Horton, R.E.

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I want to extend my sincere appreciation to the authors for submitting high-quality papers that required a minimum of editorial revision. They are to be commended for responding to requests for papers in a professional and timely manner.

A very special thank you is extended to Mrs. Gail Dean, Secretary, Department of Soil Science, North Carolina State University, for cheerfully bearing the burden of preparing and typing the Proceedings for publication. Gail's assistance was invaluable in locating "split infinitives" and a variety of other grammatical errors.

TABLE OF CONTENTS

SOIL SCIENCE SOCIETY OF NORTH CAROLINA

ACHIEVEMENT AWARD FOR 1976

GUY L. JONES

GUY L. JONES

Dr. Guy L. Jones was born and raised on a tobacco farm in Lenoir County, North Carolina. He received the B. S. degree in Agronomy from North Carolina State University in 1947 and served as Superintendent of the Lower Coastal Plain Tobacco Research Station for the next two years. After deciding to continue his formal education, he received the M. S. degree in Agronomy in 1950 from North Carolina State University and the Ph.D. degree in plant breeding from the University of Minnesota in 1952.

He joined the Agronomy Department of North Carolina State University and was in charge of tobacco variety evaluation from 1952 to 1960. He assumed charge of the official variety testing program from 1960 to 1965 and served as Specialist-In-Charge of Extension Agronomy from 1965 to 1975, and is now Specialist-In-Charge of Crop Science Extension.

Dr. Jones has been very active in education at North Carolina State University and in the State of North Carolina. He taught four courses during several years and provided leadership for the Agronomy Extension staff who pioneered in the use of educational and commercial television to extend information to farmers and agri-business personnel. He served as chairman of 22 advanced degree programs for graduate students. He has been very effective in promoting to various civic and professional groups the need for unified efforts by agriculture and industry for a stronger economy.

He was a leader in the developing of "minimum standards" for the release of flue-cured tobacco varieties and served as chairman of the Regional Minimum Standards Committee for several years. This has improved the quality of flue-cured tobacco and served to stabilize local markets. He has provided leadership to an extension program that has pioneered in bridging the gap between agronomic research and farm adoption through a program of on-farm testing and demonstrations. Over 300 on-farm tests were conducted in 1976.

He was instrumental in helping to organize the Plant Food Association of North Carolina and serves as an advisor to the Board of Directors. Through this organization, he has worked with the fertilizer industry in organizing many workshops on the use of fertilizers in crop production.

Dr. Jones has received various awards for his ability, aggressiveness, and knowledge of problems in North Carolina Agriculture. These traits won him the Outstanding Leadership Award (1972) and the Outstanding Extension Service Award (1973) for the North Carolina Agricultural Extension Service and North Carolina State University, respectively. He has also served as President of the Capital City Kiwanis Club, is a member of the American Society of Agronomy and the Crop Science Society of America, and is an Associate Editor of the AGRONOMY JOURNAL.

Guy is married to the former Margaret Weldon and they have two children, Margaret and Guy Jr.

The Soil Science Society of North Carolina is honored to present to Dr. Guy L. Jones the Achievement Award for 1976.

THE CROP PRICE OUTLOOK

W. D. Toussaint, Head
Department of Economics and Business
North Carolina State University

The making of outlook pronouncements used to be a relatively riskless proposition for agricultural economists. In the days of strict acreage allotments and other forms of production control--and the price supports that went with these controls--one could be reasonably certain about prices to be expected. Short of real catastrophies or some very unusual circumstances, market prices stayed very near the support price level. One could not be very wrong in projections during those times.

Outlook projections or predictions present rather serious difficulties today, however. In a period of unstable prices, such as we have had in the last few years, projections are particularly precarious. We have been in one of the most unstable price situations we have ever had in this country. This period of great instability in prices and production began about 1972, although some of the roots of the instability began in 1970 with the corn blight.

During this period, we have experienced record prices for grain, cattle and hogs. We have seen cattle prices plummet from the highs of just over two years ago. We have seen grain prices fall substantially, rise rapidly and fall again in recent months. Hog prices rose very high in 1973, fell dramatically in 1974 and rose to levels most of us would have thought impossible again in 1975. Poultry and egg prices also have been bouncing around throughout this entire period, although instability in poultry prices is not all that uncommon. Cotton prices, too, have been subject to wide variation. Only tobacco and peanuts (our products under production control) have had relatively stable prices. Through this entire period beginning in 1972, we have witnessed very rapid increases in food prices, something we simply were not accustomed to in this country. Since 1967 food prices have risen approximately 80 percent and this is approximately 16 percent more than the index of all prices has risen.

Today, it appears that the prices of agricultural commodities may be heading for a period of somewhat greater stability than we have seen in the last few years. It also appears that prices will be stabilized at levels somewhat below those of the last few years. Production of our major crops was at record or near record levels throughout the United States in 1975. As a general consequence, prices fell and grain consumption, particularly for livestock feeding, has increased substantially and is expected to increase even more as hog numbers increase and broiler and layer numbers continue to expand. Cattle feeding has increased approximately 25 percent and perhaps will increase even more if feed grain prices fall below their present levels.

Exports of wheat and feed grains have been at very high levels. This has been most fortunate for the American farmer. Whether exports will continue at this level in the future is dependent on world weather conditions as well as the ability of importing countries to buy our products. One of the major factors contributing to crop prices staying as high as they have this year is the big increase in exports of wheat and feed grains to Russia. Thus, I would like to take a little diversion and talk some about this particular situation as I see it.

We all know that Russia found itself with an extremely poor grain crop in 1975. Because of the increase in exports to Russia, a short moratorium was declared on exports to the Soviet Union. Eventually, an agreement was reached between our country and the Soviet Union and this agreement will take place in October of 1976. Approximately 13 million metric tons of grain already have been sold to Russia by the United States from our 1975 crop. More probably will be sold before the year is over.

Let us take a look at the effects that these sales to Russia have had on farm incomes and food prices. I will use as my source a recent study made for the Joint Economic Committee in the Congress of the United States. In my opinion, these estimates are quite reasonable. It was estimated that net farm income in this country would have been 22 percent below that of 1974 if there were no sales to Russia. Food prices would have been 8 to 9 percent above the level of January to March by the end of the year. With exports of 10 million metric tons, net farm income would increase 10 percent and food prices another 1 percent. Exports of 20 million tons of grain and 25 million bushels of soybeans would have increased farm income another 14 percent. That would have made net farm income about equal to that of 1974. Food prices would have increased another 1.4 percent. Obviously, we did not export 20 million tons of grain before the end of 1975 and net farm income was not equal to that of 1974. Many people had the belief that exports of this amount would have affected food prices much more than they actually did. Of course, this was the reason for the moratorium. How much the moratorium may have hurt exports to the Soviet Union, and thus prices to our farmers, is still open to debate. Generally, we do know that moratoria are disruptive. Even if the influence was not great at that particular time, there may be a substantial effect on future exports if such moratoria are repeated.

When discussing the outlook for prices of crops in 1976 and beyond, we must consider two opposing points of view. One view is that the world is chronically short of food, and, therefore, farm prices will continue to be quite high for a long time to come--maybe indefinitely. This particular point of view is espoused by many people. One of the leading spokesmen for this point of view is Lester Brown who was with the USDA for a number of years. He is quoted as saying that there is no way corn can go below $2.25 a bushel and wheat below $3.00 this winter or for years to come. He says that the world is in a desperate food situation and he can find no hope of technology solving the food problem in much of the world.

Opposing this view are many people. But, I believe that farm groups in particular are skeptical. My reading is that farm groups generally feel that higher supports for agricultural prices are needed now and definitely will be needed soon. This is because prices will fall so sharply, making farming unprofitable or only marginally profitable to them.

The rate at which production technology increases throughout the world, the rate at which world incomes grow, weather, and the energy situation--all will have substantial influence on where we end up relative to the two opposing positions. Before getting to the specific price projections, my general view is that agricultural prices will be somewhat below levels of the last couple of years for some time to come. This, of course, assumes that weather conditions in the United States will be as good as in 1975 or possibly even better. A very bad crop year from the weather standpoint could make crop prices move up rather sharply again in 1976. I do not expect prices to fall to anything like the levels of 1971 or previous years--at least for some time. Stocks of grain in this country and throughout the world simply are too low for this to happen very soon. Now, let us look at some specific crop projections or predictions.

Wheat

In 1975 the world wheat crop was approximately the same as for the previous year. Stocks of wheat built up in this country, however, as both domestic use and exports fell from the previous year's levels. For the 1975-1976 crop year, both domestic use and exports will increase substantially.

Even with expanded exports and domestic use, stocks of wheat will build up slightly from the low levels of the two previous years because of the record crop. U. S. prices are likely to average between $3.00 and $3.50 per bushel in 1976 if we achieve another good wheat crop in this country.

Corn and Feed Grains

Production of corn and feed grains was off sharply in 1974. Domestic use fell because of the big decrease in livestock feeding. Exports also fell slightly but stocks of feed grain at the end of the year were very low. Record crops in 1975 brought about a reduction of prices, and domestic use and exports both will increase a good deal from the previous year. If livestock feeding continues to grow and exports are at a high level, stocks will build up only moderately. On the other hand, end-of-year stocks could be more than double those of the previous year if domestic use and exports increase only moderately from the previous year. With a good crop of corn and feed grains in 1976, prices could push down near $2.25 a bushel for the 1976 crop. Most experts see a shift in planting to corn from soybeans because of the changing relative prices of these two crops.

Soybeans

Soybean stocks built up slightly in the 1974-1975 crop year and are expected to be approximately double that level at the end of the present crop year. Total disappearance of soybeans is expected to be above that of last year but below the high level of 1973-1974. Depending on how much of a shift in planting is made away from soybeans to cotton and corn, prices for soybeans in 1976 likely will be in the $4.25-$4.75 range.

Cotton

To say the least, 1975 was a disasterous year for cotton in North Carolina, in terms of the amount planted and the amount harvested. The price situation improved substantially from the low levels of early 1975 throughout the entire year. With the recovery in cotton prices, some increases in acreage is expected in the U. S. and probably in North Carolina. U. S. stocks of cotton will be down, but world stocks remain high. Cotton prices of 55 cents to 60 cents appear likely for 1976.

Peanuts

Stocks of peanuts in the U. S. are at a very high level, and government costs will be quite high for the 1975-1976 year. I have no idea what will happen in terms of a new peanut program, and the outlook in terms of price is very heavily dependent on what kind of agreement can be reached with respect to the peanut program. The situation appears to be too fluid at the moment to make any kind of prediction for 1976 or beyond.

Tobacco

The year 1975 was not a particularly good one for North Carolina flue-cured farmers. However, North Carolina farmers apparently have reasonably good expectations for 1976. The rental value of allotments seems to be substantially higher than last year in most counties, particularly in the eastern part of the state. Stocks of flue-cured tobacco still are at reasonably low levels even though exports are down somewhat from previous years.

Average prices for flue-cured tobacco almost certainly will be higher in 1976 than in 1975. An average loan rate of approximately $1.05 per pound will exist for the 1976 crop. Substantial changes in support prices by grades are likely because of the buying experience of 1975. Expectations are that support prices on bottom stalk tobacco will be decreased substantially, and there is considerable uncertainty about farmer behavior with respect to harvesting of these bottom leaves. If a large number of farmers fail to harvest the bottom leaves, overall average prices should be substantially above the average loan rate in 1976. An average price of $1.10 per pound or more is quite likely.

Summary

The last three years have been good ones for most crop farmers. We are nearing a period of greater price stability, but at lower prices than those of the last few years. With farm costs stabilizing, too, the outlook is quite good for crop producers. Yet, I do not anticipate a repeat of the 1973 and 1974 experience in the next few years.

STRATIGRAPHY AND GEOMORPHOLOGY OF SURFICIAL FORMATIONS, NEUSE DRAINAGE, COASTAL PLAIN OF NORTH CAROLINA - SIXTY YEARS AFTER L. W. STEPHENSON

R. B. Daniels and E. E. Gamble
Soil Scientists, Soil Conservation Service, USDA
and Soil Science Department, North Carolina State
University, Raleigh, North Carolina

and

Walter H. Wheeler
Professor of Geology
University of North Carolina
Chapel Hill, North Carolina

Introduction

Probably no one individual has contributed more to the ideas concerning the surficial stratigraphy and geomorphology of the Coastal Plain of North Carolina than L. W. Stephenson. His classic work published in 1912 has not been without detractors, nor have all of Stephenson's concepts been correct. Yet, nearly 65 years after publication, it still is the basic framework against which all other work should be tested. The present report is based on nearly 16 years work in the Neuse River drainage and the reader can judge for himself how important Stephenson's initial work has been.

Stratigraphy and Geomorphology

The stratigraphy and geomorphology of the Neuse drainage shows a 3-part division of the North Carolina Coastal Plain (Fig. 1). These divisions are the upper, middle, and lower (Daniels *et al.*, 1966a), and their boundaries are marked by regionally traceable scarps (Table 1). Each division of the Coastal Plain has surficial sedimentary units that can qualify as formations, but most of the middle and lower Coastal Plain units are so similar that they can be readily separated only as morphostratigraphic units, a term defined by Frye and Willman (1962). The major surface formations and morphostratigraphic units that we recognize and their correlation with the formations of earlier workers is given in Table 2.

Table 1. Major physiographic divisions of the North Carolina Coastal Plain.

Division	Altitude Maximum	Altitude Minimum	Scarps marking lower boundary
Upper	183 m	89 m	Coats (Daniels et al., 1966a) or Orangeburg (Colquhoun, 1965; Johnson and DuBar, 1964).
Middle	89 m	29 m	Surry (Daniels et al., 1966b; Flint, 1940).
Lower	29 m	Sea Level	

In the upper Coastal Plain, small areas of the Cretaceous Middendorf Formation (the Tuscaloosa Formation of earlier workers, Table 2) are exposed on the Neuse-Cape Fear divide (Fig. 2). Except for the area northwest from Fuquay these exposures are limited either to valley sides or to topographic saddles along the divide axis. The Miocene Macks Formation is exposed in some topographic saddles and along the valley sides. It is much more discontinuous in distribution than the underlying Middendorf Formation. Overlying the Macks is the Pinehurst Formation. The Pinehurst Formation is the major unit exposed on the Neuse Cape Fear Divide from the Coastal Plain - Piedmont contact to the toe of the Coats scarp. The Pinehurst Formation is the Lafayette of Stephenson (1912) and the Citronelle of Doering (1960). It is of fluvial origin (Mundorf, 1946; Fichards, 1950; Daniels et al., 1966a) and has a basal coarse sand and gravel unit grading upward into a finer textured sediment in the upper 1/3 of the section. Quartz sands and kaolinitic clays are the dominant minerals (Gamble and Daniels, 1974).

Fossils have not been found in the Pinehurst so its age must be determined from its relation to other sediments. The Macks Formation is a late Miocene

Table 2. Correlation of major surface formations, morphostratigraphic units and selected subsurface formations, Coastal Plain of North Carolina.

	Stephenson 1912	Mundorf 1946	Richards 1950	Doering 1960	DuBar & Solliday 1963	Fallaw and Wheeler 1969	Daniels et al 1966a, b, 1972, 1974	This paper Formations	This paper Morphostratigraphic units
Pleistocene	Pamlico	Pamlico	Pamlico	Pamlico	Flanner Beach	Neuse	Pamlico msu	Unnamed	Pamlico
	Chowan	Talbot	Talbot	Talbot			Talbot	Unnamed	Talbot
		Penholoway	Penholoway	Penholoway					
	Wicomico	Wicomico	Wicomico	Wicomico			Wicomico msu	Unnamed	Wicomico
					James City		Small sequence	Croatan	
Pliocene	Sunderland	Sunderland	Sunderland				Sunderland		Sunderland
	Coharie	Coharie	Coharie			?	Coharie	Unnamed	Coharie
		Brandywine	Brandywine?				Brandywine		Brandywine
			Croatan			Croatan			
	Lafayette	Unclassified	Highlevel	Citronelle			Pinehurst	Pinehurst[a]	
		High level Gravels	Gravels				?	?	
Miocene							Macks	Macks	
Cretaceous			Black Creek				Black Creek	Black Creek	
			Tuscaloosa				Tuscaloosa	Middendorf	

[a]Work in the vicinity of the Pinehurst type section (Conley, 1962) raises considerable question about the validity of the formation. But we are not ready at this time (1976) to make a final decision and therefore will continue to use the name Pinehurst provisionally.

marine deposit that may be the equivalent of the Yorktown in eastern North Carolina (Daniels et al., 1966a; Wheeler et al., in preparation). Pre-Pinehurst erosion cut channels into the Macks, but we have found no evidence of pre-Pinehurst weathering of the Macks. For this reason, it has been suggested that the Macks and Pinehurst may be closely related in time. In the absence of other evidence, the Pinehurst can only be dated as being post-Macks or post-late Miocene, probably Pliocene. Doering (1960) has suggested an early Pleistocene age for the citronell.

The interstream divides in the upper Coastal Plain are broken by numerous saddles and other topographic lows (Fig. 2). The divides are gently to sharply rounded and few nearly level areas remain. The local relief both along and across the divide axis is greater than in other areas of the Coastal Plain (Danield et al., 1970). The most extensive level areas remaining on the Neuse-Cape Fear divide are near the Coats scarp at altitudes of about 100 m. Less than 10% of the upper Coastal Plain retains significant areas of depositional or pre-Brandywine erosional surfaces (Daniels et al., 1971c). Although the sediments in the upper Coastal Plain have a long weathering history, most of the area is in erosional surfaces that are believed to be relatively young (Gamble et al., 1970a).

Middle Coastal Plain

The divides in the middle Coastal Plain have few outcrops of Cretaceous or Tertiary marine formations (Fig. 3). The sediments of the divides, and in most other areas except deeply dissected stream valleys, are the Brandywine, Coharie, and Sunderland morphostratigraphic units (msu). A morphostratigraphic unit is recognized largely on its surface form (Frye and Willman, 1962), not on the distinctiveness of its sediments. These msu's are the same as, or a slightly modified version of, the Coharie and

Sunderland Formations of Stephenson (1912). The sediments of the Brandywine, Coharie, and Sunderland msu are similar to but somewhat finer textured than the Pinehurst (Daniels and Gamble, 1974). Most areas have a coarse basal unit and an upper fine unit (ibid; Daniels et al., 1966b). Quartz sand and kaolinitic clays dominate the mineralogy (Gamble and Daniels, 1974) as in the upper Coastal Plain.

Stephenson (1921) believed the sediments of the middle Coastal Plain were marine, but later workers rejected the marine origin because there were no fossils or other features diagnostic of marine conditions (Flint, 1940; Richards, 1950; Pusey, 1960; Colquhoun, 1965). Recent workers have had conflicting evidence. DuBar et al. (1974) have abundant evidence from southern North Carolina of marine units occupying the same topographic positions as the Coharie and Sunderland msu. Daniels and Gamble (1974) and Colquhoun (1974) found more evidence of a fluvial than a marine origin for these units, although there is some scattered inconclusive evidence that part of these units may be marine (Daniels and Gamble, 1974; Daniels et al., 1971b). These apparently conflicting origins for the same msu should be expected until more regional detail can be worked out by more than one stratigrapher. We suspect that both marine and fluvial sediments occur in the middle Coastal Plain surficials.

The middle Coastal Plain sediments can be dated directly by the rare fossils of some units, and indirectly by geomorphic evidence. DuBar et al. (1974) mapped the Miocene - (?) Pliocene fossiliferous Duplin Formation in southern North Carolina in the same position as our Coharie msu. Their "Marietta unit" is in the topographic position as our Sunderland msu and they believe it to be a lagoonal - near shore marine unit of Pliocene - (?) Pleistocene age that is not appreciably younger than the Duplin. We have not found fossils within the surficial units of the middle Coastal Plain in the Neuse drainage and the ages of these sediments must be determined indirectly.

The Coats and Surry Scarps are the major bounding geomorphic features of the middle Coastal Plain and the history of these scarps must be used in dating these nonfossiliferous deposits. Johnson and DuBar (1964) and Colquhoun (1965) consider their Orangeburg scarp in North and South Carolina, roughly the equivalent of our Coats, to be a Miocene sea cliff. The Coats scarp truncates the Pinehurst and Macks Formations (Fig. 2) so it is a post-Pinehurst erosional feature. Because an erosional feature is younger than the youngest formation it cuts, the maximum age for the Coats Scarp is post-late Miocene, or probably Pliocene.

The Surry Scarp is an erosional feature that truncates the Sunderland msu (Daniels *et al.*, 1966b). It is a result of the marine transgression that preceeded deposition of the Wicomico (Flint, 1940). The Wicomico msu in South Carolina has Pleistocene fossils (Colquhoun *et al.*, 1968). Thus, the Surry Scarp probably is a Pleistocene feature and the sediments of the Sunderland msu are pre-Surry (Fig. 3). The problem in obtaining a more accurate dating is that we do not know when within the Pleistocene, early or mid, the Surry was cut. Thus, the surficial sediments of the middle Coastal Plain can range from Pliocene to early Pleistocene age and questionably to mid-Pleistocene age. Using largely geomorphic considerations, we have given our middle Coastal Plain deposits about the same age as DuBar *et al.* (1974) using fossil evidence has given the same units in southern North Carolina and northern South Carolina.

The divides of the middle Coastal Plain south of the Neuse River have large areas of level to gently undulating topography. Carolina Bays and other undrained depressions are common in the middle Coastal Plain. These broad divides areas are believed to be essentially unmodified depositional surfaces related to the underlying sediments (Daniels *et al.*, 1971c).

Lower Coastal Plain

A major change in sediments, character of landscape, and soils occur at the Surry Scarp (Daniels et al., 1966b, 1970b). To someone used to working in the middle and upper Coastal Plain, the area east of the Surry Scarp is a different world.

We map the Wicomico, Talbot, and Pamlico msu east of the Surry Scarp rather than the four formations suggested by Mundorf, Richards, and Doering (Table 2). The Wicomico msu is the highest unit. It is truncated by the Walterboro Scarp, although the inset relation shown (Fig. 4) is more inferred than proven. We do not have detailed drill traverses across the Walterboro scarp but a subsurface topographic map giving altitudes at the base of the Wicomico and Talbot msu show a sharp increase in slope at the Walterboro scarp. It is on this evidence that we are suggesting an inset relation between the admittedly similar sediment on either side of the Walterboro scarp. At the Suffolk scarp, much more detailed work has shown an inset relation between Talbot and Pamlico (Daniels et al., 1972). The Arapahoe ridge, the high part of the landscape at the Suffolk Scarp (Fig. 4), is a storm beach resting upon sediments of the Talbot msu. The sands of the Arapahoe ridge probably were deposited during the transgressive high stand of the Pamlico sea (Daniels et al., unpubl. ms.).

One of the major differences in sediments of the lower Coastal Plain is the loss of the common basal coarse - upper fine textured sequence of the upper and middle Coastal Plain sediments. Sands, silts, and clays are common in the lower Coastal Plain, but they can occur in almost any vertical and horizontal sequence. This is well illustrated at the Flanner Beach section on the Neuse estuary below New Bern (Daniels et al., 1972). Another striking difference from the higher subdivisions is the large amount of gray and, especially greenish gray, gley, colors in the surficial sediments of the lower Coastal Plain (Table 3).

Table 3. Colors of surficial sediments.

Formation or msu	Color % Yellow	Gray	Gley	Total length of drill hole Feet	Meters	Number of drill holes
Pinehurst	97	8	0	943	287	39
Brandywine msu	82	18	0	633	193	27
Coharie msu	53	44	3	1214	371	39
Sunderland msu	30	62	8	1223	373	40
Wicomico msu	30	47	23	1063	324	47
Talbot msu	9	48	43	2140	652	87
Pamlico msu	14	37	49	1078	329	60

Yellow = Chroma >3; value 4 or more in hues of 10YR or redder and values of 5 or more in hues of 5Y and 2.5Y.

Gray = Chroma of 3 or less or value 4 or less in hues of 5Y and 2.5Y.

The mineralogy of the lower Coastal Plain sediments has many similarities and differences from the mineralogy of the middle and upper Coastal Plain sediments. Heavy minerals from all subdivisions are dominated by a metamorphic suite. In the upper and middle Coastal Plain resistant minerals such as zircon, rutile, and kyanite dominate. In the lower Coastal Plain the same minerals are found but hornblende, mica, and epidote tend to dominate.

On the Neuse-Cape Fear divide, there are few feldspars found in the surficial sediments of the upper and middle Coastal Plain (Gamble and Daniels, 1974). But on the Neuse-Tar divide, abundant feldspars are found at depth in the Sunderland, Wicomico, Talbot, and Pamlico msu. Feldspars are weathered from the upper 2 m of the Sunderland (Daniels et al., 1966c), the upper 1 m of the Wicomico (Nettleton et al., 1968) and Talbot (Smith, 1970; Granger, 1970), but feldspars are common in the upper 1 m of the Pamlico sediments (Ibid).

Clay minerals of the lower Coastal Plain, and especially the less weathered parts of the Talbot and Pamlico, are montmorillonite and micas. Kaolinite is present but not dominant as it is in upper Coastal Plain sediments (Gamble and Daniels, 1974).

The sediments of the Talbot and Pamlico locally have abundant Pleistocent marine fossils, (Richards, 1950; DuBar and Solliday, 1963; Fallaw and Wheeler, 1969) but no fossils have been found in the Wicomico except locally in South Carolina (Colquhoun _et al._, 1968). Surface features interpreted as barriers, back-barrier flats and beach ridges are common in southern North Carolina (DuBar, 1971), although only a few beach ridges on the Talbot are found in the Neuse drainage (Daniels _et al._, 1972).

The Pleistocene age of the Talbot and Pamlico sediments is well established, and evidence listed by Colquhoun _et al._ (1968) in South Carolina point to a Pleistocene age for the Wicomico. The relation between the Wicomico and the Pliocene - (?) Pleistocene Croatan (Fig. 4) also suggests a Pleistocene age for the Wicomico. A question still remains about the placement of these units within the Pleistocene because the time span has not been large enough to allow sufficient biostratigraphic discrimination.

Emiliani (1969) and Emiliani and Rona (1969) show that one of the many high stands of sea level was about 122,000 years ago. Ward _et al._ (1971) and Moiner (1971) believe the high stand at about +7m (+20-25 feet), or our Pamlico, was 145,000 to 122,000 years ago. Newman and Moore (1975) stated that the 125,000 year old coarls associated with a +6m stand of sea level in the Bahamas is the equivalent of the Pamlico of the Atlantic Coast. These data for the high stand of the Pamlico sea seem to be a reasonable agreement with data from many sources and areas. They are not without controversy, however, since unpublished information from Maryland suggests the Pamlico high stand was about 30,000 years ago (Oral Communications, C. S. Denny, U. S. Geol. Survey). Beyond the 145,000-122,000 year date the age of various high stands and their altitudes become extremely speculative. Ward et al. (1971) have suggested the following dates for the high stands of sea level associated with the various msu:

msu	Approximate date
Talbot	220,000
Wicomico	300,000
Sunderland	400,000-900,000
Coharie	1,400,000
Brandywine	1,970,000

Ward et al. assumed a uniform rate of uplift in computing the ages of the various sea levels. Considerable caution must be used in accepting these dates, because their suggested ages are at odds with other stratigraphic and geomorphic evidence. This, of course, is not unusual in stratigraphic and geomorphic studies.

The lower Coastal Plain has broad level to gently undulating areas that have been changed very little since the sediments were deposited. Large pocosins occupy the central parts of these broad interstream divides and many have 1 to 2 m of organic material. The lower segment is the least dissected subdivision of the Coastal Plain Province.

Summary

The preceding summary of Coastal Plain stratigraphy in the Neuse drainage of North Carolina clearly shows how much of the basic work of L. W. Stephenson has been retained and is useful after 65 years (Table 2). His work has been modified, some of it even rejected by some workers, but it is amazing that so much of it is still useful considering the amount of time he had to work the area, the availability of topographic maps, travel conditions, near absence of drilling equipment, and scarcity of exposures that existed during his investigations. It would be interesting to know how well the work of Coastal

Plain geologists working from about 1960 to present will fit the concepts of the geologists of the year 2040.

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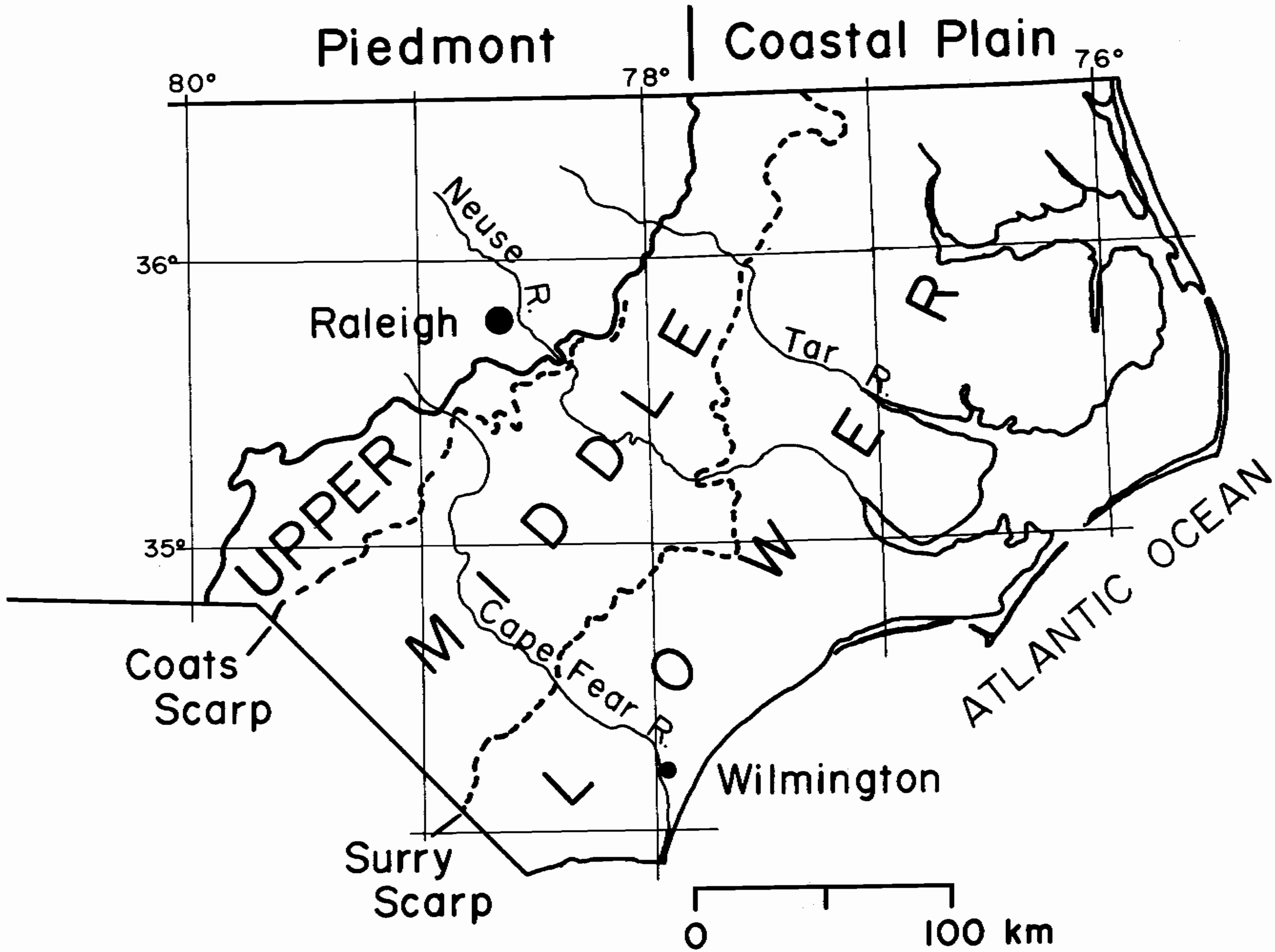
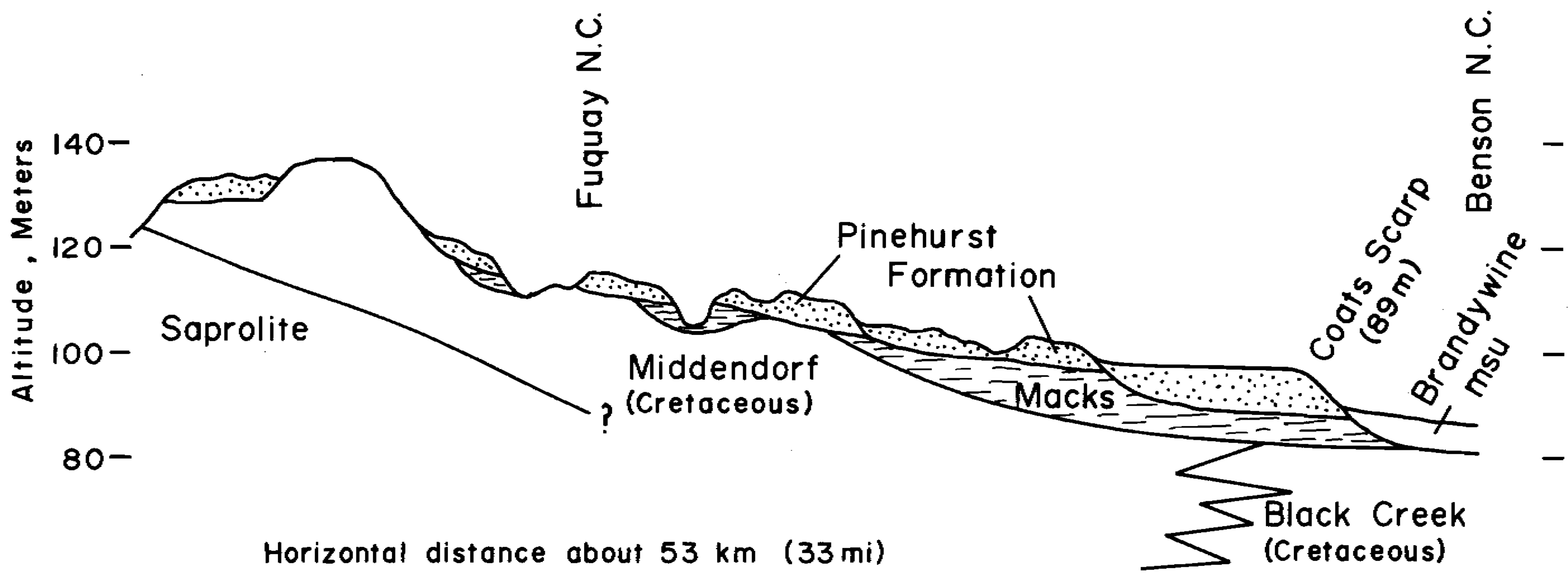
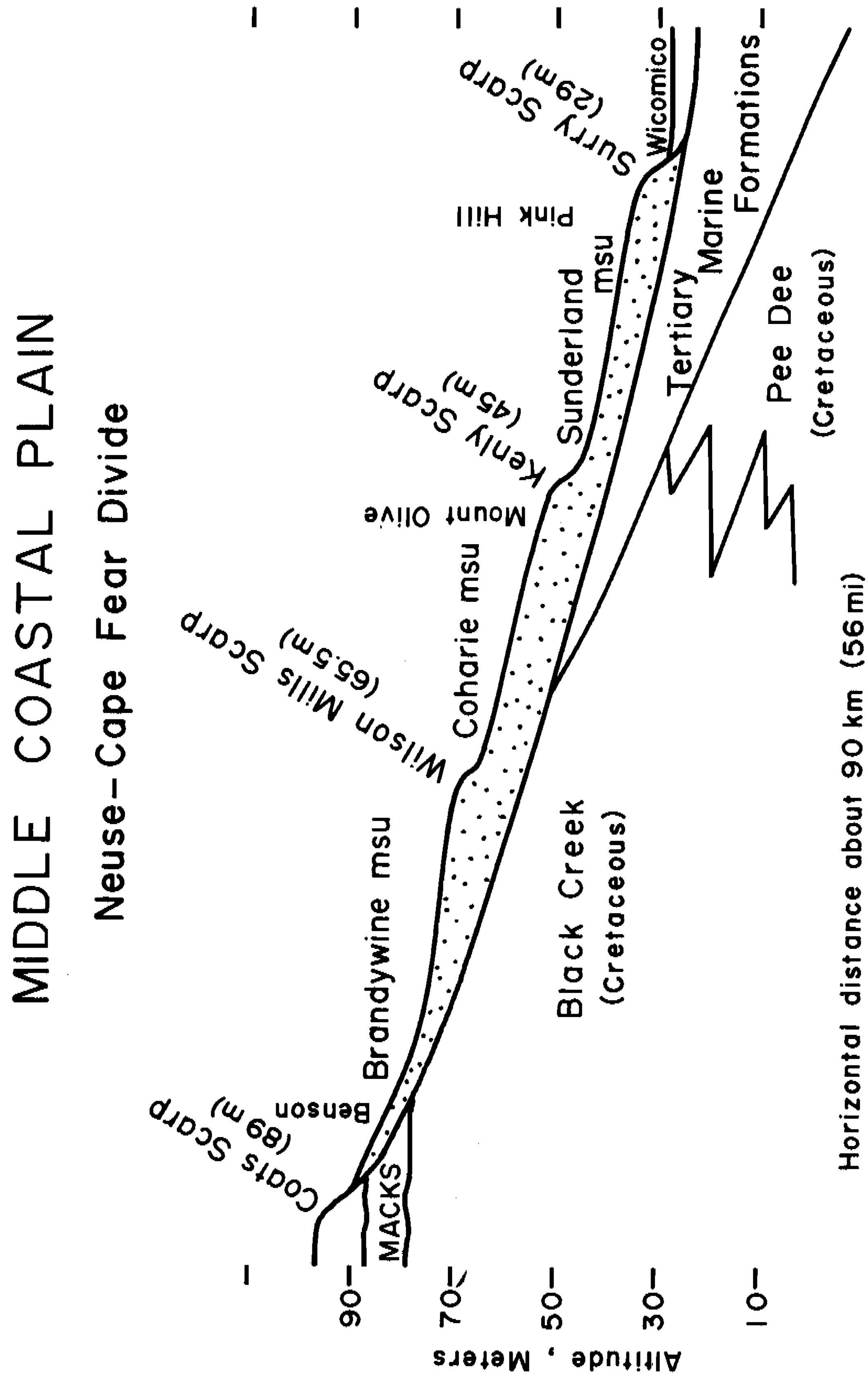
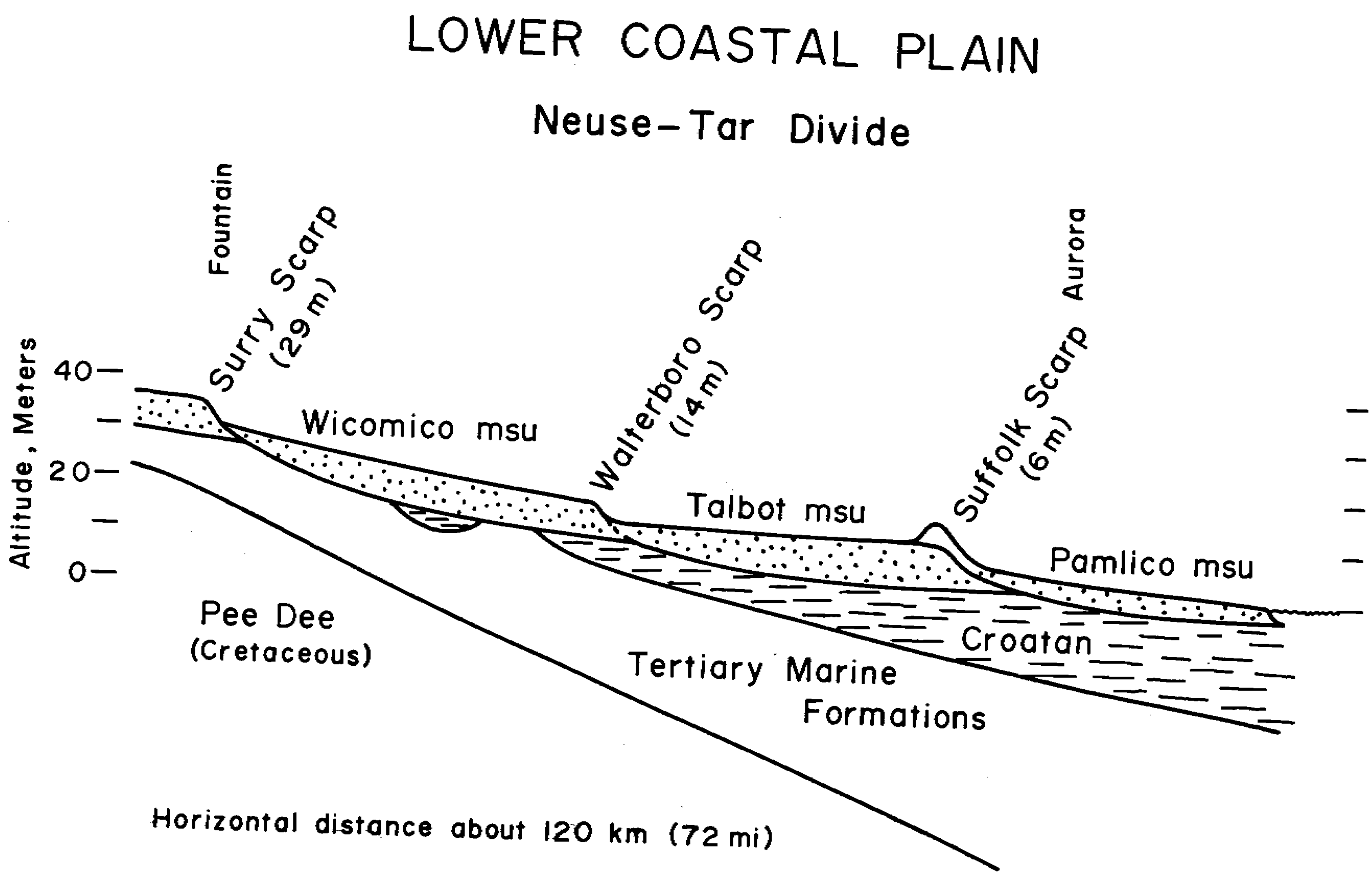

Piedmont
Coastal Plain
80°
78°
76°
36°
35°
Neuse R.
Raleigh
Tar R.
Cape Fear R.
Wilmington
UPPER
MIDDLE
LOWER
Coats Scarp
Surry Scarp
ATLANTIC OCEAN
0
100 km

UPPER COASTAL PLAIN

Neuse – Cape Fear Divide




MIDDLE COASTAL PLAIN
Neuse-Cape Fear Divide
Coats Scarp
(89m)
Benson
MACKS
Brandywine msu
Wilson Mills Scarp
(65.5m)
Coharie msu
Mount Olive
Kenly Scarp
(45m)
Sunderland
msu
Pink Hill
Surry Scarp
(29m)
Wicomico
Black Creek
(Cretaceous)
Tertiary
Marine
Formations
Pee Dee
(Cretaceous)
Horizontal distance about 90 km (56 mi)
90
70
50
30
10
Altitude, Meters


LOWER COASTAL PLAIN
Neuse-Tar Divide
Fountain
Surry Scarp
(29 m)
Walterboro Scarp
(14 m)
Suffolk Scarp
(6 m)
Aurora
Altitude, Meters
40
20
0
Wicomico msu
Talbot msu
Pamlico msu
Pee Dee
(Cretaceous)
Tertiary Marine
Formations
Croatan
Horizontal distance about 120 km (72 mi)

HARDPANS IN COASTAL PLAIN SOILS OF NORTH CAROLINA

D. K. Cassel

Department of Soil Science
North Carolina State University
Raleigh, NC 27607

Pans or "hardpans" have been identified on Atlantic Coastal Plain soils up and down the Atlantic Seaboard. The Soil Science Society of America defines a hardpan as follows:

> "a hardened soil layer, in the lower A or in the B horizon, caused by cementation of soil particles with organic matter or with materials such as silica, sesquioxides, or calcium carbonate. The hardness does not change appreciably with changes in moisture content and pieces of the hard layer do not slake in water."

Hardpans are blamed many times for reducing crop yields, especially in years having prolonged dry spells lasting two or three weeks during the latter half of the growing season. It is thought that high soil strength or mechanical impedance of the hardened layer restricts the depth of root development and consequently plants suffer from drought. On the other hand, during periods of high rainfall, pans may give rise to undesirable air-water relationships. In addition, the pan may restrict downward movement of water and give rise to lateral water transfer.

McCracken and Weed (1963) identified and described four types of pans commonly found in North Carolina Coastal Plain soils. (1) the plow pan or traffic pan occurs immediately below the plow layer and develops as a result of soil compaction caused by external pressures, such as those exerted by heavy farm machinery. (2) A coarse textured, brittle pan was identified in the lower portion of the A2 or at the A-B contact in Coastal Plain soils. This pan remains somewhat brittle even in wet conditions and is thought to be genetically formed. McCracken and Weed named such pans "arena pans." (3) A third pan, a fragipan, is described as occurring near the base of the B horizon. Daniels et al., (1966) estimated that large acreages of fragipans occurred in the North Carolina Coastal Plain but later reversed this notion (Steele et al., 1969). (4) Finally, an "organic pan" is a Bh or spodic horizon and occurs in soils such as Leon. Of the four pans described above the traffic pan is the most widespread. Although no acreage estimates are available, I believe that virtually all Coastal Plain soils having (a) sandy loam or loamy sand A horizons 25 cm or more thick and (b) which are or have been cultivated, have traffic pan development to some degree.

From my observations, neither the traffic pan nor the arena pan fall within the accepted Soil Science Society of America's definition of "hardpan" because their hardness varies strongly with water content and furthermore, they will slake to some degree in water. Nevertheless, I still refer to these two pans as hardpans.

Currently, there are two research projects in the Soil Science Department that were developed to learn about the development and management of hardpan soils. The first project, now in its second year, is the Cooperative ARS - NCSU Soybean Project and is funded in part by a grant from the Agricultural Research Service, USDA. This project is an interdisciplinary project involving microbiology, soil fertility, soil physics, entomology, agricultural engineering, nematology, plant physiology and genetics. A second project deals with the characterization of physical and chemical properties of Coastal Plain soils and began in July, 1975.

The Cooperative ARS - NCSU Soybean Project

The thrust of this project is to increase water availability to soybeans growing in hardpan soils. It is thought that exchangeable aluminum in the subsoil or mechanical impedance offered by the traffic and/or arena pans or a combination of these two factors limit root growth. Several soil management practices were devised to test this hypothesis. Each of the treatments, except for the control, was designed in an attempt to deepen the rooting zone. The five soil management practices deal specifically with the method of land preparation preceding planting; the five treatments are listed below:

1. Normal (plow, 2 or 3 discing, harrow, plant)
2. Chisel plow (plow, chisel plow, plant)
3. Subsoil and bedding (plow, subsoil and bed, plant)
4. Bedding (plow, bed, plant)
5. Chisel plow (identical to treatment 2 except lime was incorporated to 10 inches during Spring, 1974)

No traffic other than spraying for insect control is allowed on any of the five treatments after planting.

In order to collect information regarding pan hardness or mechanical imepdance a penetrometer was designed and constructed in the Department of Biological and Agricultural Engineering. The penetrometer, a steel rod with a bullet shaped tip, is forced vertically downward into the soil at a constant rate to a depth of 41 cm. The pressure required to force the rod downward into the soil is monitored continuously by a strip chart recorder. With this apparatus, then, pressure versus depth information at any given point in the field may be obtained at any time during the growing season.

In the present experiment, penetrometer readings were taken at seven positions, each 15 cm apart, in a transverse normal to the soybean row. These data were used to assess the variability (or uniformity) of mechanical impedance in a large portion of the soybean rooting zone. Mechanical impedance changes within a given plot were followed by taking penetrometer measurements periodically. Sufficient data were collected to compare mechanical impedance between the various treatments.

Figure 1 shows the maximum penetrometer readings (kg/cm^2) in the 0 - 14 cm depth for June 13 and June 27, 1975, at 7 positions on the transect normal to the row. Each datum is the mean of 16 measurements. On June 13, the penetrometer resistance for the normal treatment was approximately uniform across the transect and was 20 kg/cm^2. The penetrometer reading for the chisel plow treatment was also approximately uniform across the transect but was only about 6 kg/cm^2. Penetrometer readings for the subsoiled treatment reached a minimum of 6 kg/cm^2 near the row and increased on either side of the row. The water content P_w (percent by weight) in the 0 - 14 cm depth for the midrow (M) and in the row (R) is shown above the curves. N, S and C stand for normal, subsoil plus bedding and chisel plow, respectively. Similar data are shown for June 27 when the soil was drier. The chisel plow treatment was the most effective implement for reducing mechanical impedance in the 0 - 14 cm depth.

At the 28 - 41 cm depth (Figure 2) the subsoil treatment is clearly the superior treatment in reducing mechanical impedance in the row. The 28 cm depth is below the depth of influence of the chisel plow. Within the 28 - 41 cm depth the mechanical impedance is about twice as great in the soybean row for the normal and chiseled plow treatments when compared with the subsoiled treatment.

Figure 3 presents isopiestic (equal pressure) curves for the same three treatments for June 13 and 27. The soil was drier on June 27 than on June 13 as shown in the table inserts in Figures 2 and 1, respectively. Consequently, the measured mechanical impedance on June 27 was greater for each treatment at a given depth than those measured on June 13. On June 27 the normal treatment was so hard that the penetrometer in most cases did not penetrate the soil below a depth of 10 to 15 cm. This zone is represented by hatched marks in Figure 3.

I believe that the pan which shows up in the normal treatment in Figure 3 was induced as a result of disking and plowing and that the subsoiling and chiseling operations were successful in destroying much of this induced pan.

Characterization of Physical and Chemical Soil Properties of Coastal Plain Soils

One aspect of this research deals with characterization of hardpans in Coastal Plain soils. Eight soil profiles have been described on or near the Sandhills Experiment Station near Jackson Springs, North Carolina. Hardpans were detected with the aid of a pocket penetrometer in seven of these eight profiles. Pans occurred by past tillage operations. Several of the sites have been planted to trees for the last 30 to 40 years, as determined by wood borings, but the traffic pans still persist. Site F, a virgin soil, was also wooded, but no traffic pan was found. Mechanical impedance increased at the 38 cm depth due to a change in soil texture (Table 1). Tree roots thoroughly permeated the upper 38 cm of soil at Site F whereas at Site E, which was located within 75 meters of Site F, the tree roots grew downward until, at the base of the Ap layer, they grew horizontally; very few roots were observed below the Ap at Site E. Rate of tree growth as estimated from the width of annual rings was 3 to 4 times greater at Site E compared with Site F.

Summary

Several laboratory and field experiments are currently being conducted to elucidate the physical and chemical conditions necessary for pan information. Methods for alleviating the hardpan conditions are

also being studied. It appears, however, that tillage when the soil is too wet is an extremely important factor in inducing the formation of traffic pans on Coastal Plain soils.

Table 1. Penetrometer data and soil water content for soil profiles under forest cover. Site E was formed about 40 years ago. Site F occurs 70 m away on virgin land.

	Horizon	Depth	Penetrometer Reading	P_w
		(cm)	(kg/cm^2)	(% by wt)
Site E	Ap1	0-18	0.3	3.6
	Ap2	18-30	1.6	4.2
	A2	30-51	1.5	4.5
Site F	A1	0- 8	0.3	12.9
	A21	8-15	0.6	6.2
	A22	15-36	0.7	5.2
	B2	36-71	1.8	9.9

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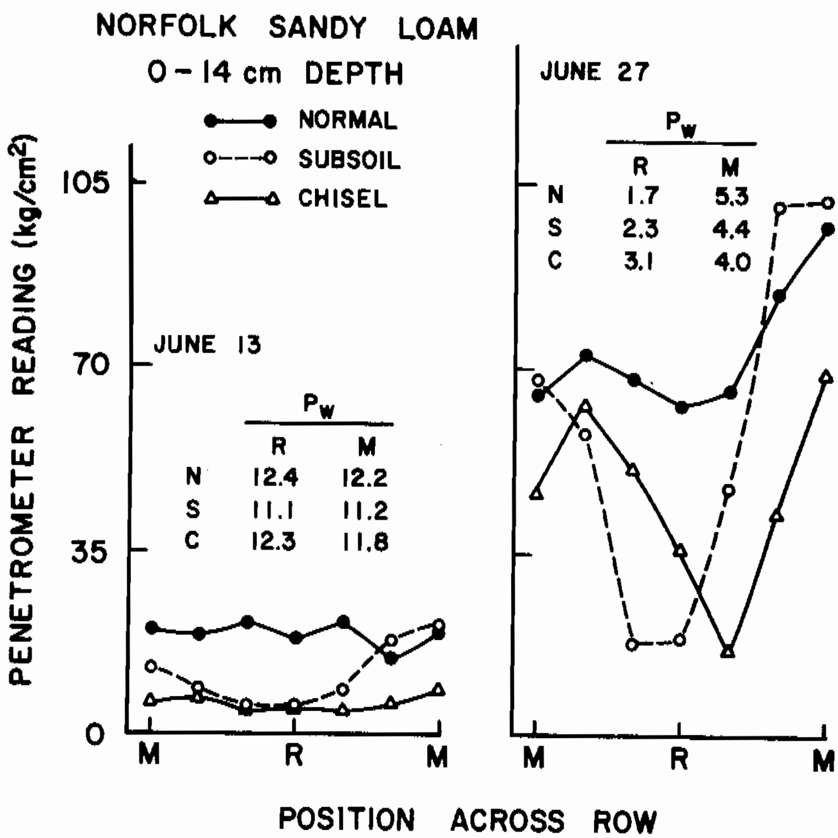

Figure 1. Maximum penetrometer readings (kg/cm^2) in the o-14 cm depth of Norfolk sandy loam at 7 positions normal to a soybean row for 3 methods of land preparation.

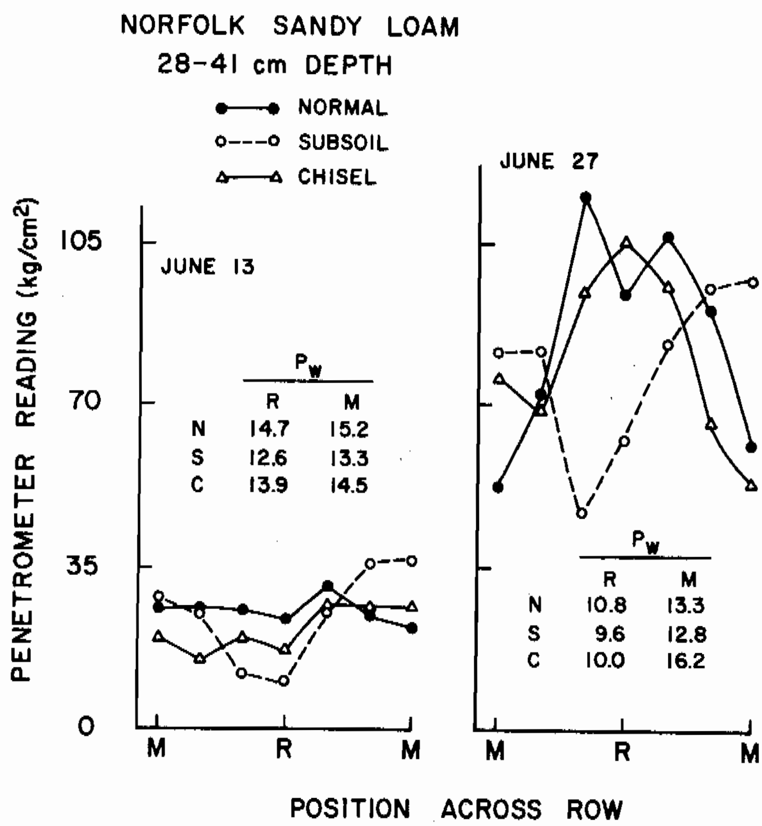

Figure 2. Maximum penetrometer readings (kg/cm^2) in the 28-41 cm depth at 7 positions normal to a soybean row for three methods of land preparation.

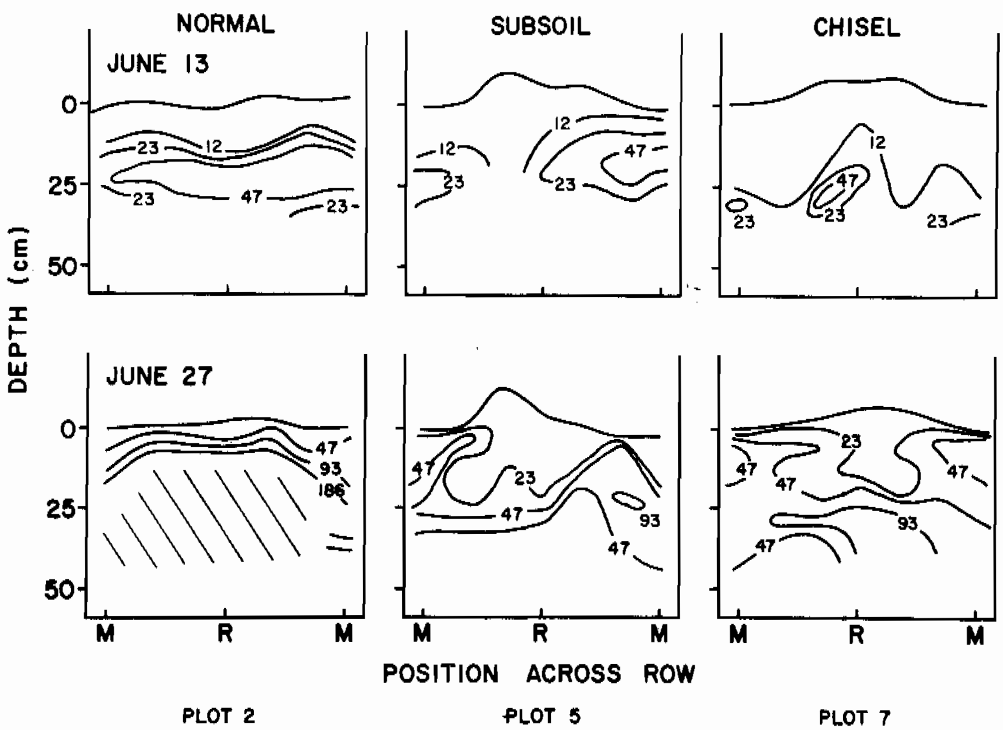

Figure 3. Isopiestic curves of penetrometer resistance (kg/cm^2) for the normal, subsoil, and chisel treatments on June 13 and June 27.

SOIL-LAND USE INTERPRETATIONS

H. J. Kleiss
Department of Soil Science
North Carolina State University

Introduction

Many sectors of the public are now demanding soil information for land management decisions. This has prompted a reevaluation of the type and nature of soil data provided in our National Cooperative Soil Survey Program. My goal in this discussion is to briefly review the relationship of soil classification to soil use evaluation and to reconsider the type of soil interpretations that are commonly provided in soil survey reports.

Soil Survey and Classification

Soil survey is a means for defining the spatial variability of soils on the landscape. A soil survey program has three basic components: soil mapping, soil classification, and soil interpretation. Mapping units, which are delimited on maps of various scales, are geographically defined so as to characterize a specific segment or area of the landscape. The mapping unit descriptions provide definition for the landform position or spatial characteristics of the map unit. The classification criteria for the given class provide defined physical and chemical characteristics of the soils in the delimited area. This combination forms the basis for our geographical soil information or "land characteristics." Within the framework of soil classification and with reference to defined soil distribution on maps, soil survey interpretations provide evaluations of soil quality or behavior for specific purposes.

The system of soil classification used by the National Cooperative Soil Survey Program in the United States is called Soil Taxonomy. It provides a "natural classification" of soils, as well as the framework for soil interpretations. The soil classifier groups soils on as many unique natural soil properties as possible. Each soil is classified at several levels of detail from the broad Order level to the narrowly defined Series level (Figure 1). Relationships among soils are identified within Soil Taxonomy, without direct concern for a specific soil use or objective. The soil classifier (or taxonomist) considers all soil characteristics and selects those attributes which are most associated as the characteristics to define and separate taxonomic classes.

As depicted on Figure 2, the soil scientist, in the course of a soil survey, divides the landscape-soil continuum into a large number of specifically defined soil units. He integrates both the formal taxonomic criteria with characteristic spatial parameters to form soil map units and produces a soil map.

Users of Soil Information

A variety of potential user groups in search of soil information or land information turn to these soil maps to satisfy a multitude of needs. These seekers of soil information may be classed in one of two broad categories. Users may be concerned with a specific area and require information on soil properties related to specific uses such as highway construction, septic tank filter fields, or production of some intensive crop. This user has a narrow view (Figure 3). He is concerned with a specific site and has fairly narrowly defined technical needs or problems. His perspective includes one project and few soils or soil map units.

The other user category includes those concerned with more extensive land management. For instance, the urban or regional planner must address a number of types of development (land uses) over a larger land area and thus must consider many soils. This user takes a broad view (Figure 4) of the soil survey.

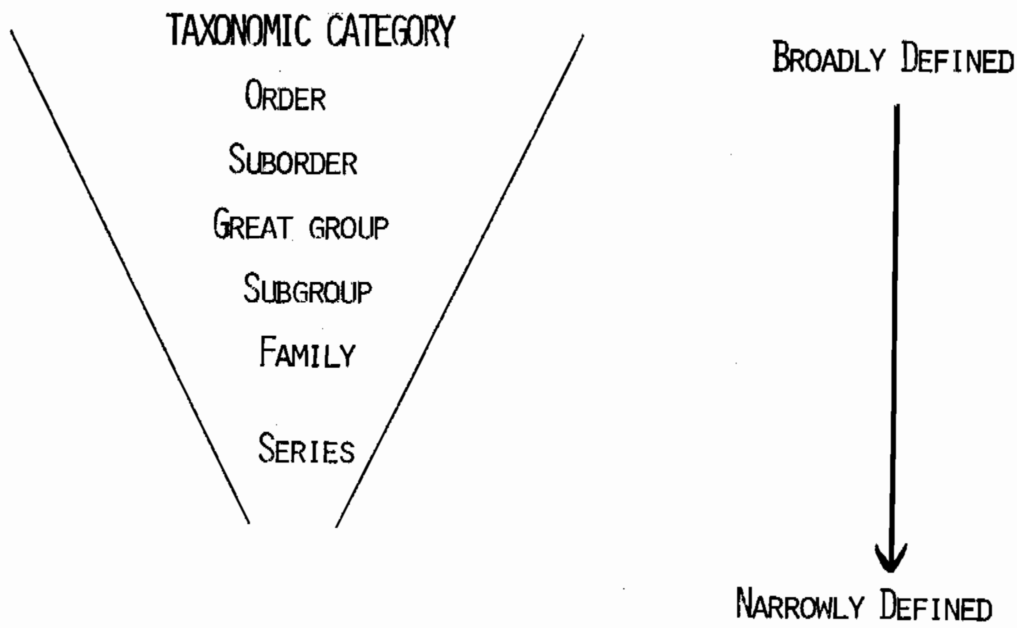

Figure 1: Schematic of Taxonomic Refinement

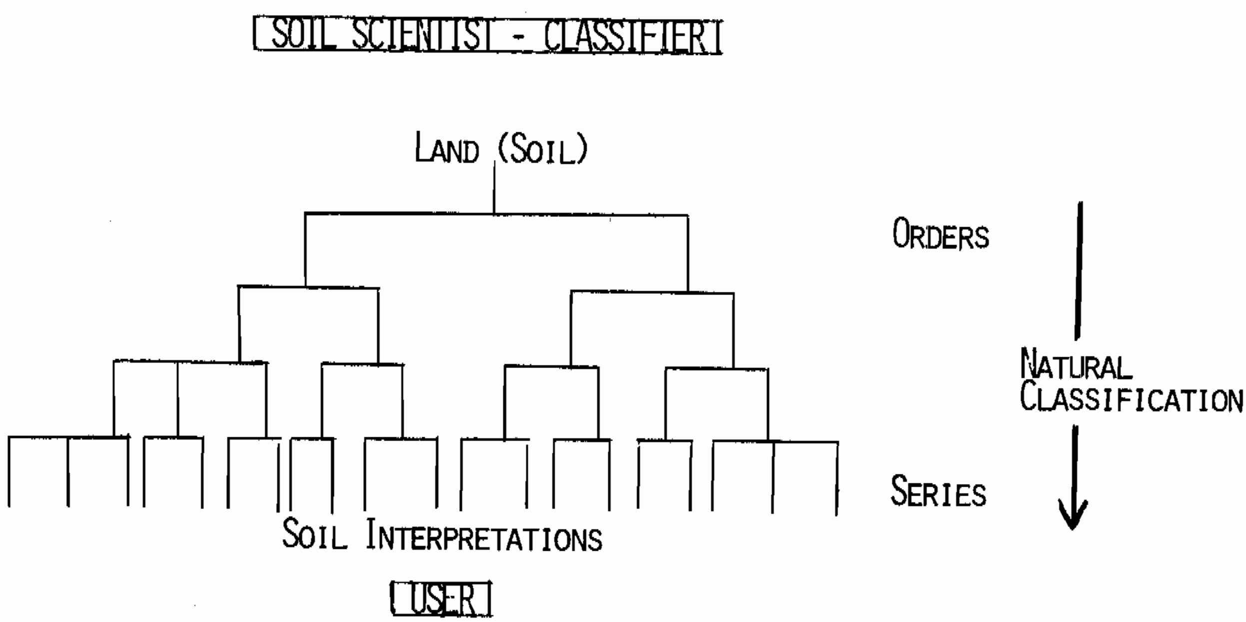

Figure 2: Relationship of Soil Classification to Soil Use Interpretations

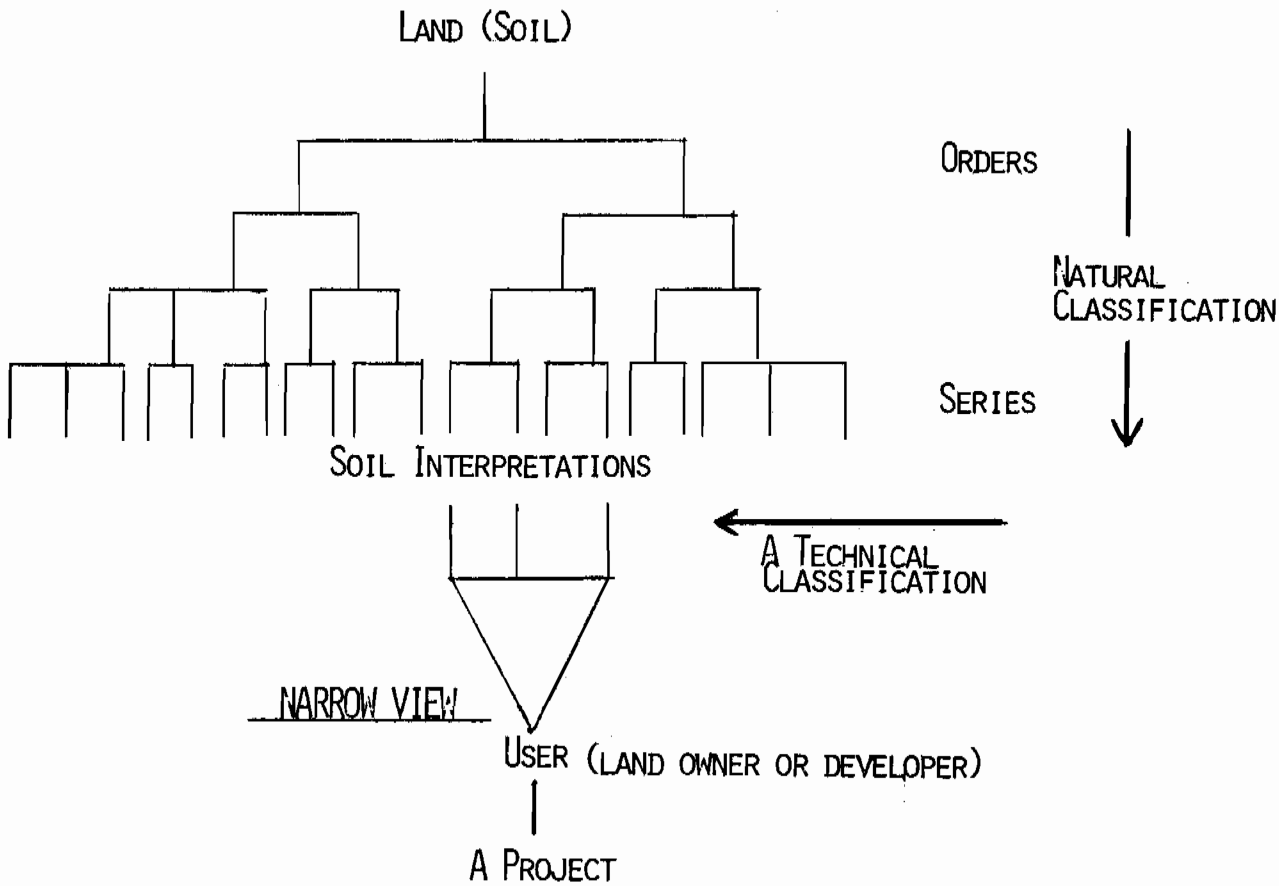

Figure 3: View of Soil Interpretations for a Specific Land Use

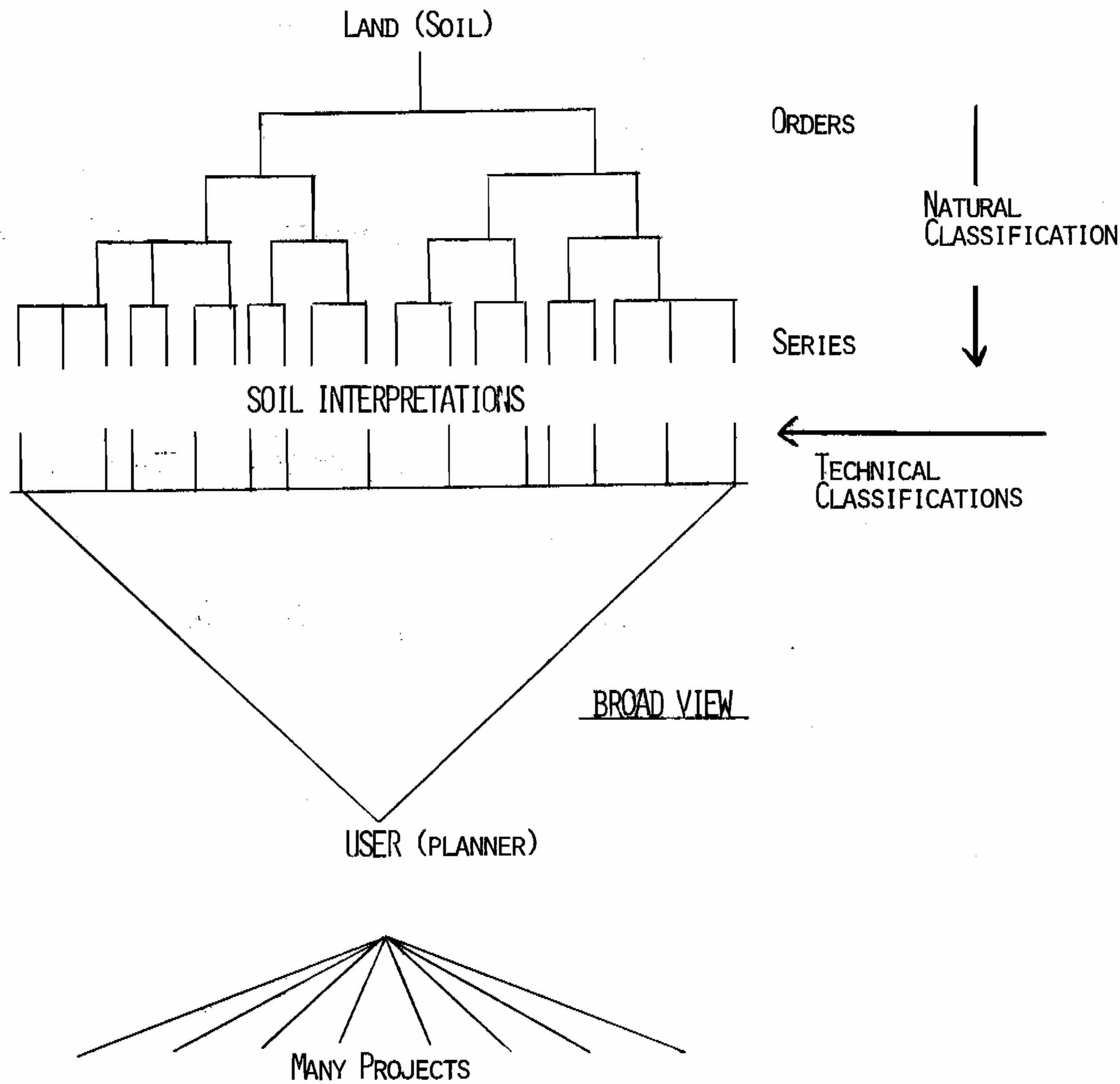

Figure 4: View of Soil Interpretations for Multiple Land Uses

These technical demands of varying types and intensities which are made on the soil survey information create a need for specific technical or single purpose classifications. The process of bridging the interface between natural and specific use technical classifications is what is encompassed by soil interpretations. Soil interpretations relate the soil information known to soil scientists to specific land use evaluations. The conversion from natural to technical soil classification involves the integrated efforts of the soil scientists and experts for each particular land use activity for which soil interpretations are formulated. These include engineers, wildlife biologists, foresters, crop production specialists, and others.

Types of Soil Interpretations

The technical groupings or ratings resulting from this interpretive process have taken two basic forms which can be considered broadly as either a positive approach or a negative approach. The positive interpretations have typically taken the form of capability or suitability ratings. Land capability classes, which have been used for many years in farm conservation planning, are the most common example of this type of interpretation approach. The interpretations are positive in terms of relating soil properties to the <u>potential</u> or <u>capability</u> for particular cropping practices. Similarly, the woodland suitability or wildlife suitability ratings provide information on potential productivity of various species on given soils. Estimates of crop or pasture yields are formulated by mapping unit.

I tend to think of these kinds of interpretations as "positive" or as giving "soil potentials." This positive approach includes actual management considerations. The woodland suitability soil groups, for example, include evaluation of erosion hazard, equipment restrictions, seedling mortality, windthrow hazard, etc.

On the other hand, most of the non-agricultural or non-plant growth related interpretations use a negative or limitation connotation. Soil interpretations for foundations, streets, landfills, absorption fields, etc., have been largely through the identification of the degree and kind of soil limitation for the particular land use. For example, a soil map unit of White Store sandy loam, on 2 to 6% slopes has a severe soil limitation for homesites due to high shrink swell potential. Cecil sandy loam on 2 to 6% slopes has a moderate limitation for septic tank absorption fields due to limited permeability. I perceive the slight, moderate, or severe soil limitation ratings as negative interpretations. Rather than relating soil potential, these interpretations cite the unfavorable aspects of soils for a given use. They tend to indicate what should not be done rather than what can be done with a given soil unit.

There are some reasons for not taking the positive or suitability approach with the soil interpretations for these intensive land uses. The overall suitability of a site for many of the engineering uses is determined by things other than the nature of the soil, and variable design can overcome certain soil limitations. In addition, there is a lack of extensive data about the performance and cost of potential practices for overcoming soil limitations in specific soils or on specific map units. Not withstanding these problems, I would like to pursue the idea of soil potential a little further.

Soil Potentials

We can define soil potential as the ability of a soil to produce, yield, or support a given activity or structure at a cost expressed in economic, social, or environmental units of value. In determining soil potential we must identify the practices needed to overcome limitations and determine the initial and maintenance costs involved. We have done this for agricultural land use by formulating management alternatives such as contouring, strip-cropping or terracing to overcome erosion hazards, and the use of crop rotations and fertilizers to overcome physical or chemical soil limitations.

This positive or soil potential approach involves a shift in the equilibrium of the interface between soil survey-classification and the user, in the direction of the user. This interface, as depicted in Figure 3 or 4, is pushing the role of the soil scientist more into the decision making process of the user. Positive soil interpretations or recommendations involve relatively specific management suggestions. Due to the agricultural background and orientation of the soil survey program, this involvement in management with the agricultural sector is natural and indeed reason for early soil activity.

In recent years the rapid increase in demand for soil information from the non-agricultural users has created a similar shift in the interface equilibrium between survey and interpretations, toward soil management decisions of this user group. This shift has perhaps been somewhat less comfortable and more demanding due to the intensity of some of the non-agricultural soil information requirements. The response to these demands in terms of what I have called "negative soil interpretations" that is, limitation ratings or "can't do" evaluations rather than capability or potential "can do" evaluations, may have been a reflection of the lack of experience of the agriculturally based soil scientist in dealing with many of the so-called engineering interpretations.

The need for a more positive or soil potential approach to many of these kinds of interpretations is greatest for the "broad view" user of soil information (Figure 4). More specifically it is the urban and regional planners that desire comparative data or evaluations over relatively large areas encompassing many soils and many kinds of alternative land uses. Providing soil use interpretations to these users only in terms of limitations does not in many cases provide a sufficient soil data base for effectively evaluating what can be done in a given soil area.

As is the case in our assessment of soil potential for agricultural uses, it is necessary to identify the practices that might be used to overcome the soil limitations for a given land use. We are continuously increasing the data base on available practices that can be used to overcome soil limitations for non-farm land uses. For example, relatively simple variations in foundation design including the floating slab or steel-reinforced concrete can be used to overcome high shrink-swell potential in soils where we would normally indicate severe limitations in our soil interpretations. Innovative designs for septic tank absorption systems such as the mound system, variation of trench depth, or the use of perimeter drains around absorption fields can improve the function of septic tank systems on some slowly permeable soils or soils with seasonally high water tables. These practices alter the soil potential for certain land uses which heretofore had been given the "red light" by severe limitation ratings.

By following the identification of soil limitations with a consideration of the requirements for overcoming these limitations, the soils of a given area could be more effectively ranked as to suitability for a given land use. This would provide an added element of quantification that our soil interpretations need and would increase the utility of soil information in planning. The discussion of modifying factors which may change soil ratings for septic tank suitability, now included in the rules and regulations promulgated for the Ground Absorption Sewage Disposal System Act, is one step in the direction of considering more of the actual soil potential rather than only its limitations. For example, the lowering of the water table can improve the suitability classification where soil drainage would normally indicate a soil was unsuitable for an absorption field. The use of a shallow trench system can increase the potential for a soil with a depth restriction.

To appropriately weigh all the alternative land uses the full array of management practices to overcome limitations would have to be identified. The range of practices will vary with time and locality. New technology will continue to change soil potential for various uses. In some areas nearly all the soils may have severe ratings for some kinds of urban development. If a community in this situation is to survive, ways to overcome these limitations and in fact change the potential soil use will be developed. This has been the case in some parts of the country.

The greatest opportunity for developing effective soil potentials is at the local level, where soil scientists actively engaged in county soil survey programs are in close contact with user groups and are familiar with specific soil problems and the attempts being made to overcome them. Development of management alternatives with broad regional or interstate applicability are likely to be less meaningful. Useful soil potentials must be closely related to the specific land use alternatives which are in competition at the city or county level. Meaningful soil potentials will be integrated with the local goals and objectives that are guiding land use decisions.

Summary

Development of an effective array of soil potentials which involves a shift in the soil scientist's position at the classification-interpretation interface will require the further coordination with engineers, sanitarians, biologists, and related professions. The soil potential concept of soil interpretations would provide land planners with a more positive approach to making land use decisions. This approach, which has been called edaphic planning, should make more effective use of the soil survey information which we strive so hard to produce and perfect.

THE NORTH CAROLINA STATE UNIVERSITY
INTERNATIONAL SOILS RESEARCH PROGRAM

Pedro A. Sanchez
Department of Soil Science
North Carolina State University
Raleigh, NC 27607

The Soil Science Department, since its inception, has been involved in studies of soils in tropical areas. These activities have a service objective, to help increase world food production through improved soil management in less developed countries. They also have a selfish institutional objective of strengthening the teaching, research and extension capability for the benefit of the State by widening the knowledge of soils by the faculty and by introducing new concepts or practices developed in the tropics to North Carolina farmers. The striking similarity in physical and chemical properties between major soils of the interior of South America and North Carolina provides for a two-way transfer of information.

The results of a 5-year federally sponsored research program are presented for two major underdeveloped regions: the savannas of Central Brazil and the Amazon Jungle. Other research is conducted in Central America and extrapolation studies via soil characterization, economic interpretation and the development of a fertility-capability soil classification system.

The Cerrado of Brazil constitutes the largest continuous savanna area in the American tropics. The vast majority of the Cerrado is covered by highly weathered Oxisols with marked wet and dry seasons. The different forms of native vegetation are associated with differences in soil fertility parameters. The soils are uniformly and extremely low in bases, phosphorus, and some micronutrients. They are high in aluminum saturation and fix high amounts of phosphorus in clayey areas. They are deep, well drained and have excellent structural properties.

Erratic rainfall distribution during the rainy season, combined with limited soil moisture storage in spite of high clay contents and a restricted rooting depth due to aluminum toxicity, makes moisture a major limiting factor. The major management problems involve both moisture and fertility considerations. Results have shown the yield benefits of deeper lime incorporation due to deeper water extraction. Residual studies over several corn crops indicate the effectiveness of an initial broadcast followed by banded phosphorus applications. Using rock phosphates of high reactivity without liming appears to be a promising alternative. The addition of moderate quantities of lime, calcium silicate and/or phosphorus results in a significant increase in cation retention of these soils. Studies have been conducted with nitrogen and zinc. A strong initial and residual response to small zinc applications was found.

Short-term droughts during the rainy season severely affect the growth and yield of crops. The probability of the number and duration of droughts and the growth data indicate that over the long run dry spells limit corn yields during the rainy season to 54% of maximum yields. The low available moisture of these clayey Oxisols compounds the problem even further. There is a good possibility of irrigating 5 to 10% of the area around Brasilia throughout the year with gravity systems from rivers and springs.

Varietal differences in tolerating high levels of exchangeable aluminum and low levels of available phosphorus have been shown. Tolerance to these factors appears to be associated with the plant's ability to absorb and translocate phosphorus in the presence of high levels of aluminum. Differences observed in nutrient culture solution have been confirmed in the field.

In the Amazon Jungle of Peru, Ultisols very similar to those of the Coastal Plain of North Carolina predominate. The experiment station is located in Yurimaguas, where the present form of agriculture is shifting cultivation. Due to population pressures, the purpose of this project is to develop soil management practices for continuous cropping within the economic constraints of the area, particularly poor communications and high transportation costs.

A comparison of the manual slash-and-burn land clearing method with bulldozer clearing showed the former method to be overwhelmingly superior because it improved soil chemical properties through additions of ash. Bulldozing these Ultisols with sandy topsoils caused severe soil compaction similar to that observed in eastern North Carolina. Yields of rice, corn, cassava, soybeans and pastures were severely reduced in the bulldozed clearings.

Without fertilizers and lime, crop yields decline very fast. With modest applications of about 50 kg/ha each of N and K per crop, and initial applications of 50 kg P/ha and 4 tons/ha of lime, three crops per year (rice-corn-soybeans) can be grown with average grain yields of 40 to 60 bu/A each. A farm management system consists of putting most of the land in grass-legume pastures for beef cattle production and part on intensive production of food crops grown in intercropped systems.

A multiple cropping combination permitted the harvest of four crops in 9 months in a single field. The gross market value was 40% higher than if the crops were grown in monocultures, because of a positive interaction in intercropping systems. Preliminary work on corn-soybean intercropping in Plymouth, North Carolina shows that 40% more grain was produced in an intercropped acre than in two half-acres of pure corn and soybeans.

APPENDICES

MINUTES

OF THE NINETEENTH ANNUAL SESSION
SOIL SCIENCE SOCIETY OF NORTH CAROLINA

January 28-29, 1976

The Nineteenth Annual Session of the Soil Science Society of North Carolina was held January 28-29, 1976 at the North Carolina State University Faculty Club, Raleigh, NC. Registration began at 8:30 a.m., January 28, and the meeting was called to order at 9:45 by President-Elect R. E. McCollum.

The annual business session for the Society was called to order at 1:30 p.m. by President-Elect R. E. McCollum. The minutes of the last meeting were read by Dr. McCollum and were approved and adopted as printed in the 1975 Proceedings. Dr. McCollum gave the President's report which summarized a survey on how to make the Society's meetings more interesting to a wider segment of people. One hundred replies were recieved from 300 questionnaires. Those surveyed included past Society members, Soil Conservation Service personnel and Plant Food Association members. A majority of opinions from those responding indicated that the Society should continue this type and length of meeting; the meeting should be scheduled on dates adjacent to the North Carolina Plant Food Association Winter Meeting; the content of the program did not duplicate information available elsewhere; the content of the program appealed to a wide segment of people; the program was not overloaded with University personnel; timeliness of topics was good; the Society should continue to function.

John Reeves gave the treasurer's report which stated that as of the auditors report on January 26, 1976 the Society had $761.10 in the bank. Dr. F. R. Cox read the auditors report which stated that the books were in acceptable order.

Old Business

Mr. Bob Kirby reported on the progress of a bill to provide for the registration of soil scientists. A draft of the bill will be presented to the North Carolina legislature and will probably be acted upon in the forthcoming session. A copy was provided for the Proceedings.

Mr. Louis Aull reported on the accomplishments of the North Carolina State Soils Judging Team which has been supported by the Society. The NC State team ranked fifth out of ten in the southeastern regional contest in the Fall of 1975 and fifth out of nineteen in the 1975 national contest. The Society voted to again support the activities of the NC State Soil Judging Team with one hundred dollars.

New Business

None.

Dr. Charles Sopher read the results of the Nominating Committee and the election was held. The new President-Elect was Bobby Carlile and the new member of the Executive Committee was James Ware.

The meeting adjourned to a tour of the North Carolina Department of Agriculture Agronomic Division Laboratory.

The following items are submitted as part of the minutes of the 1976 Society meeting: (1) bill to provide for the registration of soil scientists; (2) report of the Auditing Committee, January 26, 1976; (3) memberships of Standing Committees of the Soil Science Society of North Carolina; (4) program of the January 28-29, 1976 Annual Meeting of the Soil Science Society of North Carolina

Respectfully submitted,

John H. Reeves, Secretary-Treasurer
Soil Science Society of North Carolina

A BILL TO BE ENTITLED

AN ACT TO PROVIDE FOR THE REGISTRATION OF SOIL SCIENTISTS; TO PROHIBIT THE USE OF THE TITLE "SOIL SCIENTIST" EXCEPT BY PERSONS DULY REGISTERED; TO CREATE THE NORTH CAROLINA BOARD OF REGISTRATION FOR SOIL SCIENTISTS AND TO PRESCRIBE ITS POWERS AND DUTIES.

THE GENERAL ASSEMBLY OF NORTH CAROLINA ENACTS:

SECTION 1. General provisions. (a) No person shall in connection with his name, or otherwise, assume, use or advertise any title or description tending to convey, directly or indirectly, the impression that he is a registered soil scientist as hereinafter provided.

(b) On and after __________ it shall be unlawful for any person, partnership, association, or corporation in this state to use the title "Soil Scientist" or to advertise as such without first obtaining a certificate of registration issued by the North Carolina Board of Registration for Soil Scientists under the provisions of this chapter.

SECTION 2. DEFINITIONS. As used in this act unless a different meaning clearly appears from the context:

(a) "Soil Scientist" or "Professional Soil Scientist" shall mean a person who by reason of his special Knowledge of the physical, chemical and biological sciences applicable to soils as natural bodies and of the methods and principles of soil classification as acquired by soils education and soil classification experience in the formation, morphology, description and mapping of soils is qualified to practice soil science and who has been duly registered by the North Carolina Board of Registration for Soil Scientists.

(b) "Soil-Scientist-In-Training" shall mean a person who complies with the requirements for education and character and who has passed an examination in the fundamental soil and related subjects as provided for in this act.

(c) "Soil" is all of the groups of natural bodies occupying the unconsolidated portion of the earth's surface capable of supporting plant life and having properties due to the combined effect of climate and living organisms as modified by topography and time, upon parent materials.

(d) "King of Soil" is a group of natural bodies that has a discrete combination of landscape, morphological, chemical and physical properties.

(e) "Soil Mapping" is plotting the boundaries, describing and evaluating the kinds of soil as to their behavior and response to management under the various uses.

(f) "Practive of Soil Science" and "Practive of Professional Soil Science" shall mean any service or work the adequate performance of which requires education in the physical, chemical, biological and soil sciences, training and experience in the application of special knowledge of these sciences to soil classification, the soil classification by accepted principles and methods, investigation, evaluation and consultation on the effect of measures, observed and inferred soil properties upon the various uses, the preparation of soil descriptions, maps and reports and interpretive drawings, maps and reports of soil properties and the effect of soil properties upon the various uses, and the effect of the various uses upon kinds of soil, any of which embraces such service or work either public or private incidental to the practice of soil science.

A person shall be construed to practice or offer to practice soil science within the meaning and intent of this act who by verbal claim, sign, advertisement, letterhead, card or use of some other title represents himself to be a soil scientist, but shall not mean or include the practice of soil science by a person exempt under the provisions of this act, nor the work ordinarily performed by persons who sample and test soil for fertility status or construction on materials and engineering surveys and surroundings to determine soil properties influencing the design and construction of engineering and architectural projects. Notwithstanding the foregoing provisions, a person shall not be construed to practice soil science unless he offers soil science services to or performs such soil science for the public.

(g) "Board" shall mean the North Carolina Board of Registration for Soil Scientists.

SECTION 3. NORTH CAROLINA BOARD OF REGISTRATION FOR SOIL SCIENTISTS; APPOINTMENT OF MEMBERS; TERMS.

(a) The North Carolina Board of Registration for Soil Scientists is hereby created and assigned the duty to administer the provisions of this act. The Board shall consist of five members appointed by the Governor. One member shall be appointed at large and four members shall be duly practicing registered soil scientists. The practicing registered soil scientists shall be appointed from a list of persons recommended and nominated by the Soil Science Society of North Carolina consisting of at least two nominees for each position on the Board to be filled. Each nominee shall be a professional soil scientist who has been actively engaged in the practice of soil science for a period of at least _____ years. The initial board shall be appointed for terms of one, two, three, four and five years respectively beginning on December 1, 197_. All subsequent terms of office shall be for five years. The members of the Board shall serve until their successors are duly appointed and qualified.

(b) Each member of the Board shall be a citizen of the United States and a permanent resident of North Carolina.

(c) Vacancies in the membership of the Board shall be filled by appointment by the Governor for the balance of the unexpired term, provided that the appointment to fill a vacancy for a practicing registered soil scientist shall be made from a list of nominees recommended and nominated by the Soil Science Society of North Carolina.

(d) The Board shall elect annually the following officers: A Chairman and a vice-chairman from its own membership, and a secretary and a treasurer or a secretary-treasurer either of whom may be but are not required to be members of the Board.

(e) A quorum of the Board shall consist of not less than three members.

SECTION 4. COMPENSATION AND EXPENSES OF BOARD MEMBERS

Each member of the Board shall receive per diem and allowances as provided with respect to occupational licensing boards by G.S. 93B-5.

SECTION 5. ORGANIZATION AND MEETINGS OF THE BOARD.

The Board shall meet within 30 days after its initial members are appointed, and thereafter shall hold at least two regular meetings each year. Special meetings may be held at such time and place as the bylaws of the Board may provide.

SECTION 6. POWERS OF THE BOARD.

The Board may promulgate all reasonable and necessary rules and regulations for the administration of this act and for the proper performance of its duties and the regulation of the proceedings before it. The Board shall adopt an official seal. Any member of the Board may administer oaths or affirmations to witnesses appearing before the Board.

The Board shall be entitled to the services of the Attorney General of North Carolina in connection with the affairs of the Board or may, on approval of the Attorney General, employ an attorney to assist or represent it in the enforcement of this chapter, but the fee paid for such service shall be approved by the Attorney General.

SECTION 7. RECEIPTS AND DISBURSEMENTS.

The treasurer or the secretary-treasurer of the Board shall receive and account for all monies derived under the provision of this chapter, and shall keep such monies in a separate fund to be known as the "Registered Soil Scientists Fund." Monies in the aforesaid fund shall be expended to carry out the purposes of the Board. The treasurer or the secretary-treasurer shall give surety bond to the Board in such sum as the Board may determine, the premium of which shall be regarded as a proper expense of the Board shall be paid from the "Registered Soil Scientists Fund."

SECTION 8. RECORDS AND REPORTS.

The Board shall keep a record of its proceedings and a register of all applications for registration. The register shall show the name, age, residence of each applicant; the date of the application; applicant's place of business; his educational and other qualifications; whether or not examination was required; whether application was rejected or registration was granted; date of action by the Board; and such other information as may be deemed necessary by the Board. Annually on the first day of July the Board shall submit to the Governor a report of its transactions of the preceeding year.

SECTION 9. GENERAL REQUIREMENTS FOR REGISTRATION.

To be eligible for registration as a professional soil scientist or certification as a soil-scientist-in-training, an applicant must be of good character and reputation and shall submit a written application to the board containing such information as the board may require, together with five references, three of which shall be professional soil scientists having personal knowledge of his soil science experience; or in the case of an application for certification as a soil scientist-in-training, by three character references.

SECTION 10. REGISTRATION

An applicant otherwise qualified shall be admitted to registration as a professional soil scientist without examination within one year after July 1, 1977 if he is:

(1) A person of good character who has been a resident of this State for at least one year immediately preceding the date of his application and was a practicing soil scientist on July 1, 1977, and meets the requirements of this act and has performed work of a character satisfactory to the board; or,

(2) A person holding a certificate of registration in the practice of soil science on the basis of comparable qualifications issued to him by a proper authority of another state, possession or territory of the United States and who in the opinion of the board meets the requirements of this act.

An applicant otherwise qualified shall be admitted to registration as a professional soil scientist if he has successfully passed an examination in the principles and practice of soil science as prescribed by the board and has one of the following additional qualifications:

(1) Is a graduate of a soils curriculum approved by the board as satisfactory and with a specific record of an additional two years or more of experience of a grade and character which indicates to the board that the applicant is competent to practice soil science and who holds a

valid soil-science-in-training certificate; or

(2) Is a person who has earned a bachelor's degree or equivalent in one of the natural sciences and five years or more of experience in soil science work of a character and grade which indicates to the board that the applicant is competent to practice soil science or

(3) Is a person who holds a valid soil-science-in-training certificate with a specific record of five years or more experience as a soil-scientist-in-training of a grade and character which indicates to the board that the applicant is competent to practice soil science; or

(4) Is a person with experience of not less than four years of soil science research or as a teacher of soils in a college or university offering an approved soils curriculum of four years or more, and a minimum of two years of soil science experience of a character and grade which indicates to the board that the applicant is competent to practice soil classifying.

SECTION 11. CERTIFICATION AS SOIL-SCIENTIST-IN-TRAINING

Unless otherwise qualified, a person shall be admitted to certification as a soil-scientist-in-training, which certification shall be valid for five years, if he is a person who is:

(1) A graduate of soils curriculum approved by the board and has passed an examination in the fundamentals of soil science; or

(2) An applicant who has completed a soil curriculum not approved by the board and who has a specific record of five years of soil science experience of a grade and character satisfactory to the board and who passes an examination in the fundamentals of soil science.

SECTION 12. APPLICATION, FEES

Application for registration as a professional soil scientist and for certification as a soil-scientist-in-training shall be on a form prescribed and furnished by the board, shall contain statements made under oath showing the applicant's education, a detailed summary of his experience, and references as required by this act and shall be accompanied by an application fee established by the board of not less than five nor more than twenty-five dollars.

SECTION 13. REGISTRATION FEES

Registration fees shall be established by the board subject to the following limitations:

(1) The registration fee for professional soil scientists shall be in an amount not less than twenty nor more than one hundred dollars;

(2) The registration fee for soil-scientist-in-training certification or enrollment shall be established by the board in an amount not less than ten nor more than fifty dollars;

(3) Should the board deny the issuance of a certificate to an applicant, the fee paid shall be retained as an application fee.

SECTION 14. EXAMINATIONS

Examinations shall be held at such times and places as the board shall determine. Examinations required on fundamental soil subjects may be taken at any time prescribed by the board. The final examinations may not be taken until the applicant has completed a period of soil science experience as provided in this act. The passing grade on any examination shall not be less than seventy percent. A candidate failing one examination may apply for re-examination, which may be granted upon payment of a fee established by the board of not less than ten nor more than twenty-five dollars. Any candidate for registration having an average grade of less than fifty percent may not apply for re-examination for a period of one year from the date of such examination.

SECTION 15. ISSUANCE OF CERTIFICATES

The board shall issue a certificate of registration upon payment of the registration fee as provided for in this act to any applicant who in the opinion of the board has met the requirements of this act. Enrollment cards shall be issued to those who qualify as soil-scientists-in-training. Certificates of registration shall carry the designation "professional soil scientist," shall show the full name of the registrant without any titles, shall be numbered and shall be signed by the chairman and the secretary under the seal of the board. The issuance of a certificate of registration by the board shall be prima facie evidence that the person named therin is entitled to all rights and privileges of a professional soil scientist during the term for which the certificate is valid providing it has not been revoked or suspended.

SECTION 16. RENEWAL OF CERTIFICATES

Certificates of registration shall expire on the last day of the month of December following their issuance and shall become invalid after that date unless renewed. It shall be the duty of the secretary of the board to notify every person registered under this act of the date of the expiration of the certificate of registration and the amount of the fee required for its renewal. Such notice shall be mailed to the registrant at his last known address at least one month in advance of the expiration of such certificate. Renewal may be effected at any time prior to or during the month of December by the payment of a fee established by the board not to exceed the fees established for registration. Renewal of an expired certificate may be effected under rules promulgated by the board regarding requirements for re-examination and penalty fees.

SECTION 17. DUPLICATE CERTIFICATES

A new certificate of registration to replace any certificate lost, destroyed or mutilated may be issued subject to the fules of the board, and such certificate shall have the word "Duplicate" affixed on the face thereof. A reasonable charge shall be made for such issuance.

SECTION 18. CODE OF ETHICS

The board shall cause to have prepared and shall adopt a code of ethics a copy of which shall be delivered to every registrant and applicant for registration under this act. Such delivery shall constitute due notice to all registrants. The board may revise and amend this code of ethics from time to time and shall forthwith notify each registrant in writing of such revisions and amendments. Such code of ethics when adopted shall apply to all certificate holders.

SECTION 19. REVOKING CERTIFICATES

The board shall have the power to suspend, refuse to renew or revoke the certificate of registration of, or reprimand any registrant who is guilty of: the practice of fraud or deceit in obtaining a certificate of registration, any gross negligence, incompetence or misconduct in the practice of soil science, any felony or crime involving moral turpitude or violation of the code of ethics adopted and promulgated by the board.

SECTION 20. CHARGES OF MISCONDUCT, HEARINGS, DISPOSITION

Any person may prefer charges of fraud, deceit, gross negligence, incompetence, misconduct or violation of the code of ethics against any individual registrant. Such charges shall be in writing and shall be sworn to by the person or persons making them and shall be filed with the secretary of the board. All charges unless dismissed by the board as unfounded or trivial shall be heard by the board within three months after the date on which they shall have been preferred. The time and place for such hearing shall be fixed by the board and a copy of the charges, together with a notice of the time and place of hearing, shall be served upon the accused either personally or sent by registered or certified mail to the last-known address of such individual registrant at least thirty days before the date fixed for hearing. At any hearing the accused registrant shall have the right to appear in person or by counsel, or both, to cross-examine witnesses appearing against the accused, and to produce evidence and witnesses in defense of the accused. If the accused person fails or refuses to appear, the board may proceed to hear and determine the validity of the charges. If after such hearing a majority of the board votes in favor or sustaining the charges, the board shall make findings of face, draw its conclusions and issue its order therin and serve the same upon the accused. In such order the board may reprimand, suspend, refuse to renew, or revoke the accused individual's certificate of registration. Any person who feels aggrieved by any action of the board in denying, suspending, refusing to renew, or revoking his certificate of registration may appeal therefrom to the Superior Court of the county of his residence within thirty days after receipt of the order of the board. The hearing by the court shall be de novo.

SECTION 20. EXEMPTIONS

This act shall not be construed to prevent or affect:

(1) The work of an employee or subordinate of a person holding a certificate of registration under this act or an employee of a person practicing lawfully under subsection (1) of this section, provided such work does not include final soil science decisions and is done under the direct supervision of and verified by a person holding a certificate of registration under this act or a person practicing lawfully under subsection (1) of this section.

(2) The practice of any other legally recognized profession or trade.

(3) The practice of soil science by any person regularly employed by the state or United States Government or who is regularly employed to perform soil science services solely for his employer or for a subsidiary or affiliated corporation of his employer, providing the soil science performed is in connection with the property, products or services of his employer.

SECTION 21. VIOLATIONS AND PENALTIES

Any person who shall practice or offer to practice professional soil science in this State without being registered in accordance with the provisions of this act, or any person, firm partnership, organization, association, corporation or other entity using or employing the words "soil scientist" or "professional soil scientist" or any modification or derivative thereof in its name or form of business or activity except as authorized in this act, or any person presenting or attempting to use the certificate of registration of another, or any person who shall give any false or forged evidence of any kind to the board or to any member thereof in obtaining or attempting to obtain a certificate of registration, or any person who shall falsely impersonate any other registrant of like or different name, or any person who shall attempt to use an expired or revoked or nonexistent certificate of registration, or who shall practice or offer to practice when not qualified, or any person who falsely claims that he is registered under this act, or any person, partnership, corporation or other entity who shall violate any of the provisions of this act shall be deemed guilty of a misdemeanor and, upon conviction, shall be fined not more than one thousand dollars or be imprisoned for not more than three months. Each violation shall constitute a separate offense.

SOIL SCIENCE SOCIETY OF NORTH CAROLINA

REPORT OF THE AUDITING COMMITTEE, JANUARY 26, 1976

We have examined the financial records of the Society and found them to be in order as follows:

Balance on hand, February 10, 1975	1077.41	
Receipts	951.85	
Disbursements		1258.16
Balance on hand, January 26, 1976		761.10
Totals	$2019.26	$2019.26

Itemized disbursements

Annual meeting	677.11
Typing, printing, postage	480.07
Judging Team	100.00
Intangible tax	.98
	$1258.16

J. B. Watts

F. R. Cox

Auditing Committee

MEMBERSHIP OF STANDING COMMITTEES

OF

SOIL SCIENCE SOCIETY OF NORTH CAROLINA

Nominating

John Carpenter, Chairman
Charles D. Sopher
Joel Cawthorn

Awards

Bill Pickett, Chairman
Jack Baird
Gene Kamprath

Program and Arrangements

Bobby Carlile, Chairman
Keith Cassel
Gene Stikeleather
William Hatfield
Guy Jones

Public Relations

Joe Phillips, Chairman
Walton Dennis
Hubert Byrd

Editing and Publishing

Gordon Miner, Chairman
Art Wollum

Audit

Fred Cox, Chairman
J. B. Watts

Executive Committee

Bob McCollum, President
John Carpenter, Past President
Bobby Carlile, President Elect
John Reeves, Secretary-Treasurer
Steve Barnes, Member-At-Large
James Ware, Member-At-Large

PROGRAM PARTICIPANTS

BARNES, STEVE
Agronomist, First Colony Farm

BUOL, DR. S. W.
Professor, Soil Science, N. C. State University

CASSEL, DR. D. K.
Associate Professor, Soil Science, N. C. State University

CURRIN, TAYLOR
Soil Conservation Services

DANIELS, DR. R. B.
Professor, Soil Science, N. C. State University and U. S. Department of Agriculture

EADDY, DR. D. W.
Director, Agronomic Division
N. C. Department of Agriculture

FERRELL, L. L.
Manager, Blend Fertilizer Sales, FCX, INC.

HOELSCHER, W. L.
Manager, Farmers Chemical Company
Tunis Plant

KLEISS, DR. JOE
Assistant Professor, Soil Science, N. C. State University

McCOLLUM, DR. R. E.
Associate Professor, Soil Science, N. C. State University

ROGERS, B. J.
Regional Manager, IMC

SANCHEZ, DR. PEDRO
Associate Professor, N. C. State University

TOUSSAINT, DR. W. D.
Professor and Head, Economics & Business Department, N. C. State University

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S O I L   S C I E N C E   S O C I E T Y

O F

N O R T H   C A R O L I N A

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PROGRAM

NINETEENTH ANNUAL MEETING

JANUARY 28 - 29, 1976

N. C. STATE UNIVERSITY FACULTY CLUB
RALEIGH, NORTH CAROLINA

PRESIDENT............ J. A. Carpenter
PRESIDENT-ELECT....... R. E. McCollum
SECRETARY-TREASURER...... John Reeves

EXECUTIVE COMMITTEE MEMBERS

C. D. Sopher............ Hubert Byrd

JOHN CARPENTER

SOIL SCIENCE SOCIETY OF NORTH CAROLINA

"to increase and disseminate knowledge of soils of the State and their uses"

Wednesday Morning, January 28, 1976

8:30 Registration and Coffee

9:45 Call to Order and Announcements
R. E. McCollum, President Elect

Presiding - L. L. Ferrell

10:00 The Fertilizer Situation
B. J. Rogers

10:20 The Natural Gas Situation as it Relates to Ammonia Production
W. L. Hoelscher

10:40 Farming - From a Farmers Point of View
C. D. Worthington Jr.

11:00 The Crop Price Outlook
W. D. Toussaint

11:20 Land Management of Organic Soils
Steve Barnes

12:00 Buffet Lunch — Faculty Club

1:30 Business Session
R. E. McCollum

Minutes of the Eighteenth Annual Meeting
Treasurer's Report
Auditor's Report
Report From the Committee on Registering or Certifying Soil Scientists

2:30 Tour of Soil Testing Laboratory
Don Eaddy

5:45 Social Hour
Ballentines Banquet Room
Ballentines Cafeteria
Cameron Village

6:45 Banquet - Awards
Charles L. McCuller, Speaker

Thursday Morning, January 29, 1976

Presiding - Stan Buol

8:45 Land Forms of the North Carolina Coastal Plains
Ray Daniels

9:05 Hard Pans in Coastal Plains Soils of North Carolina
Keith Cassel

9:25 Soil - Land Use Interpretation
Joe Kleiss

9:45 Sediment Control Program
Taylor Currin

10:05 The N. C. State International Soil Research Program
Pedro Sanchez

10:25 Break - Coffee

10:45 Open Forum

11:30 Adjourn

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