular shaped masses; slightly effervescent, but slowly reactive with cold 1N HCL; gradual boundary.

C32--2035 to 2111 cm; light yellowish brown (2.5Y 6/4) silt; few medium distinct olive gray (5Y 5/2) mottles; structureless, massive; very friable; few very fine and fine pores, most have dark yellowish brown (10YR 4/6) oxidized walls; few fine and medium (1-5 mm) dark yellowish brown (10YR 4/4) soft irregular shaped masses; slightly effervescent, but slowly reactive with cold 1N HCL; gradual boundary. Subsampled: 2035-2073 cm; 2073-2111 cm.

C33--2111 to 2180 cm; greenish gray (5GY 5/1) silt; few medium distinct olive gray (5Y 5/2) mottles and few medium distinct dark greenish gray (5BG 4/1) mottles; structureless, massive; very friable; few very fine and fine pores, most have dark yellowish brown (10YR 4/6) oxidized walls; few fine dark yellowish brown (10YR 4/4) soft irregular shaped masses; slightly effervescent, but slowly reactive with cold 1N HCL; gradual boundary.

C34--2180 to 2257; dark greenish gray (5BG 4/1) silt; structureless, massive; very friable; few very fine pores lined with black mangans; slightly effervescent, but slowly reactive with cold 1N HCL.
Subsampled: 2180-2219 cm; 2219-2257 cm.

Pedon Number: 92PH03

Elevation at top of measured section on exposed northeast-facing pit face: 280.5 ft. (85.5 m)

Notes: This part of description was taken from pit face located about 60 m northeast of core described above. Depth measurements taken from channel cut in sloping (43° - 45°) exposure face.

Peoria Loess
9-10 m of Peoria Loess in cut face. Composite sample of gastropod shells from an 2-3 m interval in middle of exposed Peoria section (5 m above contact with Farmdale paleosol and 3 m below top of exposure; see figure 7) yielded a C-14 age of 21,070$\pm$230 (U.S. Geological Survey, Reston, VA., C-14 Laboratory No. WW-102; Lawrence Livermore No. CAMS- 4942).

(Depth measurements taken up from datum at the top of the Farmdale paleosol)
C??--281 to 245 cm; light yellowish brown (2.5Y 6/4) silt; structureless, massive; friable; few very fine, few fine and few medium pores; few (<1%) fine and medium (1-4 mm) gray hard round calcium carbonate concretions; one old root channel about 2 cm in diameter filled with yellowish brown (10YR 5/8) silt; strongly effervescent, but slowly reactive to cold 1N HCL; gradual smooth boundary.

C??--245 to 115 cm; grayish brown (2.5Y 5/2) silt; structureless, massive; friable; few fine and few medium pores; few fine and medium gray hard round calcium carbonate concretions; few weathered gastropod shell fragments; about 10% of matrix is composed of brownish yellow (10YR 6/6) halos around an old root channel about 2 mm to 2 cm in diameter; few (1%) fine and medium (2-4 mm) hard round black-brown (Fe-Mn) concretions; two horizontal and one diagonal yellowish brown (10YR 5/6) oxidation bands 3 cm in diameter across middle of horizon; strongly effervescent, but slowly reactive to cold 1N HCL; diffuse smooth boundary.

Subsampled: 245-202 cm; 202-159 cm; 159-115 cm.

C??—115 to 65 cm; pale brown (10YR 6/3) silt; structureless, massive; friable; few very fine and few fine pores; about 3% of matrix is composed of brownish yellow (10YR 6/6) halos around an old root channel about 2 mm to 2 cm in diameter; about 4% of matrix is composed irregular to round grayish brown (10YR 5/2) silt masses 1-5 cm in diameter; few (1%) fine and medium (2-4 mm) hard round black-brown (Fe-Mn) concretions; strongly effervescent, but slowly reactive to cold 1N HCL; diffuse smooth boundary.

Subsampled: 115-90 cm; 90-65 cm.

C??—65 to 35 cm; brown (10YR 5/3) silt; structureless, massive; friable; few very fine and few fine pores; about 2% of matrix is composed of brownish yellow (10YR 6/6) oxidized areas about 2 mm to 1 cm in diameter; about 1% of matrix is composed irregular to round grayish brown (10YR 5/2) silt masses 1-5 cm in diameter; few (<1%) fine and medium (2-4 mm) hard round black-brown (Fe-Mn) concretions; few (1%) medium and coarse (2-8 mm) soft black (Mn) masses; strongly effervescent, but slowly reactive; gradual smooth boundary.

C??—35 to 0 cm; brown (10YR 5/3) silt; structureless, massive; friable; few very fine and few fine pores; about 1% of matrix is composed of brownish yellow (10YR 6/6) oxidized areas about 2 mm to 1 cm in diameter; two irregular to round krotovinas about 5 cm in diameter filled with light brownish gray (10YR 6/2) and pale brown (10YR 6/3) silt; few (<1%) fine and medium (2-4 mm) hard round black-brown (Fe-Mn) concretions; few (<1%) medium and coarse (2-8 mm) soft black (Mn) masses; strongly effervescent, but slowly reactive to cold 1N HCL decreasing to slightly effervescent at base of horizon; gradual smooth boundary.

Pedon Number: 92PH02

Roxana Silt

(Depth measurements taken down from datum at 271.3 ft. (82.7 m) at top of Farmdale paleosol - the surface soil of the Roxana)

Farmdale paleosol

2A1—0 to 17 cm; dark brown (10YR 4/3) silt loam; common medium distinct gray (10YR 5/1) and common medium distinct strong brown (7.5YR 4/6) mottles; structureless; friable; few very fine, few fine and occasional medium pores; about 50% of pores have oxidized walls; few (<1%) fine and medium (2-4 mm) hard round black-brown (Fe-Mn) concretions; clear smooth boundary.

2A2—17 to 43 cm; dark grayish brown (10YR 4/2) silt loam; common medium distinct dark yellowish brown (10YR 4/3) and common fine and medium faint dark brown (10YR 3/2) mottles; structureless; friable; few very fine and few fine pores; about 30% of pores have oxidized walls; two horizontal dark yellowish brown (10YR 4/6) oxidation bands about 5 mm wide occur near base of horizon; few (<1%) fine and medium (2-4 mm) hard round gray calcium carbonate concretions; few (<1%) fine and medium (2-4 mm) hard round black-brown (Fe-Mn) concretions; clear smooth boundary.

2A3—43 to 62 cm; dark grayish brown (10YR 4/2) silt loam; many fine and medium faint dark brown (10YR 3/2) mottles; structureless; friable; few very fine and fine pores; few (<1%) fine (1-2 mm) hard round black-brown (Fe-Mn) concretions; gradual smooth boundary.

2A4--62 to 85 cm; dark brown (10YR 3/2) silt loam; few fine distinct strong brown (7.5YR 4/6) mottles; structureless; friable; few very fine and fine pores; many pale brown (10YR 6/3) uncoated silt grains on fracture faces; few irregular shaped pockets of pale brown (10YR 6/3) uncoated silt grains 5-10 mm in diameter; clear smooth boundary.
C-14 age determination for disseminated organics in this horizon is 28,980±800 (U.S. Geological Survey Radiocarbon Laboratory, Reston, Virginia; Laboratory No. W-6437) (see figure 7).

2A5--85 to 96 cm; dark brown (10YR 3/2) silt loam; structureless; friable; few very fine and fine pores; many pale brown (10YR 6/3) uncoated silt grains on fracture faces; common irregular shaped pockets of pale brown (10YR 6/3) uncoated silt grains 2-10 mm in diameter; few (<1%) fine and medium (2-4 mm) brown hard round (Fe-Mn) concretions; clear smooth boundary.

2Bt1--96 to 184 cm; brown (10YR 5/3) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; structureless; (Note: Some thought given to describing weak coarse subangular blocky structure.) friable; many very fine, many fine and few medium pores; most fine and medium pores lined with yellowish red (5YR 4/6) clay; most of remaining pores have strong brown (7.5YR 4/6) oxidized pore walls; 2 krotovinas 6-8 cm in diameter filled with dark grayish brown (10YR 4/2) silt loam; 6-8 horizontal to diagonal strong brown (7.5YR 5/6, 5/8) oxidation bands across horizon on shaved face, appear to be common medium distinct yellowish brown (10YR 5/6) mottles on picked face; common (2%) fine (1-2 mm) hard round black-brown (Fe-Mn) concretions; gradual smooth boundary.
Subsampled: 96-140 cm; 140-184 cm.

2Bt2--184 to 285 cm; pale brown (10YR 6/3) silt loam; few medium distinct yellowish brown (10YR 5/6) mottles; structureless; friable; many very fine, many fine and many medium pores; most fine and medium pores lined with yellowish red (5YR 4/6) clay; most of remaining pores have strong brown (7.5YR 4/6) oxidized pore walls; few (1%) fine (1-2 mm) hard round black-brown (Fe-Mn) concretions; clear smooth boundary.
Subsampled: 184-218 cm; 218-252 cm; 252-285 cm.

2Bt3--285 to 359 cm; light yellowish brown (10YR 6/4) silt loam; few medium distinct yellowish brown (10YR 5/6) mottles; structureless; friable; many very fine, many fine and many medium pores; most fine and medium pores lined with yellowish red (5YR 4/6) clay; most of remaining pores have strong brown (7.5YR 4/6) oxidized pore walls; few horizontal and vertical yellowish brown (10YR 5/6) oxidation bands 5-10 mm wide across horizon; few (1%) fine (1-2 mm) hard round black-brown (Fe-Mn) concretions; gradual smooth boundary.
Subsampled: 285-322 cm; 322-359 cm.

2Bt4--359 to 415 cm; light yellowish brown (10YR 6/4) silt; few medium distinct brownish yellow (10YR 6/6) mottles; structureless; friable; common very fine, common fine and common medium pores; most fine and medium pores lined with yellowish red (5YR 4/6) clay; most of remaining pores have strong brown (7.5YR 4/6) oxidized pore walls; 3 diagonal yellowish brown (10YR 5/6) oxidation bands 1-2

cm wide across horizon; common (2%) fine (1-2 mm) hard round black-brown (Fe-Mn) concretions; diffuse smooth boundary.
Subsampled: 359-387 cm; 387-415 cm.

2Bt5--415 to 532 cm; strong brown (7.5YR 5/4) silt; structureless; friable; common very fine, common fine and common medium pores; most fine and medium pores lined with yellowish red (5YR 4/6) clay; most of remaining pores have strong brown (7.5YR 4/6) oxidized pore walls; few distinct pockets of pale brown (10YR 6/3) uncoated silt grains 2-10 mm in diameter; common (2%) fine (1-2 mm) hard round black-brown (Fe-Mn) concretions; diffuse smooth boundary.
Subsampled: 415-454 cm; 454-493 cm; 493-532 cm.

Unnamed paleosol at base of Roxana
(paleosol probably welded to Sangamon(?) paleosol at top of Loveland)
2At--532 to 594 cm; brown (10YR 4/3) silt loam; common medium distinct strong brown (7.5YR 4/6, 5/6) mottles; weak medium and coarse angular blocky structure; friable; many very fine, common fine and common medium pores; many fine and medium pores lined with yellowish red (5YR 4/6) clay; most very fine pores have strong brown (7.5YR 4/6) oxidized pore walls; few distinct pale brown (10YR 6/3) and very pale brown (10YR 7/3) uncoated silt grains on faces of peds; common (2%) fine (1-2 mm) hard round black-brown (Fe-Mn) concretions; gradual smooth boundary.
Subsampled: 532-568 cm; 568-594 cm.

2ABt--594 to 623 cm; dark yellowish brown (10YR 4/4) silt loam; common fine and medium distinct strong brown (7.5YR 4/6, 5/6) mottles; weak medium and coarse angular blocky structure; friable; many very fine, many fine and common medium pores; many fine and medium pores lined with yellowish red (5YR 4/6) clay; most very fine pores have strong brown (7.5YR 4/6) oxidized pore walls; common distinct pale brown (10YR 6/3) and very pale brown (10YR 7/3) uncoated silt grains on faces of peds; common (2%) fine and medium (1-5 mm) hard round black-brown (Fe-Mn) concretions; clear wavy boundary.

Loveland loess
Sangamon (?) paleosol at top of Loveland
3Bt1--623 to 656 cm; brown (7.5YR 5/4) silt loam; few medium faint strong brown (7.5YR 5/6) mottles; weak medium and coarse angular blocky structure; friable; many faint clay films on faces of peds; many very fine, many fine and common medium pores; common distinct very pale brown (10YR 7/3) uncoated silt grains on faces of peds; few (1%) fine (1-2 mm) soft black (Mn) masses; common (2%) fine (1-2 mm) and few (1%) medium and coarse (2-10 mm) hard round black-brown (Fe-Mn) concretions; gradual smooth boundary.

3Bt2--656 to 703 cm; strong brown (7.5YR 4/6) silty clay loam; moderate medium and coarse angular blocky structure; firm; many distinct yellowish red (5YR 4/6) clay films on faces of peds; common (25%) prominent black (10YR 2/1) mangans on faces of peds; many very fine, common fine and few medium pores; few (1%) fine, medium and coarse (1-8 mm) hard round black (Fe-Mn) concretions; gradual smooth boundary. Subsampled: 656-680 cm; 680-703 cm.

3Bt3--703 to 761 cm; strong brown (7.5YR 5/6) silt loam; moderate medium and coarse angular blocky structure; firm; many faint strong brown (7.5YR 4/6) moist, (yellowish red 5YR 4/6 dry) clay films on faces of peds and lining pores; few (4%) prominent black (10YR 2/1) mangans on faces of peds and lining many larger pores; common very fine, common fine and common medium pores; diffuse smooth boundary.

Subsampled: 703-732 cm; 732-761 cm.

3Bt4—761 to 796 cm; strong brown (7.5YR 4/6) silt loam; weak medium and coarse angular blocky structure; firm; common distinct yellowish red (5YR 4/6) clay films on faces of peds and lining larger pores; few vertical clay flows 1-5 mm in diameter following voids; few (20%) distinct very pale brown (10YR 7/3) uncoated silt grains on faces of peds; common very fine, many fine and few medium pores; few (1%) prominent black (10YR 2/1) mangans on faces of peds and lining pores; gradual smooth boundary.

3Bt5—796 to 843 cm; strong brown (7.5YR 4/6) silt loam; weak medium and coarse angular blocky structure; friable; common faint strong brown (7.5YR 4/6) clay films on faces of peds and lining some pores; common (25%) very pale brown (10YR 7/3) uncoated silt grains on faces of peds; common very fine, common fine and few medium pores; few (<1%) prominent black (10YR 2/1) mangans on faces of peds and lining pores; gradual smooth boundary.
Subsampled: 796-820 cm; 820-843 cm.

3BCt—843 to 946 cm; yellowish brown (10YR 5/4) silt; weak medium and coarse angular blocky structure; friable; common (30%) distinct very pale brown (10YR 7/3) uncoated silt grains on faces of peds; common very fine and common fine pores; occasional pores lined with clay; few (<1%) fine (1-2 mm) soft round black (Mn) masses; few (2%) prominent black (10YR 2/1) mangans lining pores; diffuse smooth boundary. Subsampled: 843-877 cm; 877-911 cm; 911-946 cm.

3C1—946 to 1069 cm; yellowish brown (10YR 5/4) silt; structureless, massive; friable; few (15%) distinct very pale brown (10YR 7/3) uncoated silt grains on fracture faces; occasional pocket of very pale brown (10YR 7/3) uncoated silt grains 2-10 mm in diameter; few very fine and few fine pores; few (<1%) fine (1-2 mm) soft round black (Mn) masses; few prominent black (10YR 2/1) mangans lining pores; diffuse smooth boundary. Subsampled: 946-977 cm; 977-1008 cm; 1008-1039 cm; 1039-1069 cm.

3C2—1069 to 1128 cm; yellowish brown (10YR 5/4) silt; structureless, massive; friable; few (15%) distinct very pale brown (10YR 7/3) uncoated silt grains on fracture faces; few very fine and few fine pores; few (<1%) fine (1-2 mm) soft round black (Mn) masses; diffuse smooth boundary.
Subsampled: 1069-1099 cm; 1099-1128 cm.

3C3—1128 to 1236 cm; light yellowish brown (10YR 6/4) silt; structureless, massive; friable; few (15%) distinct very pale brown (10YR 7/3) uncoated silt grains on fracture faces; few very fine and few fine pores; few (<1%) fine (1-2 mm) soft round black (Mn) masses; diffuse smooth boundary.
Subsampled: 1128-1155 cm; 1155-1182 cm; 1182-1209 cm; 1209-1236 cm.

3C4—1236 to 1295 cm; light brown (7.5YR 6/3) silt; many (25%) distinct medium and coarse brownish yellow (10YR 6/6) mottles; structureless, massive; friable; common very fine, common fine and common medium pores; some fine and medium pores have strong brown (7.5YR 4/6) oxidized walls; few prominent black (10YR 2/1) mangans lining fine and medium pores; few (<2%) fine (1-2 mm) soft round black (Mn) masses and few (<1%) fine (1-2 mm) soft round strong brown (Fe) masses; diffuse smooth boundary.
Subsampled: 1236-1266 cm; 1266-1295 cm.

3C5--1295 to 1386 cm; light yellowish brown (10YR 6/4) silt; common medium distinct yellowish brown (10YR 5/6) mottles; structureless, massive; friable; common very fine, common fine and few medium pores; some fine and medium pores have strong brown (7.5YR 4/6) oxidized walls; few fine and medium pores lined with black (10YR 2/1) mangans; few coarse and very coarse (5-25 mm) hard round gray CaCO3 concretions; few (2%0 fine (1-2 mm) soft round black (Mn) masses and few (1%) fine (1-2 mm) soft round strong brown (Fe) masses; many prominent black (10YR 2/1) mangans on joint face which diagonals across horizon; abrupt smooth boundary.
Subsampled: 1295-1325 cm; 1325-1355 cm; 1355-1386 cm.

Loveland loess (continued) or Crowley's Ridge Silt
If Crowley's Ridge Silt then this paleosol is the Crowley's Ridge paleosol.
4A(3C6)--1386 to 1423 cm; light yellowish brown (10YR 6/4) silt; few medium distinct yellowish brown (10YR 5/6) mottles; structureless; friable; common very fine, few fine and few medium pores; many very fine and fine pores lined with black (10YR 2/1) mangans; few fine and medium pores have strong brown (7.5YR 4/6) oxidized walls; few (1%) fine (1 mm) soft round black (Mn) masses; one continuous horizontal yellowish brown (10YR 5/6) oxidation band 55 mm wide at top of horizon; abrupt smooth boundary.

4C(3C7)--1423 to 1496 cm; yellowish brown (10YR 5/4) silt; few medium distinct brownish yellow (10YR 6/8) mottles; structureless; friable; common very fine, common fine and few medium pores; most pores lined with black (10YR 2/1) mangans; few fine and medium pores have strong brown (7.5YR 4/6) oxidized walls; few (1%) fine (1-2 mm) soft round black (Mn) masses and few (<1%) fine (1-2 mm) soft strong brown (Fe) masses, some with concentric halos up to 10 cm across; diffuse smooth boundary.
Subsampled: 1423-1459 cm; 1459-1496 cm.

4Ct1(3Ct1)--1496 to 1554 cm; yellowish brown (10YR 5/4) silt; common (20%) medium and coarse distinct yellowish brown (10YR 5/8) mottles; structureless; friable; common very fine, common fine and few medium pores; many pores lined with black (10YR 2/1) mangans and many have strong brown (7.5YR 4/6) oxidized walls; occasional medium pore lined with strong brown (7.5YR 4/6) clay films; few (1%) fine and medium (.5-3 mm) soft round black (10YR 2/1) (Mn) masses and few (<1%) fine, medium and coarse (1-10 mm) soft strong brown (7.5YR 4/6) (Fe) masses; gradual smooth boundary. Subsampled: 1496-1525 cm; 1525-1554 cm.

4Ct2(3Ct2)--1554 to 1607 cm; brown (10YR 5/3) loam; few medium distinct brownish yellow (10YR 6/8) mottles that are mainly above oxidation band; structureless; friable; common very fine, common fine and few medium pores; many pores lined with black (10YR 2/1) mangans and many have strong brown (7.5YR 4/6) oxidized walls; occasional vertical medium pore lined with strong brown (7.5YR 4/6) clay films; fine sand content increases with depth; one wavy strong brown (7.5YR 5/6, 6/6) oxidation band 30 mm wide beginning at 1580 cm; diffuse smooth boundary.
Subsampled: 1554-1581 cm; 1581-1607 cm.

Crowley's Ridge Silt equivalent or unnamed unit of dunal and (or) fluvial sand
(This horizon, either alone, with the overlying 4 horizons and (or) the underlying 2 horizons , or some combination of these horizons is in the stratigraphic position of the Crowley's Ridge Silt at other localities in the valley)

5Ct(4Ct)–1607 to 1656 cm; yellowish brown (10YR 5/4) fine sandy loam; structureless breaking to single grains; friable; common fine and common medium pores; few pores have yellowish brown (10YR 5/6) oxidized walls; some thin clay bridging of grains in upper part of horizon; occasional pocket of very pale brown (10YR 7/3) uncoated sand grains 1-5 mm in diameter in the lower 15 cm of horizon; common distinct very pale brown (10YR 7/3) uncoated sand grains on fracture faces in lower 15 cm of horizon; one horizontal oxidation band about 1 cm wide across base of horizon; few (1%) fine and medium (1-4 mm) soft black (10YR 2/1) (Mn) masses scattered below band; occasional subangular chert clast up to 2 cm is diameter; clear wavy boundary.

Subsampled: 1607-1631 cm; 1631-1656 cm.

Note: Sand is primarily clear fine and very fine subangular to subrounded quartz with 1-5% heavies and red translucent grains.

6C(5C)–1656 to 1746 cm; light gray (10YR 7/2) and very pale brown (10YR 7/3) fine sand; few coarse faint very pale brown (10YR 7/4) mottles; structureless; very friable; few (<1%) hard round coarse (5-10 mm) gray CaCO3 concretions (CaCO3 cemented sand) in a horizontal line about 15 cm below upper boundary; one subrounded Mn coated gravel about 40x25 mm in size, one 2 cm long angular chert fragment and one subangular chert fragment about 3 cm in diameter all in line with concretions; few (<1%) fine and medium (1-4 mm) soft black (10YR 2/1) Mn masses scattered throughout horizon; abrupt smooth boundary.

Subsampled: 1656-1686 cm; 1686-1716 cm; 1716-1746 cm.

Note: Sand composition appears to be similar from 6C through 8BC.

Unnamed Alluvium

2 units: The upper unit is different from and stratigraphically above the Lafayette(?) gravels exposed in adjacent cut-face of the quarry. The lower unit (8 BC) is possibly the top of the Lafayette (?) gravel.

7Bt (6Bt)–1746 to 1756 cm; brown (7.5YR 5/4) loamy fine sand; few fine distinct strong brown (7.5YR 5/8) mottles; structureless; friable; few medium and few coarse pores lined with thin yellowish red (5YR 4/6) clay films; few medium pores lined with black (10YR 2/1) mangans; few irregular shaped pockets of light gray (10YR 7/2) and very pale brown (10YR 7/3) uncoated sand grains up to 1 cm in diameter; few old root channels about 3 mm in diameter filled with very pale brown (10YR 7/3) uncoated sand grains; few (1%) fine and medium (1-5 mm) soft round reddish brown (5YR 4/4) Fe masses; few (1%) fine and medium (1-5 mm) soft round black (10YR 2/1) (Mn) masses; clear wavy boundary.

Note: Sand is primarily subrounded and subangular quartz with about 5% heavies in the very fine sand fraction and heavies and/or labiles up to 5% in the fine sand fraction.

7Bt1–1756 to 1810 cm; mottled, 50% strong brown (7.5YR 4/6), 30% light brownish gray (10YR 6/2) and 20% light yellowish brown (10YR 6/4) sandy clay loam; horizon mottled throughout, but more heavily mottled in upper part forming a vertical pattern on face; moderate medium and coarse subangular blocky structure; very firm; strong brown peds somewhat brittle; about 5 percent by volume rounded and subrounded pebbles up to 2 cm in diameter throughout the matrix; pockets up to 10 cm across with 50 percent by volume rounded and subrounded pebbles up to 2 cm in diameter; contact with horizon above marked with pebble line of primarily subangular to angular chert fragments 1-2 cm in diameter spaced several cm apart; few medium and few coarse pores; common distinct clay films on faces of peds and lining most pores; most pores were originally lined with mangans then covered with clay; few soft plinthite nodules up to 5 mm in diameter; few (1%) fine and medium (1-5 mm) hard round reddish brown (5YR 4/4) Fe concretions; one krotivina about 15 cm in diameter with 4-5 mm thick strong brown (7.5YR 4/6) rind that is beginning to harden, interior filled with light gray (10YR 7/2) and strong brown (7.5YR 5/8) silt loam; clear wavy boundary.

Subsampled; 1756-1783 cm; 1783-1810 cm.

7Bt2--1810 to 1851 cm; yellowish red (5YR 5/8) sandy loam; interbedded with discontinuous 5-8 cm strata of strong brown (7.5YR 4/6) sandy loam with few medium light brownish gray (10YR 6/2) and few medium brownish yellow mottles; the strong brown strata contain 5-70 percent by volume gravel up to 2 cm in diameter in discontinuous lenses; weak medium and coarse subangular blocky structure; very firm; many faint clay films on faces of peds and bridging sand grains; few medium and few coarse pores; some pores lined with mangans and some with clay; prominent black (10YR 2/1) mangans (Mn) on all grains and fragments in lenses; clear wavy boundary

8BC--1851 to 1881+ cm; yellowish red (5YR 5/6) sandy loam; common coarse distinct reddish brown (7.5YR 6/6) and few medium distinct brownish yellow (10YR 6/6) mottles; very weak coarse and very coarse subangular blocky structure; friable; few medium and few coarse pores; some lined with mangans; few prominent black (10YR 2/1) mangans on faces of peds near top of horizon; few irregular shaped pockets up to 1 cm in diameter of light gray (10YR 7/2) uncoated sand grains.

COMPOSITION OF MMV LOESS

S.G. VanValkenburg and H.W. Markewich

Each horizon or layer of loess described and sampled as part of the MMV study is split into specific size fractions for mineralogic analyses - >200 mesh; >80 and <200 mesh (fine sand); <.002 mm (clay); and between .002 mm and .063 mm (silt). A flow-chart of the analytical procedures for sand and clay is shown in figure 4. Data resulting from XRD analysis of the clay fraction of selected samples suggest that the clay fraction of the Peoria Loess and the Roxana Silt is predominantly illite/smectite and illite with quartz as a secondary mineral and kaolinite as a minor component. The Sangamon paleosol and Loveland loess and Crowley's Ridge Silt have a higher content of kaolinite than do the two younger loesses (figs. 5 and 6, and Table 1). The "messy" appearance of the XRD traces of the Sangamon paleosol and weathered Loveland loess is probably due to the high iron oxide content of the soil (up to 3 percent by weight) and parent material. The high content of amorphous or microcrystalline material could also be a factor. Samples for bulk chemistry and iron speciation are presently being selected and submitted. The underlying unnamed fluvial unit contains illite/smectite but is kaolinite/quartz dominated. Mineralogic analysis of the coarser fractions of loess and alluvium from these localities is ongoing. The Phillips Bayou section has been sampled. Analyses of samples from there and other localities will continue through Fiscal Year 1994.

MINERAL MAGNETIC STUDIES OF MMV LOESS

D.T. Rodbell, J.G. Rosenbaum, and R.L. Reynolds,

Background

Loess is terrestrial wind blown silt that is composed chiefly of quartz, feldspar, mica, clay minerals, and carbonate grains (Pye, 1987). The origin of the silt particles in loess is attributed primarily to glacial grinding and secondarily to salt weathering and eolian abrasion (Pye, 1987). The concentration of silt particles along braided channels of glacial meltwater streams and their subsequent eolian entrainment and deposition results in the occurrence of loess in most glaciated regions of the world. Loess deposits provide unusually long and complete terrestrial records of Quaternary glaciation and climatic change that can be compared to marine records (e.g.. Kukla and others, 1988).

Magnetic susceptibility (MS) is defined as the ratio of the magnetization induced in a sample to the magnetic field strength (Dearin and others, 1981; Björck and others, 1982; Thompson and Oldfield, 1986). MS primarily reflects the concentration of magnetite and maghemite in a sample and is controlled secondarily by the grain size of these minerals (Bradshaw and Thompson, 1985; Thompson and Oldfield, 1986). The use of magnetic susceptibility has provided a rapid and non-destructive means to log fine-grained Quaternary stratigraphic sections (Thompson and others, 1980). The technique has been applied to loess (Kukla and others, 1988; Béget and others, 1990), marine sediments (Currie and Bornhold, 1983; Janecek and Rea, 1985), ice (Petit and others, 1990), and glacier-fed lake sediments (Bloemendal and others, 1979; Thompson and Morton, 1979; Rosenbaum and Larson, 1983).

Magnetic susceptibility has played an important role in documenting the extensive exposures of loess and paleosols in central China (Kukla and others, 1988). Paleosols formed on top of individual loess units were noted to yield higher magnetic susceptibilities than unweathered loess, and the similarity between magnetic susceptibility records from the Chinese loesses and the marine $\partial^{18}O$ record led Kukla and others (1988) to conclude that the magnetic susceptibility variations in the Chinese loesses reflect Milankovitch forcing. A similar link between magnetic susceptibility and orbital forcing has been reported for a loess deposit in central Alaska (Begét and Hawkins, 1989). However, in contrast to the Chinese records, paleosols between the Alaska loesses yield lower magnetic susceptibilities than the intervening unweathered loess. This suggests that the mechanism linking the magnetic susceptibility record in Alaska to global climate is different than that in China. Both Kukla and others (1988) and Begét and Hawkins (1989) invoke variations in the deposition rate of magnetite via variations in wind speed during the Quaternary to explain the observed records. However, recent work by Maher and Thompson (1991, 1992) have demonstrated that pedogenic formation of magnetite is the primary control on the magnetic susceptibility record in central China. The work of Maher and Thompson (1991, 1992) illustrates the need for detailed petrologic and SEM analysis in order to correctly interpret magnetic susceptibility records.

Although the first application of magnetic susceptibility to soil materials occurred in the upper Mississippi Valley (Jones and Beavers, 1964), little work has been done to document the magnetic susceptibility and isothermal remanence signature of Quaternary loesses in the region. Isothermal remanent magnetization (IRM) is a measure of the concentration, grain size, and mineralogy of magnetic minerals in a sample (Thompson and Oldfield, 1986).

Preliminary mineral magnetic data indicate systematic and widespread variations in the amount, grain size, and type of magnetic minerals in Quaternary loess deposits in the MMV(fig. 7). These variations reflect changes in the composition of the primary loess or pedogenic alteration of the loess, or both. The correspondence among several mineral magnetic parameters and indices of soil development suggest that part of the observed trends are due to pedogenesis (figs. 8 and 9). However, the relations among pedogenesis and mineral magnetic parameters are not uniform and must be better understood in order to elucidate the paleoclimatic significance of mineral magnetic records from loess in the MMV. Moreover, high frequency variations in the magnetic susceptibility of unweathered loess may record short-term fluctuations in wind speed or in the composition of Mississippi Valley alluvium. Understanding the causes of these high-frequency variations may yield important paleoclimatic information. Finally, preliminary paleomagnetic results indicate normal polarity for the fourth loess (Crowley's Ridge Silt) at the Phillips Bayou and the Old River sample localities.

Objectives of Mineral Magnetic Studies of MMV Loess

The objectives of this study are to: 1) investigate the relationship among mineral magnetic parameters and soil development; 2) establish a basis for distinguishing *between* depositional and pedogenic controls on the mineral magnetic properties of central Mississippi Valley loess; and 3) determine whether high frequency variations in the magnetic susceptibility of unweathered loess reflect local or regional controls.

Present Research

To improve our understanding of the relations *among* pedogenesis, magnetic properties, and climate, this research is focused on the parts of the loess sequence that have widespread and characteristic variations in magnetic properties and soil development. The intervals that are under consideration are the lower part of the Peoria Loess, which is unaffected by pedogenesis, the contact between the Peoria and Roxana silts, and the underlying Sangamon paleosol. The following work is being conducted.

1. Laboratory analysis of samples from the Old River and Phillips Bayou (southeastern Arkansas) sections. The properties to be measured are magnetic susceptibility at two frequencies, anhysteretic remanent magnetization, and isothermal remanent magnetization at 1.2 and -0.3 *Tesla*. In addition, directions of remanent magnetization after alternating-field demagnetization of samples from the unaltered part of the Peoria Loess will be measured. These results may aid in correlating the high-frequency variations in magnetic susceptibility that we have noted in the Peoria Loess in northwestern Tennessee and in southeastern Arkansas.

2. Chemical, magnetic, and petrologic analyses to identify the effects of pedogenesis on magnetic properties. Petrographic, thermomagnetic, and Mossbauer spectrometry methods will be applied to whole samples, magnetic separates, and chemically treated samples in order to identify magnetic minerals and to estimate their contribution to the bulk magnetic signal. This will help to distinguish between detrital and pedogenic magnetization, and will contribute to our understanding of magnetic property variations as records of climatic change in the mid-continent.

PALEOCLIMATIC DATA

Palynology of Latest Pleistocene Loosahatchie River Sediments

F.J. Rich

Samples for palynological analyses have been submitted from both loess and alluvium of the MMV in eastern Arkansas and western Tennessee. To date, samples from only one locality have been processed. This locality is on the left bank of the Loosahatchie River, about 8 m upstream from the Route 70/79 bridge (35°18'37"N. Lat., 89°38'23"W. Long., Arlington, Tennessee 7.5 min. topographic quadrangle). Wood was collected from a 46 cm diameter log buried in point bar sediments, which included leaf mat material. The deposit has a maximum thickness of about 2 meters. Depth below the terrace surface averages 7 m. The radiocarbon age of the wood was determined to be 11,200±180 (USGS Radiocarbon Laboratory, Reston, Virginia; Laboratory No. W-6341).

Sample Characteristics and Preparation

The Loosahatchie River pollen sample was described in the laboratory at Georgia Southern University, Statesboro, Georgia as leaf mat material, consisting of laminated light olive gray (5Y 6/1) silt and fine sand, mixed with some yellowish gray (5Y 8/1) and moderate brown (5YR 4/4) plant fragments. Compressed leaves and stems were very abundant and appeared to be well-preserved. Numerous small, white, thread-like rootlets intruded the sample; these were probably fresh and were derived from the vegetation growing on the bank of the Loosahatchie River. Two subsamples were taken from the leaf mat, one composed dominantly of matted leaves, and the other composed of sandy silt. Each sample consisted of 1-2 cc of sediment.

Both samples were treated the same during processing to extract pollen and spores. They were first acidified with 10% HCl to remove carbonates. They were washed once with distilled water, then covered with 52% HF to remove silicates. After standing in covered test tubes for several days they were washed free of HF. At that point they were covered with 10% KOH solution and boiled in a hot water bath for ten minutes. This produced a dark supernatant liquid. The samples were repeatedly washed until the supernatant fluid was colorless, following which the insoluble residue was mixed with a 50:50 blend of water and glycerin jelly. Two microscope slides bearing sample strews were prepared for each sample. After the slides had cured for a few days, they were observed under 400X magnification, using a Jena research polarizing microscope equipped for phase contrast. Two hundred identifiable grains were counted for each sample, and simple *percentages* were calculated to determine the relative abundance of the taxa.

Results

The pollen data for the Loosahatchie River samples are presented in Table 4. Taxonomic composition is essentially the same for both samples; this is probably as it should be. The two samples were so closely associated as depositional units that they must have accumulated at essentially the same time. The reason for sampling the leaves and silt separately was to determine whether or not hydrodynamic sorting might have resulted in the accumulation of two taxonomically different populations of pollen/spore types. Generally speaking, the same taxa are found in both samples, but there is a difference in absolute abundances. Birch *(Betula)* and elm *(Ulmus)* are particularly notable in that regard. In addition, the silt layer had greater diversity than the leaf mat. This probably follows from the fact that silt usually contains particles with the hydraulic equivalence of silt; these include pollen, spores, and certain algal cysts or colonies. The depositional event which produced the silty layer brought a relatively high variety of pollen/spores with it.

Noteworthy elements of the pollen flora include *Betula* (birch), *Quercus* (oak), *Ulmus* (elm), *Fagus* (beech), and *Acer* cf. *saccharum* (sugar maple). There were more unknowns in both samples than one likes to record, but so many grains were folded or obscured that they simply could not be identified. One more thing is of interest in comparing the samples; the leaf mat sample had pollen clusters (maculae) of grasses, elm, and beech. This usually indicates a quiet environment of deposition, such as would allow leaves to accumulate in mats, and suggests furthermore that grasses, elm, and beech grew at or very near to the site of deposition.

Discussion

The Loosahatchie samples clearly contain an assemblage of hardwood trees and shrubs and associated herbs. Those taxa are, furthermore, representative of vegetation which one expects to find in a cool-temperate area rather than one with a warm-temperate climate. There is a notable absence of *Nyssa* (black gum), and a virtual absence of *Myrica* (wax myrtle), and *Taxodium* (cypress). One would expect these to be present if the site had a very mild climate at the time of leaf-mat deposition. These genera are representative of the kind of vegetation which occupies the lower part of the Mississippi Embayment, and reflect the equable, humid nature of the climate in the area of Memphis, Tennessee, and the Loosahatchie River.

Pollen which were absent from the leaf-mat samples and which really were expected to be present were those of bisaccate conifers [*Pinus* (pine), *Picea* (spruce), and *Abies* (fir)] and the monosaccate conifer *Tsuga* (hemlock). There was 1 grain of *Pinus* among 513 grains in the two samples, and no *Picea*, *Abies*, or *Tsuga*. The site clearly was not inhabited by conifers and it seems likely that they probably didn't even grow nearby. A further implication is that the climate in the MMV must have warmed considerably relative to what has been proposed for the area during the Wisconsin glacial maximum (Royall and others, 1991).

The sense that one gets from the composition of the Loosahatchie pollen flora is that the climate 11,200 years ago was transitional from boreal to warm-temperate. Ordinarily one would have an array of samples to rely on to make such a statement, but the conclusion is supported by recent work which has been done in the same general area of the MMV. An investigation conducted by Royall and others (1991) is of particular interest here. Royall and his colleagues collected a core of sediment 3.8 meters long from Powers Fort Swale. Powers Fort Swale is roughly 160 km north-northwest of Memphis in Butler County, Missouri. The base of the Powers Fort Swale core has an age in excess of 16,000 years BP, and the core seems to represent essentially continuous deposition of sediment from that time to the present. Pollen data illustrate the presence of several pollen assemblage zones within the core. These include the following: 1) *Picea-Pinus* Pollen Assemblage Zone, 380 to 180 cm depth, 18,275 to 14,500 yr BP; 2) *Quercus-Carpinus/Ostrya* Pollen Assemblage Zone, 180 to 125 cm depth, 14,500 to 9,500 yr BP; 3) *Quercus-Fraxinus* Pollen Assemblage Zone, 125 to 75 cm depth, 9,500 to 4,500 yr BP; and, 4) Cupressaceae-*Salix* Pollen Assemblage Zone, 75 to 0 cm depth, 4,500 yr BP to present.

The date of the Loosahatchie leaf mat material, at 11,200 yr. B.P., and the proximity of the site to Powers Fort Swale suggest that the pollen assemblage from the leaf mat sample should have similarities to samples from the *Quercus-Carpinus/Ostrya* Pollen Assemblage Zone. This, in fact, is what we see. The relative abundances of the taxa are different between the two sites, but the general composition of the pollen flora is the same from one site to the other. *Quercus* and *Ostrya/Carpinus* are much less abundant at the Loosahatchie site than at Powers Fort Swale, and *Betula* and *Ulmus* are much more abundant, but these are simply differences in the amounts of pollen which accumulated rather than variations in the kinds of taxa which seem to have grown at the two sites. The general lack of conifers at the Loosahatchie site is fully in agreement with the precipitous decline in conifer pollen numbers which Royall et al. illustrate at the transition from the *Picea-Pinus* Pollen Assemblage Zone to the *Quercus-Carpinus/Ostrya* Pollen Assemblage Zone.

Conclusions

Palynological analysis of two samples from a leaf mat sample collected near the Loosahatchie River, north of Memphis, Tennessee, shows that the flora which grew in this area 11,200 years ago was substantially different from what grows in the area today. Together, the samples produced an abundance of *Betula*, *Ulmus*, *Quercus*, *Carya*, and *Acer* cf. *saccharum* pollen. The lack of conifer pollen, particularly those of *Picea*, *Abies*, and *Tsuga* suggests that at 11,200 years ago the climate of the MMV had warmed considerably compared to what it was like during the Wisconsin glacial maximum. On the other hand, the hardwood taxa which are present, the lack of *Nyssa*, and the virtual absence of *Taxodium* and *Myrica* indicate a climate which must have been cooler than the one which prevails now in the area of Memphis, Tennessee. Conclusions drawn from the Loosahatchie pollen analyses are corroborated by work done by Royall and others (1991) at Powers Fort Swale in Missouri.

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Figure Captions

Figure 1. Fisk's (1944) concept of early-stage (Pliocene and early Pleistocene?) relations between the Mississippi, Ohio, Arkansas, and Red Rivers.

Figure 2. Area of ongoing paleoclimatic studies in Arkansas, Mississippi, Tennessee, Kentucky, and Missouri. Terrace age designation is from Saucier and Snead (1989). Sand dunes distribution from Saucier (1974) and Saucier and Snead (1989).

Figure 3. The area of investigation during the 1992 Fiscal Year. Loess sections shown as solid squares and ovals. Core localities shown as solid circles. Pollen localities shown as open oval. Site 1 includes the Phillips Bayou section described on the northeast-facing exposed pit face and the Helena #1 and the Helena #2 Giddings Rig cores. Site 2 includes three vertical exposures in the borrow pit area known as Wittsburg quarry. Site 3 is the near vertical headwall of a west-northwest trending gully in the Chickasaw Bluff #3 on the east side of the Mississippi River. Site 4 is the headwall of a gully beneath the outlet for the swimming pool in Meeman Shelby State Park, Tennessee. Site 5 includes the Memphis West #1 and #2 cores from Wapanocca National Wildlife Refuge at Turrell, Arkansas. Sites 6 and 7 include the Memphis West #3 and #4 cores on the University of Arkansas Pinetree Agricultural Experiment Station at Pinetree, Arkansas. Age designations are from Saucier and Snead, 1989.

Figure 4. A general overview of laboratory procedures for sand separation and clay analysis by X-ray diffraction.

Figure 5. XRD traces of glycolated clay slurries on glass slides prepared from loess samples from Wittsburg quarry (site 2) and the Old River section (site 3): (a) interval from 1 to 2 m below top of Sangamon paleosol (Roxana/Lovelandcontact) exposed in the road cut at Wittsburg quarry (site 2); (b) 60, 75, and 90 cm below top of Farmdale paleosol (Peoria/Roxana contact) at the Old River section (site 3); (c) 18, 43, and 94 cm below top of Sangamon paleosol (Roxana/Loveland contact) at the Old River section (site 3); (d) 64, 97, 137, and 183 cm below an arbitrary "top" in an accretionay transition zone between the Crowley's Ridge paleosol and the overlying weathered Loveland loess (Loveland/Crowley's Ridge contact) at the Old River section.

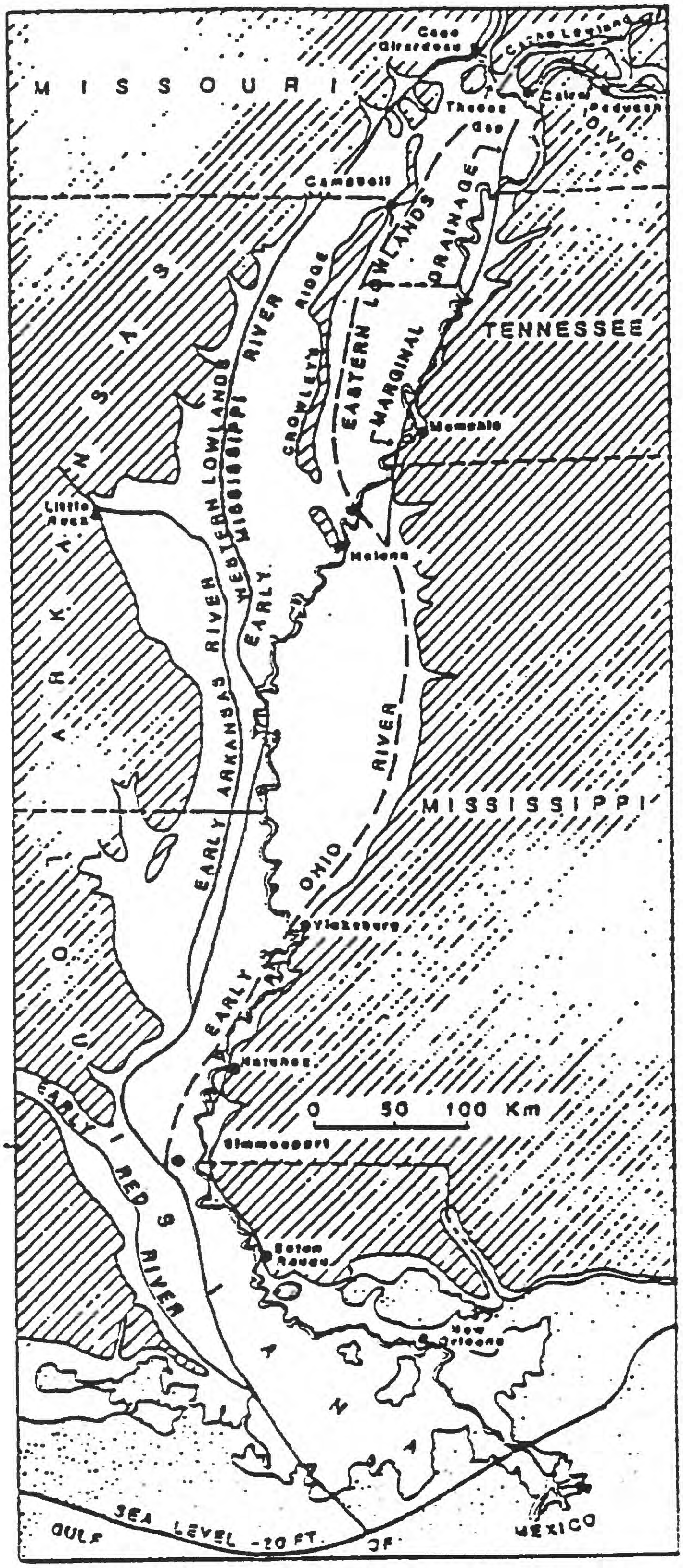
Figure 6. Stacked XRD traces of glycolated clay slurries on glass slides prepared from loess and alluvium samples from the Old River section. Only the upper 1 m of *exposed* Peoria was sampled (approximately 15 m of unexposed section between top of headwall and the ridge crest). Upper 3.3 m of Loveland section includes the Crowley's Ridge Silt and the Loveland loess .Contact between basal weathered Loveland loess and the Crowley's Ridge paleosol placed at 198 cm in the Loveland section, but the contact cannot be seen on the reduced traces (see figures 5c and 5d for less reduced traces of the Sangamon paleosol at top of Loveland and the Crowley's Ridge paleosol at the Loveland loess/Crowley's Ridge Silt contact).Top of unnamed alluvial unit was placed at 334 cm the Loveland section. (Field depths only. Sections will be combined and depths recalculated for final description.)

Figure 7. Summary of magnetic susceptibility trends in four loess sections in the central Mississippi Valley. Each curve has been smoothed by a five point running mean in an effort to concentrate on the major, first-order variations (Figures 8 and 9 include the unsmoothed MS curves for the Troy and Hornbeak sections for comparison). Magnetic susceptibility units are all volume susceptibility (k), which is measured in the filed, except for the Troy, Tennessee curve which is in mass susceptibility (c), a measurement made in the laboratory. The latter is preferable in that it accounts for bulk density variations among samples however, the curves are comparable because bulk density variations in the upper two loess units are minimal. Correlations between sections are made on pedogenic criteria and thus one can compare the susceptibility signature of individual loess units from site to site. Radiocarbon ages from the Old River section and the Phillips Bayou section are those determined by the USGS C-14 laboratory in Reston, Virginia and discussed in the text. Those from the Hornbeak section were determined by Geochron from AMS analysis of fine-grained, disseminated charcoal.

Figure 8. Plots of mineral magnetic properties with depth in the Troy, Tennessee section (36°20'N Lat., 89°12'30"W.Long.). Also plotted is percentage clay (<.002 mm) which provides a rough measure of the degree of pedogenesis to which mineral magnetic properties can be compared. For this site, magnetic susceptibility (MS) was measured in the laboratory and values are for a 1 gm sample. MS was measured at a 'low' frequency (X_{LF}; 0.46 kHz) and a 'high' frequency (X_{HF}; 4.6 kHz). The equation $[(X_{LF}-X_{HF})/X_{LF}]x100$ defines the percent frequency dependence (%FD) of a sample. Percent FD reflects the presence of *ultra*-fine grained magnetite or maghemite (~0.05μ), which may be pedogenically (and/or biogenically) produced in some environments (e.g.. Maher and Thompson, 1991; 1992). As used here, saturated isothermal remanent magnetization (SIRM) is the remanent magnetization imparted on a sample by a magnetic field of 1.2 *Tesla* whereas isothermal remanent magnetization is the remanent magnetization imparted on a sample by a magnetic field of -0.3 *Tesla*. The ratio SIRM/X reflects the presence of fine-grained magnetite or maghemite. The ratio IRM/SIRM is a measure of the coercivity of remanence (Thompson and Oldfield, 1986) which provides a rough measure of the ratio of magnetite and/or maghemite to hematite and/or goethite. Similarly, HIRM is the difference between SIRM and IRM and this provides a rough measure of the relative abundance of magnetite and/or maghemite to hematite and/or goethite.

Figure 9. Plots of mineral magnetic properties with depth in the Hornbeak, Tennessee section (36°21'N Lat., 89°16'30"W. Long.). Also plotted is soil rubification or redness as calculated by the method of Harden (1982) and Harden and Taylor (1983). For this site, magnetic susceptibility (MS) was measured in the field and all values are for a constant volume of sediment. Magnetic susceptibility was measured at a 'low' frequency (X_{LF}; 0.46 kHz) and a 'high' frequency (X_{HF}; 4.6 kHz). The equation $[(X_{LF}-X_{HF})/X_{LF}]x100$ define the percent frequency dependence (%FD) of a sample. Percent FD and subsequent parameters are the same as in figure 8.

Figure 1.


MISSOURI
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Paducah
Thebes Gap
DIVIDE
Campbell
TENNESSEE
ARKANSAS
WESTERN LOWLANDS
EARLY MISSISSIPPI RIVER
CROWLEY'S RIDGE
EASTERN LOWLANDS
MARGINAL DRAINAGE
Memphis
Little Rock
Helena
EARLY ARKANSAS RIVER
EARLY OHIO RIVER
MISSISSIPPI
Vicksburg
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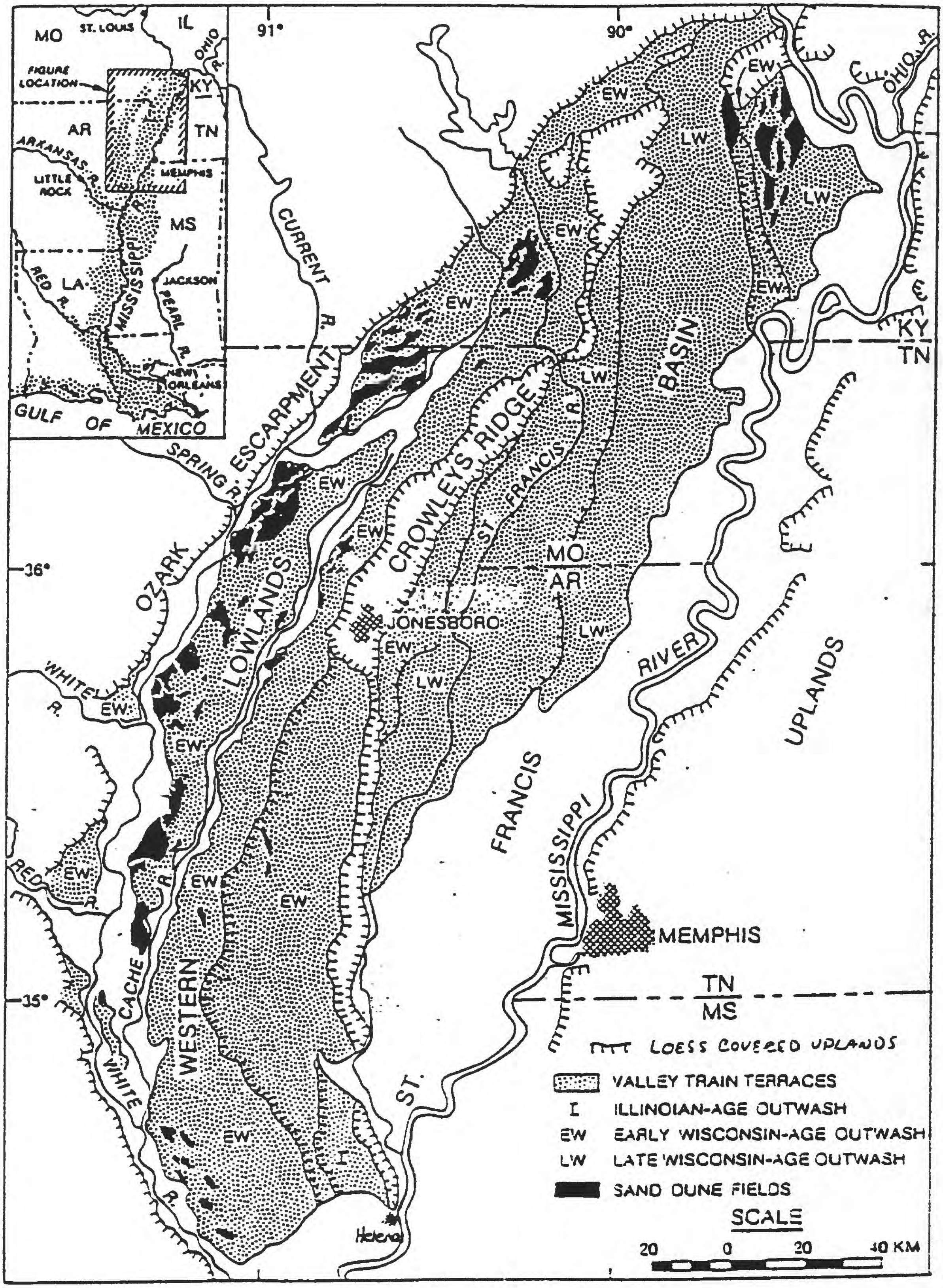
EARLY RED RIVER
Baton Rouge
New Orleans
SEA LEVEL -20 FT.
GULF OF MEXICO

Figure 2.



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GULF OF MEXICO
91°
90°
CURRENT R.
SPRING R.
OZARK ESCARPMENT
WESTERN LOWLANDS
CROWLEYS RIDGE
ST. FRANCIS R.
BASIN
JONESBORO
MO
AR
KY
TN
WHITE R.
RED R.
CACHE R.
WHITE R.
36°
35°
MISSISSIPPI RIVER
UPLANDS
ST. FRANCIS
MEMPHIS
TN
MS
Helena
EW
LW
I
Loess Covered Uplands
VALLEY TRAIN TERRACES
I ILLINOIAN-AGE OUTWASH
EW EARLY WISCONSIN-AGE OUTWASH
LW LATE WISCONSIN-AGE OUTWASH
SAND DUNE FIELDS
SCALE
20 0 20 40 KM

Figure 3.

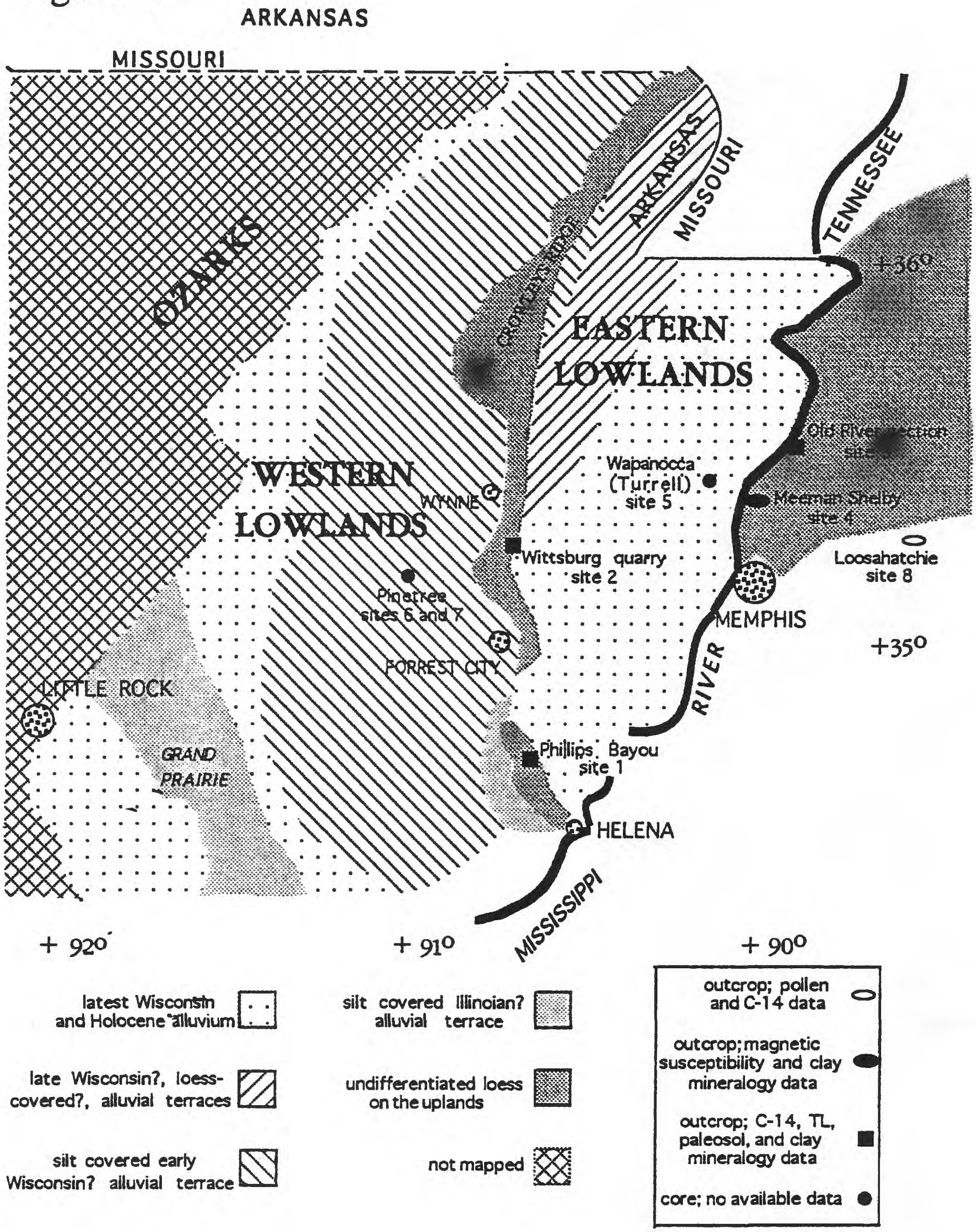
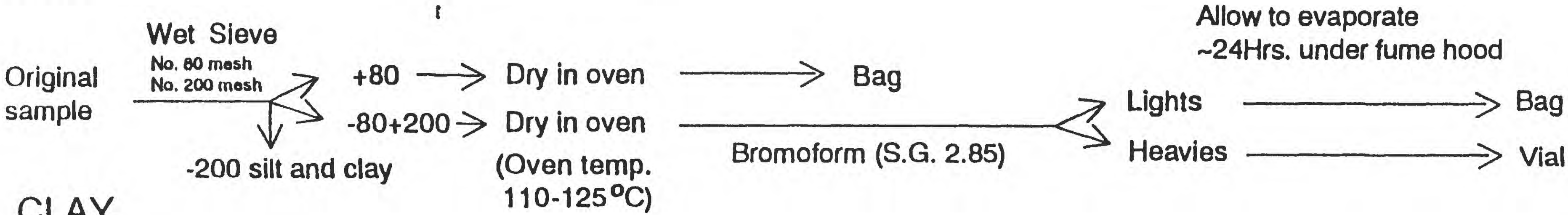

ARKANSAS
MISSOURI
OZARKS
CROWLEY'S RIDGE
ARKANSAS
MISSOURI
TENNESSEE
+36°
EASTERN LOWLANDS
WESTERN LOWLANDS
WYNNE
Old River section site
Wapanocca (Turrell) site 5
Meeman Shelby site 4
Wittsburg quarry site 2
Loosahatchie site 8
Pinetree sites 6 and 7
MEMPHIS
+35°
FORREST CITY
LITTLE ROCK
RIVER
GRAND PRAIRIE
Phillips Bayou site 1
HELENA
MISSISSIPPI
+ 92°
+ 91°
+ 90°
latest Wisconsin and Holocene alluvium
late Wisconsin?, loess-covered?, alluvial terraces
silt covered early Wisconsin? alluvial terrace
silt covered Illinoian? alluvial terrace
undifferentiated loess on the uplands
not mapped
outcrop; pollen and C-14 data
outcrop; magnetic susceptibility and clay mineralogy data
outcrop; C-14, TL, paleosol, and clay mineralogy data
core; no available data

Figure 4.

LAB PROCEDURES FOR SAND SEPARATION AND CLAY ANALYSIS

An Overview

SAND



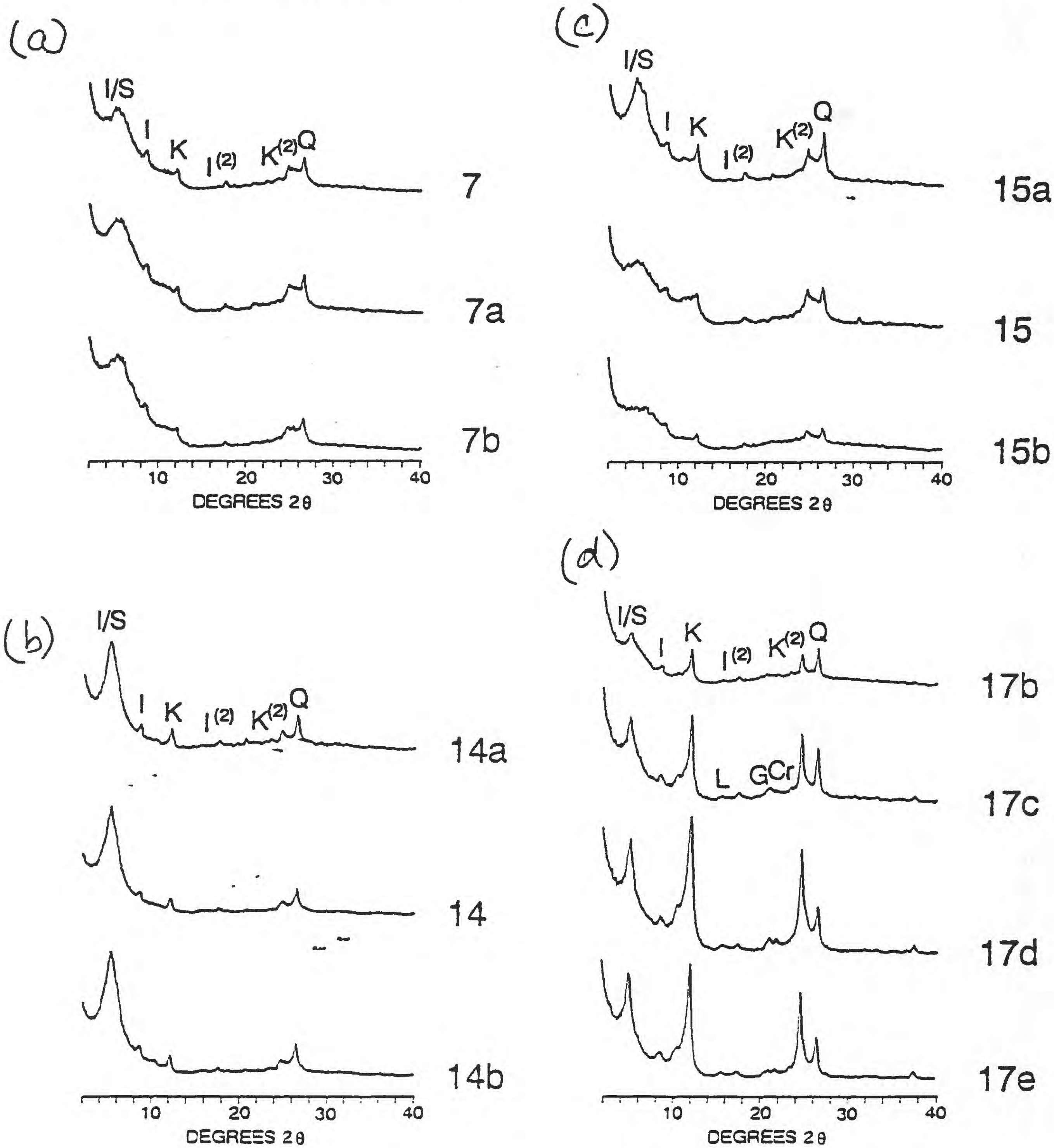
CLAY

SLIDE PREPARATION

1. Put sample in beaker and label as appropriate (i.e. project name and location/depth).
2. Add deionized water.
3. Sonicate 5-15 min. (may need to crush sample before doing this).
4. Fill 4 test tubes with sample as appropriate.
5. Add ~3 squirts deflocculent (3.8g/l Giant Sparking Clean), fill with deionized water until nearly full, then SHAKE WELL.
6. Centrifuge at 1950 RPM for 1 min. 35 sec. to obtain <2um fraction.
7. Pour supernatant (top fraction) into a 50ml beaker, then into 4 new test tubes.
8. Centrifuge full speed for ~3-4 min.
9. Pour off supernatant, then concentrate remaining sediment into 1 test tube.
10. Put clay slurry onto 2 labelled glass slides using a pipet, and allow to dry overnight.

MIDDLE MISSISSIPPI VALLEY

92 HTM-MMV

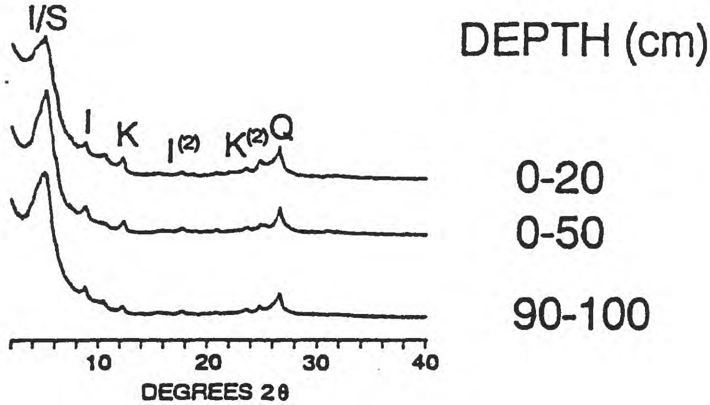


KEY

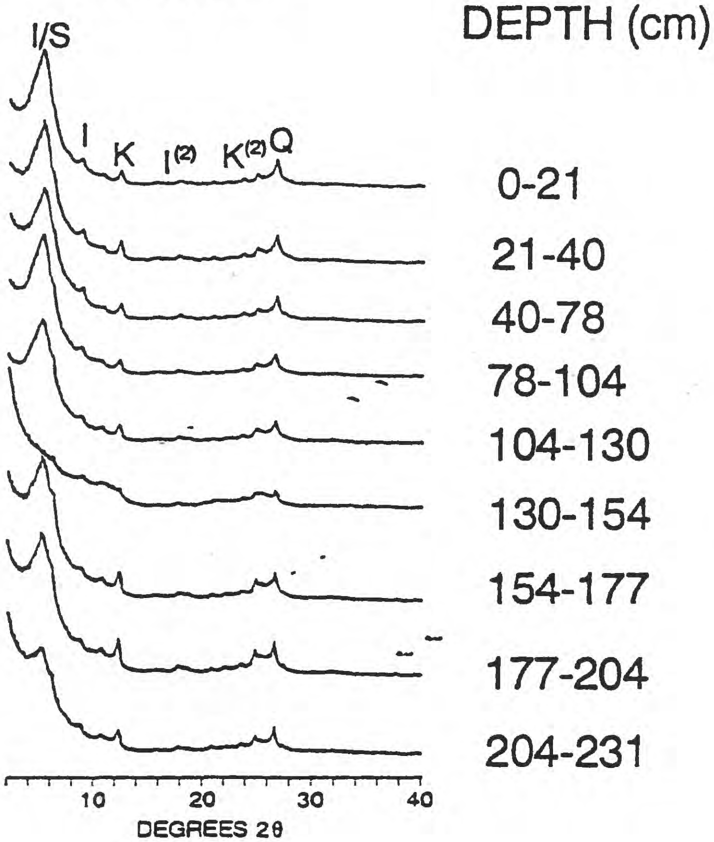
I/S = Illite/Smectite	G = Goethite
I = Illite	Cr = Cristobalite
K = Kaolinite	Q = Quartz
L = Lepidocrocite	(2) = 2nd. order reflection

MIDCONTINENT - OLD RIVER SECTION

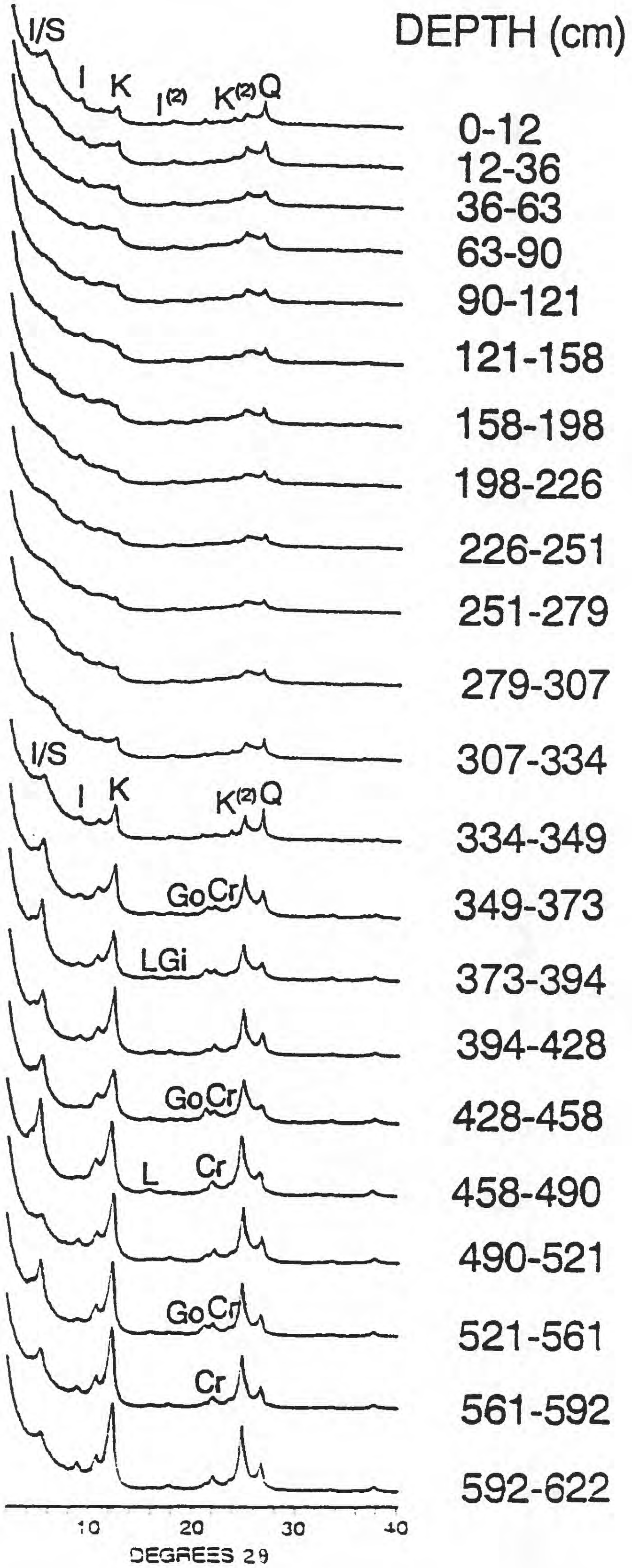
Peoria



Roxana



Loveland



KEY

I/S = Illite/Smectite
I = Illite
K = Kaolinite
L = Lepidocrocite
Gi = Gibbsite
Go = Goethite
Cr = Cristobalite
Q = Quartz
(2) = 2nd. order reflection

Scale has been reduced 50% vertically and expanded 50% horizontally from original X-ray diffractograms

Figure 7.

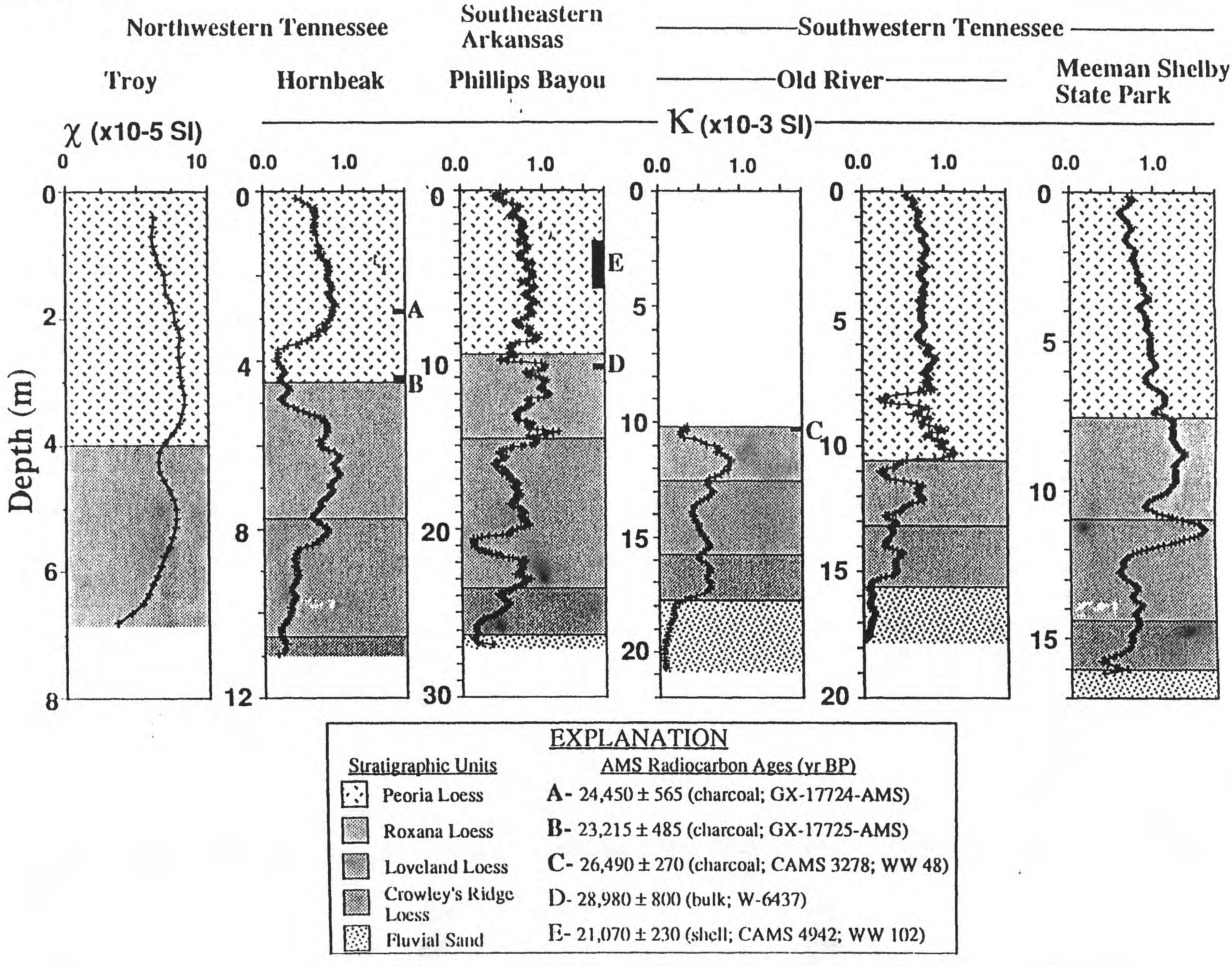

Northwestern Tennessee
Southeastern Arkansas
Southwestern Tennessee
Troy
Hornbeak
Phillips Bayou
Old River
Meeman Shelby State Park
χ (x10-5 SI)
K (x10-3 SI)
Depth (m)
A
B
C
D
E
EXPLANATION
Stratigraphic Units
Peoria Loess
Roxana Loess
Loveland Loess
Crowley's Ridge Loess
Fluvial Sand
AMS Radiocarbon Ages (yr BP)
A- 24,450 ± 565 (charcoal; GX-17724-AMS)
B- 23,215 ± 485 (charcoal; GX-17725-AMS)
C- 26,490 ± 270 (charcoal; CAMS 3278; WW 48)
D- 28,980 ± 800 (bulk; W-6437)
E- 21,070 ± 230 (shell; CAMS 4942; WW 102)

Figure 8. Troy, Tennessee

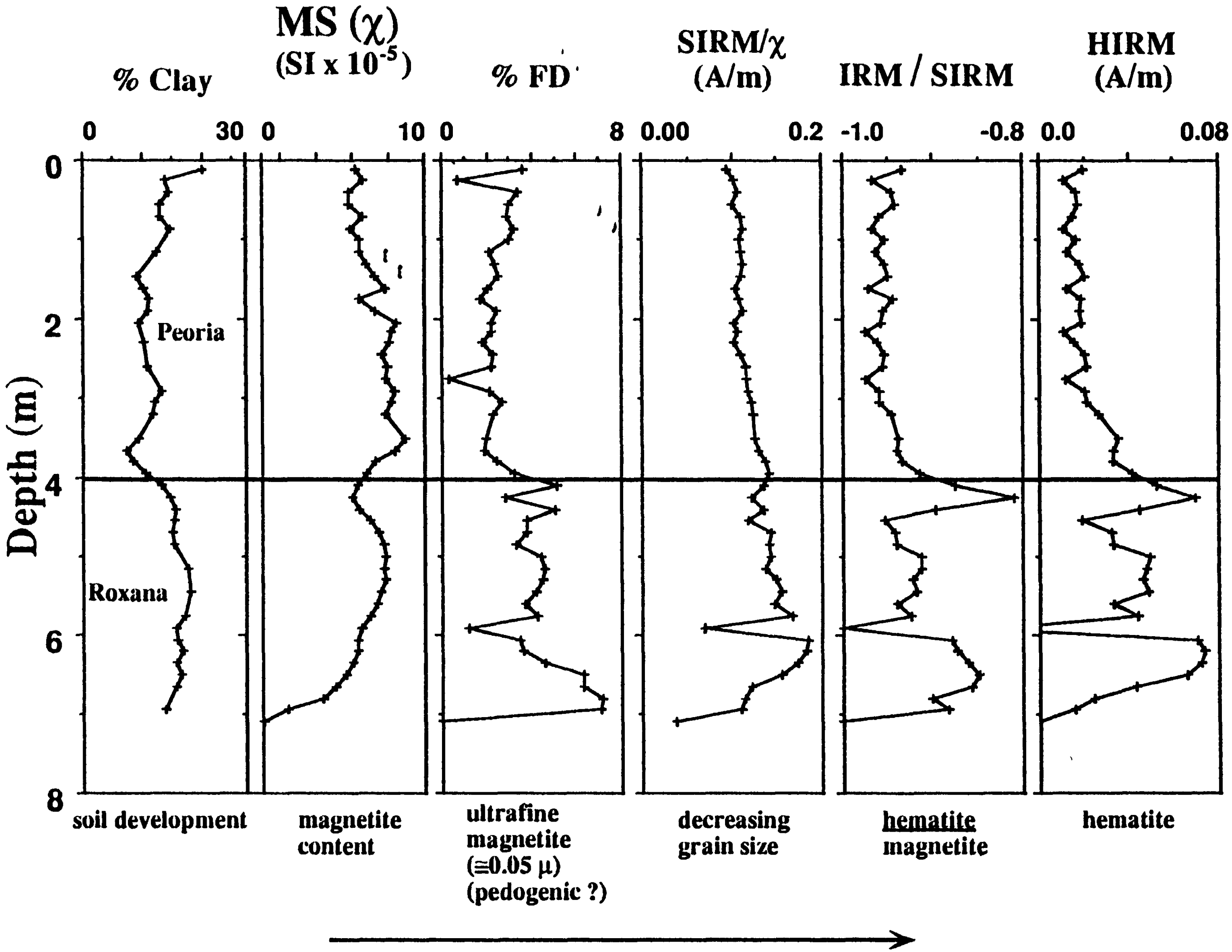
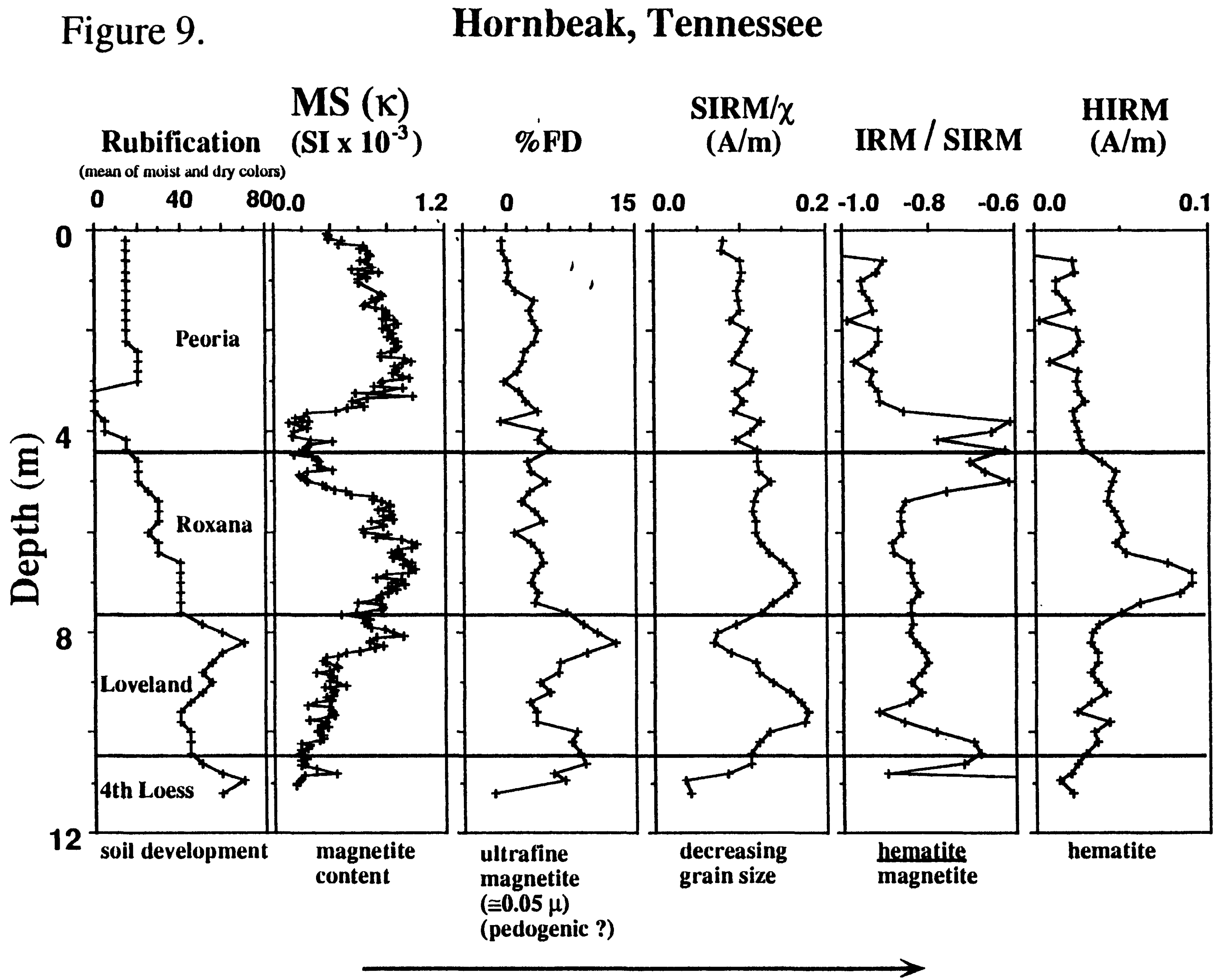


Figure 9.



Hornbeak, Tennessee
Rubification
(mean of moist and dry colors)
MS (κ) (SI x 10^-3)
%FD
SIRM/χ (A/m)
IRM / SIRM
HIRM (A/m)
0 40 80
0.0 1.2
0 15
0.0 0.2
-1.0 -0.8 -0.6
0.0 0.1
Depth (m)
0 4 8 12
Peoria
Roxana
Loveland
4th Loess
soil development
magnetite content
ultrafine magnetite (≡0.05 μ) (pedogenic ?)
decreasing grain size
hematite
magnetite
hematite

Table 1. QUANTIFICATION OF X-RAY TRACES

LOCATION	<------RELATIVE %------>					Q	OTHER
	I/S	Se	P	I	K		
92 HTM-MMV 1	15	---	---	25	60	✓	
92 HTM-MMV 3	75	---	---	19	6	✓	
92 HTM-MMV 5	73	---	---	22	5	✓	
92 HTM-MMV 6	69	---	---	26	5	✓	
92 HTM-MMV 9	62	---	---	35	3	✓	
92 HTM-MMV 10	3	---	---	23	74	✓	GOETHITE CRISTOBALITE? HALLOYSITE?
92 HTM-MMV 11	33	---	---	35	32	✓	
92 HTM-MMV 12	54	---	---	40	6	✓	
92 HTM-MMV 13	64	---	---	28	8	✓	
92 HTM-MMV 16	41	---	---	54	5	✓	
92 HTM-MMV 7	45	---	---	44	11	✓	
92 HTM-MMV 7A	51	---	---	39	10	✓	
92 HTM-MMV 7B	51	---	---	40	9	✓	
92 HTM-MMV 14	76	---	---	18	6	✓	
92 HTM-MMV 14A	74	---	---	19	7	✓	
92 HTM-MMV 14B	70	---	---	24	6	✓	
92 HTM-MMV 15	31	---	---	47	22	✓	
92 HTM-MMV 15A	53	---	---	31	16	✓	
92 HTM-MMV 15B	39	---	---	49	12	✓	
92 HTM-MMV 17B	39	---	---	32	29	✓	
92 HTM-MMV 17C	29	---	---	24	47	✓	LEPIDOCROCITE GOETHITE CRISTOBALITE?
92 HTM-MMV 17D	19	---	---	19	62	✓	LEPIDOCROCITE GOETHITE CRISTOBALITE?
92 HTM-MMV 17E	22	---	---	21	57	✓	LEPIDOCROCITE GOETHITE CRISTOBALITE?

Table 2

Troy, Northwestern Tennessee

Depth (cm)	Magnetic Susceptibility (0.46 kHz) per gram (χ) SI (x10^{-5})	χ smoothed by 5 point running mean	Depth (cm)	Magnetic Susceptibility (0.46 kHz) per gram (χ) SI (x10^{-5})	χ smoothed by 5 point running mean
10	6.200		365	8.364	7.940
25	6.614		380	7.261	7.513
40	5.783	6.191	395	6.761	6.920
55	5.783	6.136	410	6.244	6.525
70	6.574	6.090	425	5.971	6.468
85	5.929	6.200	440	6.386	6.602
100	6.383	6.393	455	6.976	6.903
115	6.333	6.535	470	7.435	7.267
130	6.746	6.926	485	7.744	7.541
145	7.283	6.916	500	7.795	7.718
160	7.884	7.094	515	7.756	7.733
175	6.333	7.422	530	7.860	7.653
190	7.222	7.601	545	7.511	7.485
205	8.386	7.633	560	7.341	7.219
215	8.178	7.906	575	6.955	6.904
230	8.048	8.048	590	6.429	6.661
245	7.696	7.941	605	6.283	6.397
260	7.935	7.981	620	6.295	6.119
275	7.851	8.002	635	6.023	5.824
290	8.378	8.029	650	5.565	5.424
305	8.152	8.118	665	4.952	4.635
320	7.830	8.335	680	4.282	3.635
335		8.332	695	2.354	
350	8.933	8.154	710	1.022	

Hornbeak, Northwestern Tennessee

Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (κ) SI (x10^{-3})	κ smoothed by 5 point running mean	Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (κ) SI (x10^{-3})	κ smoothed by 5 point running mean
20	0.380		580	0.790	0.786
40	0.390		600	0.810	0.802
60	0.390	0.420	620	0.770	0.818
81	0.480	0.472	640	0.850	0.818
100	0.460	0.516	660	0.870	0.808
120	0.640	0.570	680	0.790	0.816
140	0.610	0.608	700	0.760	0.814

160	0.660	0.652	720	0.810	0.800
180	0.670	0.656	740	0.840	0.810
200	0.680	0.656	760	0.800	0.832
220	0.660	0.658	785	0.840	0.840
240	0.610	0.662	800	0.870	0.846
260	0.670	0.636	820	0.850	0.858
280	0.690	0.652	840	0.870	0.854
300	0.550	0.650	860	0.860	0.830
320	0.740	0.648	880	0.820	0.810
340	0.600	0.630	900	0.750	0.820
360	0.660	0.640	920	0.750	0.842
380	0.600	0.642	940	0.920	0.858
400	0.600	0.676	960	0.970	0.878
418	0.750	0.682	980	0.900	0.902
438	0.770	0.706	1000	0.850	0.890
460	0.690	0.716	1018	0.870	0.862
480	0.720	0.694	1040	0.860	0.862
500	0.650	0.694	1060	0.830	0.882
520	0.640	0.714	1080	0.900	0.862
540	0.770	0.728	1095	0.950	0.840
560	0.790	0.760	1120	0.770	0.816

Phillips Bayou, Southeastern Arkansas

Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (κ) SI (x10^{-3})	κ smoothed by 5 point running mean	Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (κ) SI (x10^{-3})	κ smoothed by 5 point running mean
0	0.560		1365	0.840	0.808
5	0.640		1370	0.990	0.834
10	0.620	0.572	1375	0.850	0.872
15	0.620	0.538	1380	0.800	0.872
20	0.420	0.472	1385	0.880	0.828
25	0.390	0.446	1390	0.840	0.830
30	0.310	0.416	1395	0.770	0.800
35	0.490	0.434	1400	0.860	0.806
40	0.470	0.451	1405	0.650	0.848
45	0.510	0.493	1410	0.910	0.934
50	0.473	0.479	1415	1.050	0.992
55	0.520	0.507	1420	1.200	1.110
60	0.420	0.519	1425	1.150	1.188
65	0.610	0.534	1430	1.240	1.118
70	0.570	0.561	1435	1.300	1.048
75	0.550	0.629	1440	0.700	1.004
80	0.653	0.659	1445	0.850	0.920
85	0.760	0.697	1450	0.930	0.822
90	0.760	0.737	1455	0.820	0.874

95	0.760	0.746	1460	0.810	0.870
100	0.750	0.736	1465	0.960	0.870
105	0.700	0.710	1470	0.830	0.872
110	0.710	0.694	1475	0.930	0.898
115	0.630	0.692	1480	0.830	0.904
120	0.680	0.690	1485	0.940	0.878
125	0.740	0.666	1490	0.990	0.904
130	0.690	0.660	1495	0.700	0.884
135	0.590	0.632	1500	1.060	0.852
140	0.600	0.620	1505	0.730	0.780
145	0.540	0.592	1510	0.780	0.742
150	0.680	0.631	1515	0.630	0.638
155	0.550	0.659	1520	0.510	0.600
160	0.785	0.703	1525	0.540	0.548
165	0.740	0.713	1530	0.540	0.518
170	0.760	0.751	1535	0.520	0.508
175	0.730	0.758	1540	0.480	0.490
180	0.740	0.766	1545	0.460	0.464
185	0.820	0.774	1550	0.450	0.468
190	0.780	0.764	1555	0.410	0.472
195	0.800	0.770	1560	0.540	0.506
200	0.680	0.758	1565	0.500	0.522
205	0.770	0.750	1570	0.630	0.554
210	0.760	0.766	1575	0.530	0.532
215	0.740	0.784	1580	0.570	0.518
220	0.880	0.778	1585	0.430	0.486
225	0.770	0.764	1590	0.430	0.478
230	0.740	0.748	1595	0.470	0.430
235	0.690	0.718	1600	0.490	0.434
240	0.660	0.714	1605	0.330	0.438
245	0.730	0.726	1610	0.450	0.436
250	0.750	0.747	1615	0.450	0.396
255	0.800	0.761	1620	0.460	0.418
260	0.793	0.771	1625	0.290	0.424
265	0.730	0.789	1630	0.440	0.440
270	0.780	0.795	1635	0.480	0.452
275	0.840	0.800	1640	0.530	0.506
280	0.830	0.796	1645	0.520	0.528
285	0.820	0.778	1650	0.560	0.528
290	0.710	0.734	1655	0.550	0.500
295	0.690	0.702	1660	0.480	0.504
300	0.620	0.708	1665	0.390	0.496
305	0.670	0.738	1670	0.540	0.506
310	0.850	0.768	1675	0.520	0.548
315	0.860	0.800	1680	0.600	0.578
320	0.840	0.828	1685	0.690	0.592
325	0.780	0.814	1690	0.540	0.596
330	0.810	0.811	1695	0.610	0.604
335	0.780	0.811	1700	0.540	0.576
340	0.843	0.830	1705	0.640	0.596
345	0.840	0.826	1710	0.550	0.614
350	0.877	0.800	1715	0.640	0.656
355	0.790	0.781	1720	0.700	0.670
360	0.650	0.769	1725	0.750	0.690

365	0.750	0.738	1730	0.710	0.702
370	0.780	0.718	1735	0.650	0.678
375	0.720	0.728	1740	0.700	0.640
380	0.690	0.724	1745	0.580	0.634
385	0.700	0.716	1750	0.560	0.652
390	0.730	0.725	1755	0.680	0.642
395	0.740	0.745	1760	0.740	0.658
400	0.763	0.761	1765	0.650	0.682
405	0.790	0.775	1770	0.660	0.706
410	0.780	0.795	1775	0.680	0.682
415	0.800	0.828	1780	0.800	0.694
420	0.840	0.856	1785	0.620	0.694
425	0.930	0.873	1790	0.710	0.713
430	0.930	0.885	1795	0.660	0.675
435	0.863	0.877	1800	0.777	0.693
440	0.860	0.847	1805	0.610	0.699
445	0.800	0.813	1810	0.710	0.695
450	0.780	0.808	1815	0.740	0.666
455	0.760	0.788	1820	0.640	0.644
460	0.840	0.810	1825	0.630	0.636
465	0.760	0.842	1830	0.500	0.656
470	0.910	0.872	1835	0.670	0.654
475	0.940	0.870	1840	0.840	0.630
480	0.910	0.892	1845	0.630	0.642
485	0.830	0.880	1850	0.510	0.626
490	0.870	0.877	1855	0.560	0.590
495	0.850	0.873	1860	0.590	0.600
500	0.923	0.891	1865	0.660	0.642
505	0.890	0.901	1870	0.680	0.678
510	0.920	0.887	1875	0.720	0.694
515	0.920	0.856	1880	0.740	0.714
520	0.780	0.836	1885	0.670	0.732
525	0.770	0.794	1890	0.760	0.753
530	0.790	0.746	1895	0.770	0.745
535	0.710	0.754	1900	0.823	0.761
540	0.680	0.790	1905	0.700	0.765
545	0.820	0.798	1910	0.750	0.739
550	0.950	0.842	1915	0.780	0.714
555	0.830	0.900	1920	0.640	0.720
560	0.930	0.910	1925	0.700	0.728
565	0.970	0.908	1930	0.730	0.744
570	0.870	0.916	1935	0.790	0.774
575	0.940	0.896	1940	0.860	0.766
580	0.870	0.874	1945	0.790	0.746
585	0.830	0.864	1950	0.660	0.766
590	0.860	0.854	1955	0.630	0.758
595	0.820	0.840	1960	0.890	0.768
600	0.890	0.812	1965	0.820	0.786
605	0.800	0.790	1970	0.840	0.822
610	0.690	0.780	1975	0.750	0.822
615	0.750	0.770	1980	0.810	0.820
620	0.770	0.786	1985	0.890	0.776
625	0.840	0.824	1990	0.810	0.755
630	0.880	0.834	1995	0.620	0.717

635	0.880	0.862	2000	0.643	0.667
640	0.800	0.886	2005	0.620	0.623
645	0.910	0.900	2010	0.640	0.625
650	0.960	0.908	2015	0.590	0.614
655	0.950	0.922	2020	0.630	0.604
660	0.920	0.920	2025	0.590	0.582
665	0.870	0.890	2030	0.570	0.542
670	0.900	0.868	2035	0.530	0.494
675	0.810	0.850	2040	0.390	0.410
680	0.840	0.846	2045	0.390	0.324
685	0.830	0.828	2050	0.170	0.246
690	0.850	0.843	2055	0.140	0.194
695	0.810	0.825	2060	0.140	0.144
700	0.883	0.831	2065	0.130	0.132
705	0.750	0.845	2070	0.140	0.134
710	0.860	0.871	2075	0.110	0.136
715	0.920	0.870	2080	0.150	0.140
720	0.940	0.892	2085	0.150	0.144
725	0.880	0.886	2090	0.150	0.153
730	0.860	0.852	2095	0.160	0.153
735	0.830	0.828	2100	0.153	0.151
740	0.750	0.826	2105	0.150	0.155
745	0.820	0.812	2110	0.140	0.171
750	0.870	0.772	2115	0.170	0.188
755	0.790	0.766	2120	0.240	0.208
760	0.630	0.730	2125	0.240	0.234
765	0.720	0.690	2130	0.250	0.272
770	0.640	0.670	2135	0.270	0.300
774	0.670	0.672	2140	0.360	0.330
780	0.690	0.670	2145	0.380	0.360
785	0.640	0.693	2150	0.390	0.408
790	0.710	0.721	2155	0.400	0.428
800	0.757	0.757	2160	0.510	0.458
805	0.810	0.807	2165	0.460	0.502
810	0.870	0.847	2170	0.530	0.562
815	0.890	0.860	2175	0.610	0.616
820	0.910	0.858	2180	0.700	0.678
830	0.820	0.832	2185	0.780	0.736
835	0.800	0.830	2190	0.770	0.772
840	0.740	0.816	2195	0.820	0.780
845	0.880	0.846	2200	0.790	0.760
850	0.840	0.876	2205	0.740	0.752
855	0.970	0.918	2210	0.680	0.720
860	0.950	0.910	2215	0.730	0.710
865	0.950	0.934	2220	0.660	0.730
870	0.840	0.940	2225	0.740	0.736
875	0.960	0.930	2230	0.840	0.736
880	1.000	0.898	2235	0.710	0.738
885	0.900	0.874	2240	0.730	0.736
890	0.790	0.814	2245	0.670	0.716
895	0.720	0.720	2250	0.730	0.700
900	0.660	0.662	2255	0.740	0.688
905	0.530	0.636	2260	0.630	0.710
910	0.610	0.604	2265	0.670	0.694

915	0.660	0.592	2270	0.780	0.660
920	0.560	0.618	2275	0.650	0.700
925	0.600	0.614	2280	0.570	0.742
930	0.660	0.586	2285	0.830	0.756
935	0.590	0.604	2290	0.880	0.796
940	0.520	0.614	2295	0.850	0.830
945	0.650	0.626	2300	0.850	0.840
950	0.650	0.636	2305	0.740	0.808
955	0.720	0.648	2310	0.880	0.796
960	0.640	0.640	2315	0.720	0.776
965	0.580	0.662	2320	0.790	0.772
970	0.610	0.648	2325	0.750	0.734
975	0.760	0.658	2330	0.720	0.724
980	0.650	0.656	2335	0.690	0.696
985	0.690	0.589	2340	0.670	0.678
990	0.570	0.492	2345	0.650	0.654
995	0.277	0.477	2350	0.660	0.636
1000	0.273	0.487	2355	0.600	0.618
1005	0.573	0.572	2360	0.600	0.604
1010	0.740	0.736	2365	0.580	0.590
1015	0.995	0.908	2370	0.580	0.570
1020	1.100	0.983	2375	0.590	0.538
1025	1.130	1.033	2380	0.500	0.484
1030	0.950	1.022	2385	0.440	0.470
1035	0.990	1.010	2390	0.310	0.445
1040	0.940	1.012	2395	0.510	0.443
1045	1.040	1.010	2400	0.467	0.459
1050	1.140	0.984	2405	0.490	0.499
1055	0.940	0.940	2410	0.520	0.495
1060	0.860	0.876	2415	0.510	0.502
1065	0.720	0.812	2420	0.490	0.518
1070	0.720	0.786	2425	0.500	0.534
1075	0.820	0.784	2430	0.570	0.550
1080	0.810	0.800	2435	0.600	0.584
1085	0.850	0.836	2440	0.590	0.588
1090	0.800	0.855	2445	0.660	0.586
1095	0.900	0.907	2450	0.520	0.580
1100	0.913	0.953	2455	0.560	0.586
1105	1.070	0.981	2460	0.570	0.546
1110	1.080	1.011	2465	0.620	0.548
1115	0.940	1.040	2470	0.460	0.532
1120	1.050	1.030	2475	0.530	0.512
1125	1.060	1.018	2480	0.480	0.482
1130	1.020	1.032	2485	0.470	0.478
1135	1.020	1.022	2490	0.470	0.467
1140	1.010	1.002	2495	0.440	0.455
1145	1.000	0.986	2500	0.473	0.447
1150	0.960	0.970	2505	0.420	0.437
1155	0.940	0.970	2510	0.430	0.433
1160	0.940	0.970	2515	0.420	0.396
1165	1.010	0.964	2520	0.420	0.374
1170	1.000	0.978	2525	0.290	0.344
1175	0.930	1.004	2530	0.310	0.308
1180	1.010	1.018	2535	0.280	0.266

1185	1.070	1.034	2540	0.240	0.252
1190	1.080	1.059	2545	0.210	0.232
1195	1.080	1.073	2550	0.220	0.218
1200	1.057	1.077	2555	0.210	0.206
1205	1.080	1.069	2560	0.210	0.194
1210	1.090	1.051	2565	0.180	0.188
1215	1.040	1.012	2570	0.150	0.180
1220	0.990	0.950	2575	0.190	0.170
1225	0.860	0.856	2580	0.170	0.170
1230	0.770	0.820	2585	0.160	0.174
1235	0.620	0.798	2590	0.180	0.171
1240	0.860	0.798	2595	0.170	0.173
1255	0.880	0.818	2600	0.173	0.179
1260	0.860	0.852	2605	0.180	0.179
1265	0.870	0.844	2610	0.190	0.179
1270	0.790	0.832	2615	0.180	0.180
1275	0.820	0.808	2620	0.170	0.186
1280	0.820	0.796	2625	0.180	0.184
1285	0.740	0.770	2630	0.210	0.194
1290	0.810	0.734	2635	0.180	0.180
1295	0.660	0.714	2640	0.230	0.174
1300	0.640	0.712	2645	0.100	0.156
1305	0.720	0.686	2650	0.150	0.150
1310	0.730	0.676	2655	0.120	0.144
1315	0.680	0.688	2660	0.150	0.154
1320	0.610	0.690	2665	0.200	0.162
1325	0.700	0.668	2670	0.150	0.180
1330	0.730	0.692	2675	0.190	0.190
1335	0.620	0.694	2680	0.210	0.244
1340	0.800	0.690	2685	0.200	0.352
1345	0.620	0.678	2690	0.470	0.382
1359	0.680	0.692	2695	0.690	
1355	0.670	0.700	2700	0.340	
1360	0.690	0.774			

Old River Section, Southwestern Tennessee
(lower 1/2 of section)

Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (K) SI (x10^{-3})	K smoothed by 5 point running mean	Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (K) SI (x10^{-3})	K smoothed by 5 point running mean
1000	0.370		1535	0.530	0.618
1010	0.170		1545	0.650	0.613
1020	0.160	0.343	1555	0.600	0.561
1025	0.483	0.311	1565	0.633	0.529
1030	0.530	0.321	1575	0.390	0.505
1035	0.210	0.335	1585	0.370	0.475

1040	0.220	0.284	1595	0.530	0.472
1045	0.230	0.253	1605	0.450	0.510
1055	0.230	0.263	1615	0.620	0.574
1065	0.377	0.315	1625	0.580	0.590
1075	0.260	0.426	1635	0.690	0.628
1085	0.480	0.508	1645	0.610	0.615
1095	0.785	0.585	1655	0.640	0.617
1105	0.640	0.681	1665	0.553	0.585
1115	0.760	0.737	1675	0.590	0.581
1125	0.740	0.712	1685	0.530	0.591
1135	0.760	0.763	1695	0.590	0.612
1145	0.660	0.801	1705	0.690	0.636
1150	0.897	0.833	1715	0.660	0.638
1155	0.950	0.839	1725	0.710	0.622
1165	0.900	0.891	1735	0.540	0.588
1175	0.790	0.878	1745	0.510	0.545
1185	0.920	0.854	1755	0.520	0.445
1195	0.830	0.842	1765	0.447	0.381
1205	0.830	0.836	1775	0.210	0.317
1215	0.840	0.785	1785	0.220	0.247
1225	0.760	0.753	1795	0.190	0.188
1235	0.665	0.687	1805	0.170	0.182
1245	0.670	0.621	1815	0.150	0.172
1255	0.500	0.577	1825	0.180	0.174
1265	0.510	0.602	1835	0.170	0.174
1275	0.540	0.576	1845	0.200	0.171
1285	0.790	0.624	1855	0.170	0.165
1295	0.540	0.652	1865	0.133	0.161
1305	0.740	0.670	1875	0.150	0.145
1315	0.650	0.616	1885	0.150	0.127
1325	0.630	0.604	1895	0.120	0.120
1335	0.520	0.548	1905	0.080	0.114
1345	0.480	0.498	1915	0.100	0.104
1355	0.460	0.448	1925	0.120	0.094
1365	0.400	0.434	1935	0.100	0.094
1375	0.380	0.424	1945	0.070	0.089
1385	0.450	0.400	1955	0.080	0.077
1395	0.430	0.400	1965	0.073	0.067
1405	0.340	0.416	1975	0.060	0.065
1415	0.400	0.424	1985	0.050	0.055
1425	0.460	0.424	1995	0.060	0.050
1435	0.490	0.450	2005	0.030	0.048
1445	0.430	0.475	2015	0.050	0.048
1455	0.470	0.477	2025	0.050	0.050
1465	0.527	0.478	2035	0.050	0.060
1475	0.470	0.498	2045	0.070	0.064
1485	0.495	0.510	2055	0.080	0.068
1495	0.530	0.537	2065	0.070	0.076
1505	0.530	0.573	2075	0.070	0.068
1515	0.660	0.580	2085	0.090	
1525	0.650	0.604	2095	0.030	

Old River Section, Southwestern Tennessee (complete section)

Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (K) SI (x10-3)	K smoothed by 5 point running mean	Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (K) SI (x10-3)	K smoothed by 5 point running mean
5	0.537		905	0.590	0.718
10	0.457		910	0.530	0.718
15	0.540	0.539	915	0.720	0.732
20	0.550	0.572	920	0.920	0.800
25	0.610	0.617	925	0.900	0.896
35	0.703	0.637	930	0.930	0.946
40	0.680	0.641	935	1.010	0.968
45	0.640	0.645	940	0.970	0.990
50	0.570	0.628	945	1.030	0.915
55	0.630	0.618	950	1.010	0.845
60	0.620	0.626	955	0.557	0.805
65	0.630	0.660	960	0.660	0.773
70	0.680	0.678	965	0.770	0.757
75	0.740	0.688	970	0.870	0.838
80	0.720	0.706	975	0.930	0.912
85	0.670	0.704	980	0.960	0.958
90	0.720	0.683	985	1.030	0.972
95	0.670	0.680	990	1.000	0.987
100	0.637	0.692	995	0.940	0.934
110	0.705	0.674	1000	1.007	0.928
115	0.730	0.688	1005	0.695	0.946
120	0.630	0.695	1010	1.000	0.978
125	0.740	0.688	1015	1.090	0.995
130	0.670	0.674	1020	1.100	1.074
140	0.670	0.682	1025	1.090	1.098
145	0.660	0.682	1030	1.090	1.108
150	0.670	0.712	1035	1.120	1.102
155	0.740	0.738	1040	1.140	1.051
160	0.820	0.756	1045	1.070	0.973
165	0.800	0.774	1050	0.833	0.871
170	0.750	0.772	1055	0.700	0.671
175	0.760	0.767	1060	0.610	0.527
180	0.730	0.744	1065	0.140	0.484
185	0.793	0.738	1070	0.350	0.444
190	0.685	0.736	1075	0.620	0.404
195	0.720	0.734	1080	0.500	0.414

200	0.753	0.732	1085	0.410	0.382
205	0.720	0.755	1090	0.190	0.291
210	0.780	0.775	1095	0.190	0.235
215	0.800	0.780	1100	0.163	0.203
220	0.820	0.784	1105	0.220	0.221
225	0.780	0.786	1110	0.250	0.249
230	0.740	0.782	1115	0.280	0.272
235	0.790	0.772	1120	0.330	0.278
240	0.780	0.776	1125	0.280	0.294
245	0.770	0.774	1130	0.250	0.322
250	0.800	0.768	1135	0.330	0.400
255	0.730	0.756	1140	0.420	0.497
260	0.760	0.746	1145	0.720	0.591
265	0.720	0.728	1150	0.767	0.651
270	0.720	0.728	1155	0.720	0.717
275	0.710	0.736	1160	0.630	0.707
280	0.730	0.752	1165	0.750	0.690
285	0.800	0.766	1170	0.670	0.655
290	0.800	0.787	1175	0.680	0.671
295	0.790	0.791	1180	0.543	0.683
300	0.817	0.775	1185	0.710	0.659
305	0.750	0.749	1190	0.810	0.649
310	0.720	0.729	1195	0.550	0.700
315	0.670	0.702	1200	0.630	0.718
320	0.690	0.710	1205	0.800	0.712
325	0.680	0.708	1210	0.800	0.734
330	0.790	0.712	1215	0.780	0.742
335	0.710	0.726	1220	0.660	0.714
340	0.690	0.744	1225	0.670	0.662
345	0.760	0.740	1230	0.660	0.604
350	0.770	0.757	1235	0.540	0.562
355	0.770	0.775	1240	0.490	0.533
360	0.797	0.777	1245	0.450	0.489
365	0.780	0.765	1250	0.527	0.473
370	0.770	0.755	1255	0.440	0.455
375	0.710	0.752	1260	0.460	0.445
380	0.720	0.742	1265	0.400	0.400
385	0.780	0.740	1270	0.400	0.360
390	0.730	0.751	1275	0.300	0.314
395	0.760	0.759	1280	0.240	0.282
400	0.767	0.763	1285	0.230	0.266
405	0.760	0.777	1290	0.240	0.317
410	0.800	0.763	1295	0.320	0.363
415	0.800	0.743	1300	0.553	0.403
420	0.687	0.713	1305	0.470	0.417
425	0.670	0.693	1310	0.430	0.397
430	0.610	0.689	1315	0.310	0.346
435	0.700	0.708	1320	0.220	0.322
440	0.780	0.741	1325	0.300	0.316
445	0.780	0.767	1330	0.350	0.336
450	0.837	0.751	1335	0.400	0.358
455	0.740	0.731	1340	0.410	0.365
460	0.620	0.721	1345	0.330	0.359
465	0.680	0.696	1350	0.337	0.353

470	0.730	0.698	1355	0.320	0.345
475	0.710	0.724	1360	0.370	0.323
480	0.750	0.724	1365	0.370	0.308
485	0.750	0.716	1370	0.220	0.314
490	0.680	0.723	1375	0.260	0.304
495	0.690	0.713	1380	0.350	0.276
500	0.747	0.713	1385	0.320	0.280
505	0.700	0.725	1390	0.230	0.277
510	0.750	0.735	1395	0.240	0.267
515	0.740	0.746	1400	0.243	0.263
520	0.740	0.760	1405	0.300	0.307
525	0.800	0.754	1410	0.300	0.366
530	0.770	0.752	1415	0.450	0.413
535	0.720	0.754	1420	0.535	0.459
540	0.730	0.733	1425	0.480	0.487
545	0.750	0.713	1430	0.530	0.485
550	0.693	0.709	1435	0.440	0.458
555	0.670	0.693	1440	0.440	0.451
560	0.700	0.677	1445	0.400	0.421
565	0.650	0.666	1450	0.443	0.413
570	0.670	0.680	1455	0.380	0.401
575	0.640	0.676	1460	0.400	0.395
580	0.740	0.684	1465	0.380	0.388
585	0.680	0.705	1470	0.370	0.388
590	0.690	0.727	1475	0.410	0.396
595	0.777	0.741	1480	0.380	0.392
600	0.750	0.771	1485	0.440	0.404
605	0.810	0.805	1490	0.360	0.397
610	0.830	0.818	1495	0.430	0.409
615	0.860	0.818	1500	0.373	0.409
620	0.840	0.800	1505	0.440	0.397
625	0.750	0.784	1510	0.440	0.377
630	0.720	0.770	1515	0.300	0.338
635	0.750	0.774	1520	0.330	0.274
640	0.790	0.807	1525	0.180	0.208
645	0.860	0.845	1530	0.120	0.170
650	0.917	0.871	1535	0.110	0.122
655	0.910	0.893	1540	0.110	0.107
660	0.880	0.885	1545	0.090	0.101
665	0.900	0.858	1550	0.103	0.099
670	0.820	0.842	1555	0.090	0.093
675	0.780	0.834	1560	0.100	0.093
680	0.830	0.820	1565	0.080	0.088
685	0.840	0.814	1570	0.090	0.088
690	0.830	0.815	1575	0.080	0.090
695	0.790	0.821	1580	0.090	0.108
700	0.787	0.813	1585	0.110	0.110
705	0.860	0.751	1590	0.170	0.119
710	0.797	0.738	1595	0.100	0.117
715	0.520	0.752	1600	0.123	0.113
720	0.725	0.764	1605	0.080	0.097
725	0.860	0.801	1610	0.090	0.095
730	0.920	0.804	1615	0.090	0.078
735	0.980	0.819	1620	0.090	0.078

740	0.533	0.827	1625	0.040	0.078
745	0.800	0.775	1630	0.080	0.080
750	0.903	0.731	1635	0.090	0.082
755	0.660	0.809	1640	0.100	0.095
760	0.760	0.811	1645	0.100	0.107
765	0.920	0.794	1650	0.107	0.115
770	0.810	0.838	1655	0.140	0.125
775	0.820	0.874	1660	0.130	0.135
780	0.880	0.828	1665	0.150	0.142
785	0.940	0.729	1670	0.150	0.138
790	0.690	0.686	1675	0.140	0.136
795	0.317	0.547	1680	0.120	0.124
800	0.603	0.409	1685	0.120	0.110
805	0.183	0.309	1690	0.090	0.103
810	0.250	0.287	1695	0.080	0.097
815	0.190	0.203	1700	0.103	0.089
820	0.210	0.222	1705	0.090	0.091
825	0.180	0.281	1710	0.080	0.095
830	0.280	0.351	1715	0.100	0.080
835	0.547	0.446	1720	0.100	0.084
840	0.540	0.574	1725	0.030	0.080
845	0.683	0.690	1730	0.110	0.068
850	0.820	0.771	1735	0.060	0.064
855	0.860	0.807	1740	0.040	0.074
860	0.950	0.728	1745	0.080	0.064
865	0.720	0.690	1750	0.080	0.062
870	0.290	0.646	1755	0.060	0.062
875	0.630	0.624	1760	0.050	0.052
880	0.640	0.664	1765	0.040	0.046
885	0.840	0.790	1770	0.030	0.042
890	0.920	0.830	1775	0.050	
895	0.920	0.820	1780	0.040	
900	0.830	0.758			

Meeman Shelby State Park, Southwestern Tennessee

Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (K) SI ($x10^{-3}$)	K smoothed by 5 point running mean	Depth (cm)	Magnetic Susceptibility (@10 kHz) per volume (K) SI ($x10^{-3}$)	K smoothed by 5 point running mean
5	0.560		820	1.200	1.229
10	0.650		825	1.217	1.213
15	0.680	0.702	830	1.220	1.227
20	0.790	0.748	835	1.210	1.257
25	0.830	0.768	840	1.290	1.258
30	0.790	0.760	845	1.350	1.262
35	0.750	0.746	850	1.220	1.285
40	0.640	0.714	855	1.240	1.303

45	0.720	0.678	860	1.325	1.309
50	0.670	0.644	865	1.380	1.343
55	0.610	0.652	870	1.380	1.375
60	0.580	0.622	875	1.390	1.380
65	0.680	0.606	880	1.400	1.376
70	0.570	0.602	885	1.350	1.366
75	0.590	0.626	890	1.360	1.332
80	0.590	0.642	895	1.330	1.316
85	0.700	0.658	900	1.220	1.300
90	0.760	0.678	905	1.320	1.286
95	0.650	0.700	910	1.270	1.262
100	0.690	0.710	915	1.290	1.274
105	0.700	0.710	920	1.210	1.258
110	0.750	0.742	925	1.280	1.272
115	0.760	0.754	930	1.240	1.272
120	0.810	0.752	935	1.340	1.274
125	0.750	0.750	940	1.290	1.272
130	0.690	0.742	945	1.220	1.278
135	0.740	0.716	950	1.270	1.264
140	0.720	0.708	955	1.270	1.270
145	0.680	0.710	960	1.270	1.278
150	0.710	0.700	965	1.320	1.271
155	0.700	0.692	970	1.260	1.267
160	0.690	0.684	975	1.237	1.263
165	0.680	0.686	980	1.250	1.233
170	0.640	0.704	985	1.250	1.227
175	0.720	0.720	990	1.170	1.220
180	0.790	0.744	995	1.230	1.200
185	0.770	0.778	1000	1.200	1.188
190	0.800	0.804	1005	1.150	1.164
195	0.810	0.798	1010	1.190	1.136
200	0.850	0.790	1015	1.050	1.101
205	0.760	0.796	1020	1.090	1.065
210	0.730	0.794	1025	1.023	1.023
215	0.830	0.777	1030	0.970	1.003
220	0.800	0.775	1035	0.980	0.965
225	0.767	0.785	1040	0.950	0.942
230	0.750	0.779	1045	0.900	0.928
235	0.780	0.785	1050	0.910	0.918
240	0.800	0.794	1055	0.900	0.910
245	0.830	0.810	1060	0.930	0.916
250	0.810	0.810	1065	0.910	0.945
255	0.830	0.808	1070	0.930	1.001
260	0.780	0.816	1075	1.057	1.047
265	0.790	0.823	1080	1.180	1.112
270	0.870	0.827	1085	1.160	1.180
275	0.847	0.835	1090	1.235	1.238
280	0.850	0.859	1095	1.270	1.295
285	0.820	0.831	1100	1.345	1.363
290	0.910	0.818	1105	1.467	1.428
295	0.730	0.818	1110	1.500	1.498
300	0.780	0.828	1115	1.560	1.558
305	0.850	0.830	1120	1.620	1.587
310	0.870	0.868	1125	1.643	1.609

315	0.920	0.887	1130	1.610	1.625
320	0.920	0.891	1135	1.610	1.627
325	0.873	0.889	1140	1.640	1.616
330	0.870	0.891	1145	1.630	1.594
335	0.860	0.895	1150	1.590	1.551
340	0.930	0.910	1155	1.500	1.485
345	0.940	0.926	1160	1.393	1.437
350	0.950	0.946	1165	1.310	1.379
355	0.950	0.948	1170	1.390	1.325
360	0.960	0.952	1175	1.300	1.274
365	0.940	0.938	1180	1.230	1.218
370	0.960	0.896	1185	1.140	1.140
375	0.880	0.868	1190	1.030	1.070
380	0.740	0.846	1195	1.000	0.992
385	0.820	0.826	1200	0.950	0.920
390	0.830	0.828	1205	0.840	0.862
395	0.860	0.864	1210	0.780	0.802
400	0.890	0.882	1215	0.740	0.753
405	0.920	0.898	1220	0.700	0.715
410	0.910	0.910	1225	0.707	0.689
415	0.910	0.907	1230	0.650	0.663
420	0.920	0.907	1235	0.650	0.645
425	0.875	0.913	1240	0.610	0.632
430	0.920	0.925	1245	0.610	0.638
435	0.940	0.925	1250	0.640	0.642
440	0.970	0.926	1255	0.680	0.646
445	0.920	0.920	1260	0.670	0.640
450	0.880	0.920	1265	0.630	0.624
455	0.890	0.902	1270	0.580	0.604
460	0.940	0.906	1275	0.560	0.596
465	0.880	0.930	1280	0.580	0.586
470	0.940	0.956	1285	0.630	0.610
475	1.000	0.958	1290	0.580	0.640
480	1.020	0.974	1295	0.700	0.668
485	0.950	0.980	1300	0.710	0.674
490	0.960	0.968	1305	0.720	0.720
495	0.970	0.964	1310	0.660	0.732
500	0.940	0.966	1315	0.810	0.753
505	1.000	0.964	1320	0.760	0.789
510	0.960	0.962	1325	0.817	0.813
515	0.950	0.969	1330	0.900	0.797
520	0.960	0.965	1335	0.780	0.799
525	0.973	0.969	1340	0.730	0.798
530	0.980	0.971	1345	0.770	0.774
535	0.980	0.959	1350	0.810	0.768
540	0.960	0.956	1355	0.780	0.754
545	0.900	0.958	1360	0.750	0.746
550	0.960	0.970	1365	0.660	0.760
555	0.990	0.980	1370	0.730	0.782
560	1.040	0.996	1375	0.880	0.794
565	1.010	1.009	1380	0.890	0.842
570	0.980	1.019	1385	0.810	0.872
575	1.027	1.021	1390	0.900	0.862
580	1.040	1.033	1395	0.880	0.834

585	1.050	1.027	1400	0.830	0.844
590	1.070	1.018	1405	0.750	0.812
595	0.950	0.998	1410	0.860	0.792
600	0.980	0.964	1415	0.740	0.779
605	0.940	0.938	1420	0.780	0.787
610	0.880	0.926	1425	0.767	0.771
615	0.940	0.906	1430	0.790	0.801
620	0.890	0.900	1435	0.780	0.801
625	0.880	0.906	1440	0.890	0.812
630	0.910	0.906	1445	0.780	0.824
635	0.910	0.918	1450	0.820	0.826
640	0.940	0.932	1455	0.850	0.804
645	0.950	0.956	1460	0.790	0.804
650	0.950	0.986	1465	0.780	0.804
655	1.030	1.012	1470	0.780	0.774
660	1.060	1.040	1475	0.820	0.752
665	1.070	1.071	1480	0.700	0.746
670	1.090	1.103	1485	0.680	0.740
675	1.103	1.115	1490	0.750	0.722
680	1.190	1.135	1495	0.750	0.734
685	1.120	1.137	1500	0.730	0.744
690	1.170	1.134	1505	0.760	0.742
695	1.100	1.130	1510	0.730	0.734
700	1.090	1.138	1515	0.740	0.729
705	1.170	1.128	1520	0.710	0.719
710	1.160	1.120	1525	0.703	0.713
715	1.120	1.113	1530	0.710	0.701
720	1.060	1.075	1535	0.700	0.687
725	1.054	1.041	1540	0.680	0.656
730	0.980	1.019	1545	0.640	0.620
735	0.990	1.015	1550	0.550	0.584
740	1.010	1.034	1555	0.530	0.538
745	1.040	1.092	1560	0.520	0.494
750	1.150	1.128	1565	0.450	0.443
755	1.270	1.174	1570	0.420	0.399
760	1.170	1.216	1575	0.293	0.357
765	1.240	1.229	1580	0.310	0.381
770	1.250	1.219	1585	0.310	0.427
775	1.213	1.235	1590	0.570	0.538
780	1.220	1.235	1595	0.650	0.564
785	1.250	1.227	1600	0.850	0.662
790	1.240	1.224	1605	0.440	0.604
795	1.210	1.230	1610	0.800	0.519
800	1.200	1.238	1615	0.280	0.398
805	1.250	1.234	1620	0.225	
810	1.290	1.232	1625	0.247	
815	1.220	1.235			

Table 3

Troy, Northwestern Tennessee

Depth (cm)	SIRM[1]	IRM[2]	HIRM[3]	IRM[2]/ SIRM[1]	MS (χ)[4]	% FD[5]	ARM[6]	SIRM[1]/ χ[4]	SIRM[1]/ ARM[6]	ARM[6]/ χ[4]
10	0.588	-0.550	0.019	-0.934	6.200	3.584	0.118	0.095	4.969	0.0191
25	0.675	-0.652	0.011	-0.967	6.614	0.683	0.093	0.102	7.296	0.0140
40	0.609	-0.576	0.017	-0.945	5.783	3.383	0.094	0.105	6.452	0.0163
55	0.576	-0.542	0.017	-0.941	5.783	3.008	0.084	0.100	6.886	0.0145
70	0.720	-0.691	0.015	-0.959	6.574	2.913	0.106	0.109	6.821	0.0161
85	0.661	-0.639	0.011	-0.967	5.929	3.213	0.092	0.111	7.154	0.0156
100	0.685	-0.653	0.016	-0.952	6.383	3.000	0.098	0.107	6.975	0.0154
115	0.693	-0.668	0.013	-0.963	6.333	2.105	0.099	0.109	7.010	0.0156
130	0.749	-0.713	0.018	-0.952	6.746	2.353	0.104	0.111	7.177	0.0155
145	0.804	-0.763	0.020	-0.949	7.283	2.478	0.108	0.110	7.447	0.0148
160	0.825	-0.800	0.012	-0.970	7.884	2.065	0.100	0.105	8.254	0.0127
175	0.686	-0.647	0.019	-0.944	6.333	1.754	0.088	0.108	7.829	0.0138
190	0.802	-0.766	0.018	-0.955	7.222	2.462	0.100	0.111	8.033	0.0138
205	0.862	-0.825	0.019	-0.956	8.386	2.168	0.100	0.103	8.607	0.0119
215	0.859	-0.837	0.011	-0.974	8.178	2.174	0.098	0.105	8.734	0.0120
230	0.828	-0.796	0.016	-0.962	8.048	1.775	0.103	0.103	8.056	0.0128
245	0.849	-0.809	0.020	-0.953	7.696	2.260	0.108	0.110	7.881	0.0140
260	0.917	-0.875	0.021	-0.954	7.935	2.192	0.125	0.116	7.310	0.0158
275	0.912	-0.888	0.012	-0.974	7.851	0.288	0.123	0.116	7.404	0.0157
290	0.978	-0.938	0.020	-0.959	8.378	2.122	0.137	0.117	7.141	0.0164
305	0.994	-0.952	0.021	-0.958	8.152	2.667	0.140	0.122	7.115	0.0171
320	0.969	-0.916	0.026	-0.946	7.830	2.255	0.136	0.124	7.108	0.0174
350	1.120	-1.049	0.036	-0.936	8.933	1.990	0.155	0.125	7.239	0.0173
365	1.085	-1.019	0.033	-0.939	8.364	1.902	0.169	0.130	6.402	0.0203
380	0.998	-0.932	0.033	-0.934	7.261	2.395	0.190	0.137	5.245	0.0262
395	0.960	-0.878	0.041	-0.914	6.761	3.215	0.026	0.142	37.097	0.0038
410	0.842	-0.736	0.053	-0.875	6.244	5.078	0.032	0.135	26.403	0.0051
425	0.730	-0.591	0.069	-0.810	5.971	2.811	0.180	0.122	4.064	0.0301
440	0.869	-0.780	0.045	-0.897	6.386	4.982	0.031	0.136	28.389	0.0048
455	0.814	-0.777	0.019	-0.954	6.976	3.754	0.238	0.117	3.420	0.0341
470	1.069	-1.005	0.032	-0.940	7.435	3.801	0.248	0.144	4.316	0.0333
485	1.099	-1.032	0.033	-0.940	7.744	3.303	0.268	0.142	4.093	0.0347
500	1.117	-1.019	0.049	-0.911	7.795	4.373	0.279	0.143	4.007	0.0358
515	1.065	-0.970	0.047	-0.911	7.756	4.585	0.288	0.137	3.700	0.0371
530	1.171	-1.078	0.046	-0.921	7.860	4.438	0.295	0.149	3.970	0.0375
545	1.168	-1.072	0.048	-0.917	7.511	4.142	0.278	0.156	4.196	0.0371
560	1.073	-1.008	0.033	-0.939	7.341	3.654	0.256	0.146	4.200	0.0348
575	1.155	-1.066	0.044	-0.924	6.955	4.248	0.257	0.166	4.494	0.0369
590	0.437	-0.477	-0.020	-1.000	6.429	1.190	0.160	0.068	2.735	0.0249
605	1.161	-1.021	0.070	-0.879	6.283	3.488	0.284	0.185	4.083	0.0453
620	1.148	-1.001	0.073	-0.872	6.295	3.610	0.309	0.182	3.712	0.0491
635	1.036	-0.891	0.072	-0.861	6.023	4.528	0.324	0.172	3.195	0.0538
650	0.867	-0.735	0.066	-0.848	5.565	6.250	0.333	0.156	2.606	0.0598
665	0.605	-0.519	0.043	-0.858	4.952	6.250	0.274	0.122	2.207	0.0553
680	0.483	-0.434	0.024	-0.900	4.282	7.109	0.210	0.113	2.302	0.0490
695	0.260	-0.230	0.015	-0.882	2.354	7.080	0.140	0.111	1.856	0.0596
710	0.037	-0.039	-0.001	-1.000	1.022	0.000	0.010	0.037	3.574	0.0102

Hornbeak, Northwestern Tennessee

Depth (cm)	SIRM[1]	IRM[2]	HIRM[3]	IRM[2]/ SIRM[3]	MS (χ)[4]	% FD[5]	ARM[6]	SIRM[1]/ χ[4]	SIRM[1]/ ARM[6]	ARM[6]/ χ[4]
20	0.476	-0.503	-0.013	-1.056	5.987	-0.580	0.100	0.080	4.878	0.0163
40	0.536	-0.589	-0.026	-1.100	6.821	-0.426	0.089	0.079	6.033	0.0130
60	0.482	-0.437	0.022	-0.908	4.820	0.000	0.070	0.100	6.838	0.0146
81	0.611	-0.564	0.024	-0.923	5.963	0.239	0.085	0.102	7.173	0.0143
100	0.558	-0.533	0.012	-0.955	5.626	0.000	0.089	0.099	6.240	0.0159
120	0.546	-0.521	0.013	-0.953	5.637	1.015	0.088	0.097	6.187	0.0157
140	0.605	-0.567	0.019	-0.938	6.150	3.211	0.087	0.098	6.918	0.0142
160	0.634	-0.590	0.022	-0.931	6.374	2.709	0.091	0.100	6.998	0.0142
180	0.549	-0.543	0.003	-0.990	6.272	2.995	0.083	0.088	6.637	0.0132

200	0.596	-0.546	0.025	-0.916	5.452	3.571	0.089	0.109	6.710	0.0163
220	0.659	-0.605	0.027	-0.919	6.375	3.146	0.092	0.103	7.161	0.0144
240	0.666	-0.622	0.022	-0.933	6.840	2.053	0.093	0.097	7.190	0.0136
260	0.635	-0.617	0.009	-0.971	7.003	1.852	0.095	0.091	6.711	0.0135
280	0.734	-0.683	0.025	-0.931	6.361	1.310	0.103	0.115	7.111	0.0162
300	0.749	-0.701	0.024	-0.935	6.648	-0.345	0.113	0.113	6.660	0.0169
320	0.613	-0.563	0.025	-0.917	6.509	1.417	0.073	0.094	8.418	0.0112
340	0.698	-0.638	0.030	-0.915	6.739	2.209	0.080	0.104	8.711	0.0119
360	0.319	-0.273	0.023	-0.857	3.461	3.557	0.037	0.092	8.550	0.0108
380	0.123	-0.076	0.024	-0.613	0.997	-0.667	0.022	0.124	5.604	0.0221
400	0.147	-0.096	0.025	-0.656	1.309	4.211	0.024	0.112	6.163	0.0182
418	0.243	-0.189	0.027	-0.779	2.605	3.646	0.037	0.093	6.525	0.0143
438	0.153	-0.096	0.029	-0.623	1.279	5.102	0.027	0.120	5.735	0.0209
460	0.266	-0.188	0.039	-0.707	2.214	2.548	0.038	0.120	6.908	0.0174
480	0.283	-0.189	0.047	-0.670	2.335	2.890	0.041	0.121	6.937	0.0175
500	0.236	-0.145	0.046	-0.614	1.750	4.534	0.039	0.135	6.069	0.0222
520	0.365	-0.277	0.044	-0.761	3.069	2.632	0.053	0.119	6.923	0.0172
540	0.577	-0.493	0.042	-0.855	4.993	1.740	0.070	0.115	8.215	0.0141
560	0.693	-0.601	0.046	-0.867	6.076	3.240	0.078	0.114	8.931	0.0128
580	0.734	-0.636	0.049	-0.867	6.190	4.176	0.081	0.119	9.111	0.0130
600	0.761	-0.658	0.052	-0.864	6.463	0.839	0.084	0.118	9.012	0.0131
620	0.842	-0.747	0.047	-0.888	6.844	2.907	0.090	0.123	9.339	0.0132
640	0.901	-0.796	0.052	-0.884	6.765	3.770	0.102	0.133	8.871	0.0150
660	0.973	-0.820	0.077	-0.843	6.565	4.225	0.167	0.148	5.821	0.0255
680	1.145	-0.964	0.091	-0.842	7.095	3.178	0.248	0.161	4.618	0.0350
700	1.105	-0.925	0.090	-0.837	6.712	2.823	0.209	0.165	5.278	0.0312
720	0.949	-0.783	0.083	-0.825	6.137	3.636	0.252	0.155	3.771	0.0410
740	0.764	-0.644	0.060	-0.842	5.531	3.318	0.282	0.138	2.706	0.0511
760	0.638	-0.537	0.050	-0.842	5.163	7.039	0.301	0.124	2.120	0.0583
785	0.458	-0.384	0.037	-0.838	4.839	8.974	0.327	0.095	1.403	0.0675
800	0.433	-0.366	0.033	-0.846	5.968	10.537	0.317	0.073	1.364	0.0532
820	0.382	-0.318	0.032	-0.831	5.613	12.613	0.224	0.068	1.709	0.0399
840	0.385	-0.312	0.037	-0.810	4.360	9.281	0.124	0.088	3.095	0.0285
860	0.374	-0.301	0.036	-0.806	3.167	6.140	0.079	0.118	4.721	0.0250
880	0.356	-0.292	0.032	-0.820	2.946	5.963	0.068	0.121	5.232	0.0231
900	0.463	-0.391	0.036	-0.845	3.398	3.817	0.077	0.136	6.012	0.0227
920	0.464	-0.381	0.042	-0.821	2.966	4.977	0.075	0.156	6.171	0.0253
940	0.426	-0.362	0.032	-0.849	2.507	2.688	0.074	0.170	5.789	0.0294
960	0.573	-0.524	0.024	-0.916	3.211	3.509	0.099	0.178	5.805	0.0307
980	0.613	-0.527	0.043	-0.860	3.497	3.422	0.141	0.175	4.331	0.0404
1000	0.319	-0.251	0.034	-0.786	2.391	8.081	0.154	0.133	2.068	0.0645
1018	0.240	-0.167	0.036	-0.697	1.990	7.595	0.149	0.121	1.606	0.0751
1040	0.184	-0.126	0.029	-0.683	1.645	8.511	0.111	0.112	1.665	0.0674
1060	0.178	-0.128	0.025	-0.720	1.578	9.023	0.084	0.113	2.119	0.0532
1080	0.398	-0.357	0.021	-0.896	4.699	5.385	0.108	0.085	3.677	0.0230
1095	0.039	-0.011	0.014	-0.288	1.115	6.832	0.017	0.035	2.336	0.0151
1120	0.038.	0.005	0.021	0.125	0.942	-1.408	0.008	0.040	4.863	0.0083

1 saturated isothermal remanent magnetization (1.2T) ($Am^2/kg \times 10^{-2}$)
2 isothermal remanent magnetization (-0.3T) ($Am^2/kg \times 10^{-2}$)
3 hard isothermal remanent magnetization [(SIRM-IRM)/2]
4 magnetic susceptibility (MS) @ 0.46 kHz ($m^3/kg \times 10^{-5}$)
5 frequency dependence of susceptibility (MS @ 0.46 kHz-MS @ 4.6 kHz)/(MS @ 0.46 kHz)x100
6 anhysteretic remanent magnetization ($Am^2/kg \times 10^{-3}$)

Table 4.

Relative abundances of pollen from the two Loosahatchie River samples (site 8).

Values express abundance as *per cent* of total pollen/spores counted.

Taxon	Leaf Mat	Silt
Acer cf. saccharum	4.18	.4
A. rubrum		.73
Alnus sp.		.36
Betula sp.	11.6	24.8
Carya sp.	9.1	4.7
Celtis occidentalis	.82	1.1
Chenopodiaceae/Amaranthaceae		.36
Compositae	Trace	4.0
Corylus sp.		.36
Cyperaceae	.41	.36
Fagus grandifolia	17.4	.73
Gramineae	10.8	.73
Liquidambar styraciflua	1.2	1.4
Myrica sp.		1.1
Osmunda sp.		.36
Ostrya/Carpinus	.82	.36
Pinus sp.	.41	
Pseudoschizaea sp.		.36
Quercus sp.	14.9	32.1
Taxodium sp.	.82	1.8
Ulmus sp.	21.1	3.2
Umbelliferae	.41	
Vitis sp.	.41	
unknowns	11.6	10.9