Bob L
F.Y.I.
J.K.

Report of Progress on the Final Phase of

GLACIAL GEOLOGIC MAPPING
IN
HAMILTON COUNTY, OHIO

by

C. Scott Brockman
Ohio Department of Natural Resources
Division of Geological Survey

September 1988

Paul,
This describes the
glacial units.
Also see p. 11+12
Scott

Contents

Figure

FINAL PHASE OF

GLACIAL GEOLOGIC MAPPING IN HAMILTON COUNTY, OHIO

by

C. Scott Brockman

INTRODUCTION

The nine quadrangles presented herein (Addyston, Cincinnati West, Cincinnati East, Madeira, Lawrenceburg, Burlington, Covington, Newport, and Withamsville) represent the final phase of Geological Survey (USGS)-supported glacial mapping in Hamilton County, Ohio, by the Ohio Division of Geological Survey (ODGS). Six quadrangles (Hooven, Harrison, Shandon, Greenhills, Glendale, and Mason) were previously mapped and presented to the USGS in October, 1986. The maps and this accompanying text constitute the final report of mapping progress in Hamilton County and fulfill a cooperative agreement between the ODGS and the USGS to produce fifteen 1:24,000-scale glacial-deposits maps covering Hamilton County, Ohio. In the near future, the ODGS is planning to publish a complete report of investigations of Hamilton County with a combined glacial and bedrock surficial-deposits map at a scale of 1:62,500. The detailed geologic data gathered, developed, and presented in the course of this mapping should contribute significantly to other investigations intended to address the area's costly landslide problems.

MAPPING METHODS

Several sources of information have been used in mapping the glacial geology of Hamilton County, of which field work has been the most significant. Streams were walked and the extent and type of materials were noted on 7.5-minute quadrangles. Outcrops were measured, described, and sampled to establish the area's stratigraphy and variability of units. Where outcrops were not available, a hand auger was used to obtain samples of materials.

Laboratory analyses were used to supplement field identification

and to quantify variability of units. Textural analyses were performed on the less than 2mm materials with breaks at 0.062mm for sand/silt and at 0.004mm for silt/clay (Folk, 1974). Calcite and dolomite content were determined on the less than 0.074mm fraction with a Chittick apparatus (Dreimanis, 1962). A quantitative comparison of the diffraction intensities (DI) of clay minerals was made using the procedures of Szabo and Fernandez (1984). The DI was calculated as the ratio of 10Å illite to 7.5Å chlorite/kaolinite and was used to compare unoxidized till samples. Atterberg limits were determined for lacustrine silts and clays (ASTM, 1972: D422-63, Particle Size Analysis; D423-66, Liquid Limit; D424-59, Plastic Limit and Plasticity Index). The silts and clays were assigned AASHTO soil classifications.

The soil survey of Hamilton County (Lerch, Hale, and LeMaster, 1982) served as a preliminary guide for identifying surface materials and approximating their areal extent between outcrops. Soil-series descriptions were analyzed and assigned to appropriate lithologic mapping units that were developed as a result of field work.

Water-well logs on file at the Ohio Division of Water were used to assist in the delineation of areas of shallow bedrock and deposits of sand and gravel. Logs of engineering test holes were generally found to be more reliably detailed than water-well logs and were used for identification of additional subsurface units.

GLACIAL-DEPOSITS MAPS

PURPOSE

The character and extent of near-surface materials is directly related to land-use capability considerations; thus, the primary purpose of this project has been to map the surficial glacial deposits in Hamilton County. These materials are highly variable in character and extent. Although every effort has been made to map the materials as accurately as possible, all contacts depicted on the maps should be considered inferred. Accordingly, these maps are intended to be used only as general guides to the geology of the area and should not be used to replace site-specific geotechnical studies required for mining, construction, and other land-development projects in Hamilton County.

The units designated on the mapped quadrangles and described in

the following discussion are in lithologic terms; the relative ages of the units are a secondary descriptor (see figure 1). For example, a lacustrine silt of Wisconsinan age is designated "Siw."

Map units represent materials to a depth of 5 feet (1.5m). Where a thin unit overlies another unit within 5 feet of the surface, both units are shown on the map (stack-mapped units). For example, an area of thin Illinoian-age sand (Sai) over Ordovician-age bedrock (Bo) is designated "Sai/Bo."

It should be noted that some areas are not strictly mapped to a depth of 5 feet. Geologically important units (for example, lacustrine clays which are a landslide-prone deposit) that may have their first appearance beneath another unit at depths slightly greater than 5 feet are shown on the map (for example, "Ti/Cli"). Alluvium, which commonly forms a thin mantle over other units, is mapped where its thickness is 5 feet or greater; where alluvium is less than 5 feet thick, underlying units are depicted. Furthermore, loess, which is essentially ubiquitous in Hamilton County, is not shown in stack-mapped form. Rather, its thickness is described in the unit descriptions (see description of "Tw" and "Ti"), and units are shown on the map as if they had no loess cover. The exception is on flat pre-Illionian till surfaces where loess is 5 or more feet thick. Here, the single map unit "Lk" ("Kansan"* loess) may be considered a consolidation of two units: 5 or more feet of loess over pre-Illinoian till.

* In Hamilton County, pre-Illinoian units have traditionally been assigned a Kansan age. The present confusion of pre-Illinoian stage terms (Boellstorff, 1978) makes any pre-Illinoian age assignment provisional, and thus the term "Kansan" will appear in this report within quotation marks.

DESCRIPTION OF UNITS

Postglacial Units

Al Alluvium. Fluvial deposits of recent (Holocene) origin; includes a wide variety of textural classes from silts to boulders with disseminated or concentrated organics; generally not compact; found within floodplains of modern streams; may include glacial outwash in smaller streams where mapping scale precludes a distinction between

units. Alluvium is mapped where it is of significant areal extent, or where its thickness is greater than 5 feet. Along the major streams in the area the alluvium boundary is approximately within the 100-year flood zone.

PG, PS Gravel pit, sand pit, respectively. Boundaries are those depicted on the most recent USGS 7.5 minute quadrangles.

M Made land. Areas of extensive cutting or filling, particularly landfills. The unit is designated in areas where the form of made land mimics a natural landform and may be confused with it. The unit is generally not designated in urbanized and industrialized areas; in these areas, the underlying units are indicated.

Ice-deposited Units

Tw Till, Wisconsinan-age. Shelbyville till, informally named by Gooding (1963); its equivalent is the informally named lower Shelbyville till of Goldstein (1968); generally overlain by loess cap up to 33 inches (84cm) thick; loess cap generally thin or absent on slopes; till may contain silt, sand, and gravel lenses. Average sand/silt/clay percentages of 52 unoxidized and unleached samples of lodgment)till that do not show incorporation of other units are 24/46/30, ranging from 16/51/33 to 31/44/25; standard deviations are 3.8/3.0/3.6. Unoxidized and unleached till is gray (7.5YR 5/0, dry) and averages 11% calcite and 20% dolomite; average DI ratio is 0.9; standard deviations for calcite, dolomite, and DI are 1.9%, 3.1%, and 0.2, respectively. Oxidized color is reddish yellow (7.5YR 6/8, dry). Clasts larger than medium pebbles (greater than 0.3 inch/8mm diameter) average about 5% but vary in abundance from 1 to 20% throughout the area. Pebble casts have clay skins. Flat, well-drained areas are leached to a depth of 33-44 inches (84-112cm), including the loess cap. Joints are common and are primarily near-vertical, but also horizontal and inclined; till is oxidized 0.5 to 6 inches (1 to 15cm) averaging 2 inches (5cm) on either side of joints; 0.25 inch (0.5cm) wide central portion of joints may be reduced of oxygen and gray in color; joint faces may contain thin continuous or discontinuous sheets of calcium carbonate, iron and manganese oxides, clay, or sand; in horizontal exposures, joints have polygonal expression with a typical maximum axial dimension of 18 to 25 inches (45 to 64cm).

Shelbyville till is the surface till in the northern quarter of the county. 'Lodgment' till (described above) dominates the area; however, an ablational facies exists in some areas (unmapped) and is generally less than 5 feet thick, consisting of interbedded and contorted clastic and debris-flow materials.

Local relief in areas of Shelbyville till is relatively low and landslides in the till are small and generally limited to valley walls actively cut by streams. However, some landslides have occurred in oversteepened highway cuts.

Ti Till, Illinoian-age. Includes Richmond and Centerville Tills of Gooding (1963); units not differentiated on maps; generally overlain by loess cap up to 40 inches (102cm) thick. Texture of unaltered Illinoian till varies more widely than Tw; sand/silt/clay percentages of 88 unoxidized and unleached samples showing no incorporation of other units average 25/47/28 and range from 8/43/49 to 34/41/25. Standard deviations are 6.5/4.8/6.0. Unoxidized and unleached till averages 9% calcite and 13% dolomite; average DI is 0.9. Standard deviations of calcite, dolomite, and DI are 2.7%, 3.3%, and 0.1, respectively. (Carbonate values, particularly dolomite, are the most significant laboratory parameters to differentiate between Illinoian-age and Wisconsinan-age tills). Unaltered color is gray (7.5YR 5/0, dry), oxidized color varies from reddish yellow (7.5YR 6/6) to brown (5/4) and yellowish red (5YR 5/8). Clay skins surround pebble casts and are more developed in the weathered zone. Hilltop and plateau areas are leached to a depth of approximately 6 feet (1.8m), including the ubiquitous loess cap. Joint angles, oxidization, coatings, and polygons are similar to those developed in Tw. In areas where the modern soil is developed in post-Illinoian materials, a buried paleosol (Sangamonian-age) may be preserved in the Illinoian till. Gleyed till of the paleosol is greenish gray (5GY 6/1) to light olive gray (5Y 6/2, dry), changing with depth to dark gray (5Y 5/1) less altered till.

This unit's distribution results from deposition by two separate Illinoian-age lobes, the Clermont lobe in the central and eastern part of the county, and the Harrison lobe on the west, bounded by the Great Miami River. Harrison-lobe till(s) is limited to ridgetops and a few small till plateaus. Clermont-lobe tills are found on ridgetops and also large till plateaus. The limited extent of unaltered Harrison-lobe till does not allow a valid comparison of laboratory data between tills of the two lobes in Hamilton County at this time.

Landsliding in Illinoian till may occur in oversteepened, wet areas.

Fluvial and Lacustrine Units

Grw, Gri Gravelly sand to bouldery gravel. Contains some thin, discontinuous lenses of silt and somewhat thicker, more continuous beds of sand; deposits are well to poorly sorted, angular to well rounded; may be massive, cross bedded, or horizontally bedded and attain thicknesses of 20 or more feet (6m). Deposits generally fine upward to sand. Clasts are a variety of lithologies, in some areas they are

exclusively limestone derived from the immediate area. Some stable exposed slopes are locally cemented by calcium carbonate.

The units are found within modern valleys and paleovalleys. Criteria for differentiating the units Grw and Gri are based primarily on stratigraphic position, and to a lesser degree on depth of weathering and geomorphology (terrace levels); in the subsurface, the units have the same physical and chemical properites. The unit Gri can be shown to be associated with Ti, as can Grw with Tw. Surface deposits of the unit Gri, in flat-lying areas where the original depositional surface is relatively intact, have leach depths greater than approximately 6 feet (2m) and a B horizon clay accumulation zone greater than approximately 5 feet (1.5m) deep. For deposits associated with terraces, gravels underlying major terrace surfaces at an elevation of 600 to 650 feet (183 to 198m) (higher in tributaries) are unit Gri; those underlying major terrace surfaces at an elevation of 540 to 570 feet (165 to 174m) (higher in tributaries) are unit Grw. The lower elevation limit of the units is difficult to determine.

Saw, Sai Fine to coarse sand. Contains minor amounts of disseminated gravel and/or thin gravel and silt lenses; well to poorly sorted, moderately to well rounded with high quartz percentage, finely laminated to massive, may be cross bedded; rarely greater than 10 feet (3m) thick, except in extensive outwash sheets; locally may contain organics as disseminated particles or sticks and logs. Beds may be lithified by calcium carbonate in stable exposures; concretions may be found exhibiting varying degrees of cementation.

The units are found within modern valleys and paleovalleys throughout the county. As with the units Grw and Gri, the units Saw and Sai have similar characteristics in the subsurface. Likewise, these deposits can be distinguished using the same stratigraphic, geomorphic, and weathering criteria as the gravel units.

Sak Clayey to pebbly sand. May contain a loess cap up to 5 feet (1.5m) thick. The unit is weathered and leached. In flat-lying areas, B horizon clay accumulation is greater than 10 feet (3m) thick; clay percentage decreases through the soil downward to less weathered material. Sand is composed almost entirely of quartz with minor amounts of other resistant lithologies and sand-size manganese oxide concretions.. The sand is poorly to moderately well sorted, subangular to subrounded; pebble beds are uncommon. Pebble-size sand and silt concretions, which are cemented by iron oxide, and to a lesser extent, manganese oxide, may form a surface lag near the loess/sand contact. The dry color is brownish yellow (10YR 6/6) to reddish yellow (7.5YR 6/6). The unit may be as much as 30 feet (9m) thick.

The unit is limited to hilltops and slopes above a base-level elevation of 610 to 620 feet (186 to 189m) in the southwestern third of the county.

The unit erodes easily when vegetation is removed. Exposures generally do not develop deep-seated landslides.

Siw, Sii, Sik Clayey silt to sandy silt. Contains localized clay beds up to 1 foot (0.3m) thick; thin sand or gravel layers may also be present; may contain dropstones, generally less than 0.5 inch (1cm) in diameter and less than 1% by volume, but locally present in higher concentrations and as larger clasts; may be massive or laminated. Color of unaltered sample is light gray (10YR 6/1 to 7/1, dry), and averages 9% calcite, 16% dolomite, and a DI of 1.0. Organics are commonly present, generally disseminated but may be in thin concentrated bands; silt may contain snails, clams, and small branches or logs. Carbonate-cemented concretions occur in siltier units. Sandier units may be thixotropic. Individual deposits are up to 100 feet (30.5m) thick, but are generally thinner.

The units are found at numerous levels within paleovalley fills. They are also found as surface deposits along Ohio River valley bluffs (loess?), near the mouths of tributaries to major streams and rivers (slackwater terraces), within the till-plain surface (remnant surface lake-fills) and where overlying units have been eroded. Sandy silts, sometimes interbedded with coarser layers represent floodplain/overbank deposits. Silts and clayey silts are lacustrine deposits or, less commonly, aeolian deposits.

The silt units Siw and Sii are differentiated by the same stratigraphic and geomorphic criteria as the sand and gravel units. The unit Sik is found above 620 feet (189m) in elevation; flat-lying deposits are leached greater than approximately 5 feet (1.5m).

Large, relatively shallow angle slumps form in thick clayey silts and in areas where thinner clayey silts at stream level underlie other units. The most common AASHTO classification of disaggregated samples is A-6 and A-7; the most common Unified Soil Classification is CL. Clayey silts have a liquid limit of 35 to 47 and plasticity index of 17 to 25.

Clw, Cli, Clk Silty clay to clay. Massive to laminated with maximum thickness of 40 feet (12.2m) or more; dropstones uncommon. Average sand/silt/clay percentages of 26 unaltered samples are 1/31/68 with maximum clay 89%. Massive clay resembles softened shale when wet, has a conchoidal fracture when compact and dry. Laminated clay commonly has thin silt or sand partings 0.04 to 0.4 inches (1 to 10mm) apart, and may be interbedded with silt and minor sand or gravel. Unoxidized and unleached clay is light gray (10YR 6/1 to 7/1, dry) and averages 10% calcite and 11% dolomite, with a DI of 0.9; slightly oxidized clay is light brownish gray to vary pale brown (10YR 6/2 to 7/3, dry). The unit Clk is rarely found in an unoxidized state, is generally leached, and has a DI greater than 1.4. Clays may contain disseminated organics, snails and clams. Organics are less common in clays within the bedrock valleys of the Great Miami, Little Miami, Whitewater, and Ohio Rivers and Mill Creek, and less common overall than in silts. Siltier areas may contain cigar-shaped concretions up to 2 inches (5cm) long. The unit Clk may contain 1- to

-2 inch (2.5 to 5cm) thick, laterally discontinuous, bedded, calcareous concretions in near-surface exposures. Clays may contain vertical joints 6 to 12 inches (15.2 to 30.5cm) apart; joint faces may be covered by thin sheets of iron or manganese oxides; joints in Clk may contain linear concretions.

The clay units, like the silt units, have a wide distribution throughout the county as paleovalley fills and surface deposits. The units are lacustrine deposits. Criteria for differentiation of clay units are the same as for silt units. In addition, the unit Clk is found above 650 feet (198m) elevation (Ettensohn, 1974) and below 870 feet (265m), is oxidized and leached, and has a DI greater than 1.4.

These units have engineering properties similar to those of clayey silts described above. These units are very landslide prone and have been the source of numerous costly landslides.

Aeolian/Glacial Unit

Lk Loess over till. Well-weathered silt loam, yellowish brown (10YR 5/4 to 5/6, dry), entirely leached, and up to 5 or more feet thick overlying highly weathered pre-Illinoian ("Kansan") till; thin on slopes. The loess accumulated during pre-Illinoian and later glaciations. The underlying till, informally named Cincinnati till by Teller (1970), is silty clay and clay, brown to strong brown (7.5YR 5/4 to 5/6, dry), and leached. Clay averages above 50%, with sand and pebbles of resistant lithologies only; sand is up to 20%, but generally less than 10%; quartz grains are generally angular, rounded grains may be frosted; pebbles less than 1% by volume. Sand-size voids common, pebble ghosts are generally of siltstone; sand- to pebble-size manganese concretions occur in the B horizon, but are less than 1% by volume. No unweathered till was observed.

The unit is found in the southwestern third of the county. It drapes paleoslopes and fills paleovalleys above a base-level elevation of 610 to 620 feet (186 to 189m). Near shallow bedrock areas, the downslope extent of the unit is difficult to map as a result of long-term mixing of Lk-derived and bedrock-derived colluvium.

Compared to other units in the area, Lk has a large shrink-swell capacity as a result of a high percentage of mixed-layer clays. Foundation problems may result in areas where water has been removed from the unit such as by artificial drainage, blacktop coverings, or deep tree roots.

Preglacial Unit

Bo Bedrock and bedrock-derived colluvium. Bedrock is alternating layers of thin Ordovician-age limestone and shale in proportions varying from 50% to 85% shale. Clay from unoxidized, disaggregated shale ranges in texture from sand, less than 6%, to clay, 35% to 65%; calcite is more

abundant than dolomite by a factor of at least 1.2; calcite ranges from 6% to 14%, dolomite from 4% to 6%. Colluvium, found on slopes and valley bottoms, consists of dominantly downslope-oriented limestone fragments, clay, and organic matter. Bedrock areas downslope of till units contain varying amounts of till-derived material as part of the overlying colluvium. Colluvium has a relatively low shear strength and is the source of numerous landslides, especially on steep slopes and where it has developed over shale-dominated bedrock units.

REFERENCES CITED

American Society for Testing and Materials (ASTM), 1972, Annual Book of ASTM Standards, Part II, 1046 p.

Boellstroff, John, 1978, North American Pleistocene stages reconsidered in light of probable Pliocene-Pleistocene continental glaciation: Science, v. 202, p. 305 - 307.

Dreimanis, Alexsis, 1962, Quantitative gasometric determination of calcite and dolomite by using Chittick apparatus: Journal of Sedimentary Petrology, v. 32, p. 520-529.

Ettensohn, F. R., 1974, The pre-Illinoian lake clays of the Cincinnati region: Ohio Journal of Science, v. 74 no. 4, p. 214-226.

Folk, R. L., 1974, Petrology of sedimentary rocks: Austin, Texas, Hemphill Publishing Company, 182 p.

Goldstein, F. R., 1968, The Pleistocene geology of a portion of Butler County, south-western Ohio: M.S. thesis, (unpublished), Miami University, Oxford, Ohio, 102 p.

Gooding, A. M., 1963, Illinoian and Wisconsinan glaciation in the Whitewater Basin, southwestern Indiana and adjacent areas: Journal of Geology, v. 71, p. 665-682.

Lerch, N. K., Hale, W. F., and LeMaster, D. D., 1982, Soil survey of Hamilton County, Ohio: United State Department ofAgriculture, Soil Conservation Service, 219 p.

Szabo, J. P. and Fernandez, R. L., 1984, Clay mineralogy of Wisconsinan tills of the Cuyahoga Valley National Recreation Area, northeastern Ohio: Ohio Journal of Science, v. 84, p. 205-214.

Teller, J. T., 1970, Early Pleistocene glaciation and drainage in southwestern Ohio, southeastern Indiana, and northern Kentucky: Ph.D. dissertation, (unpublished), University of Cincinnati, Cincinnati, Ohio, 115 p.

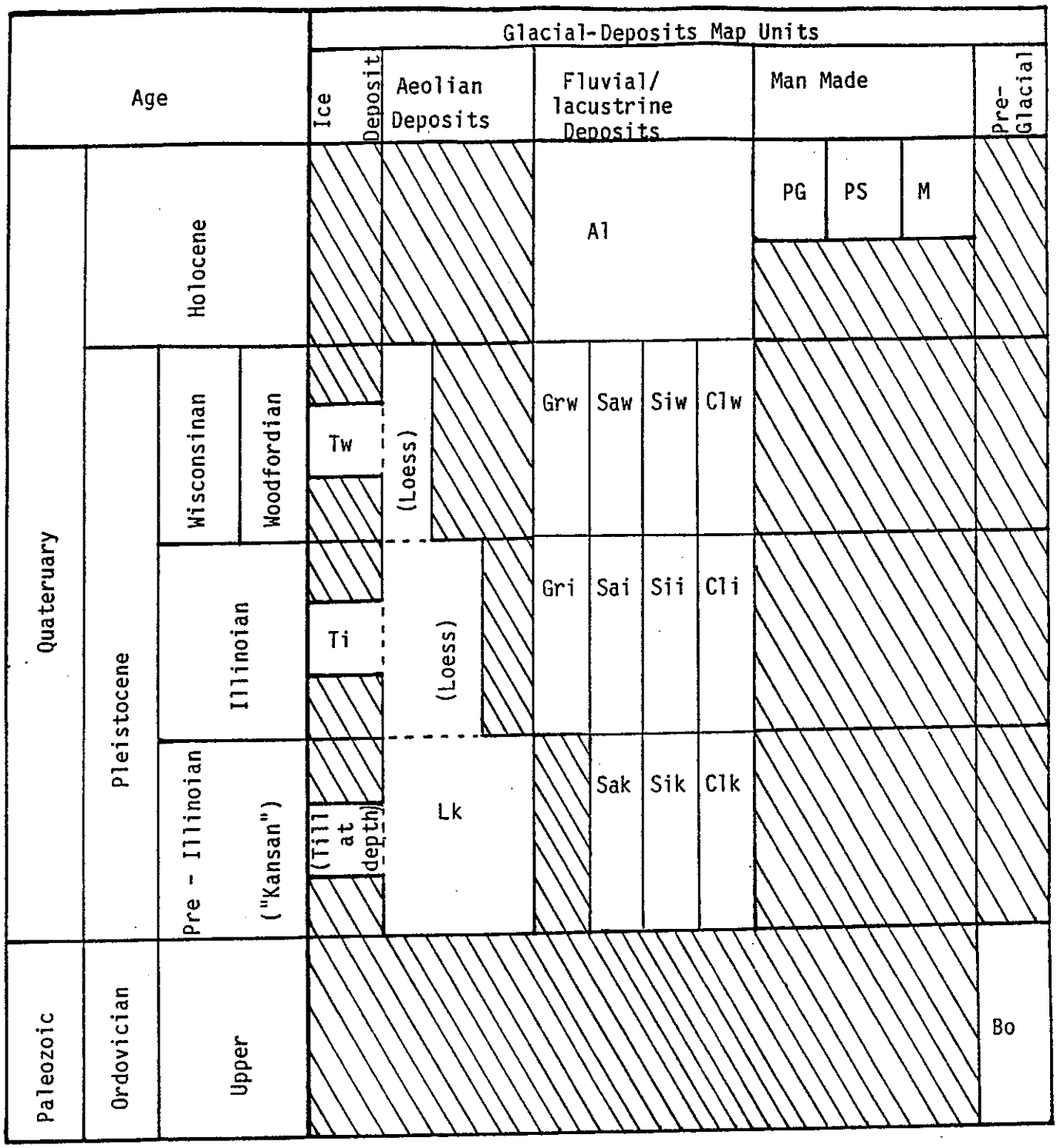
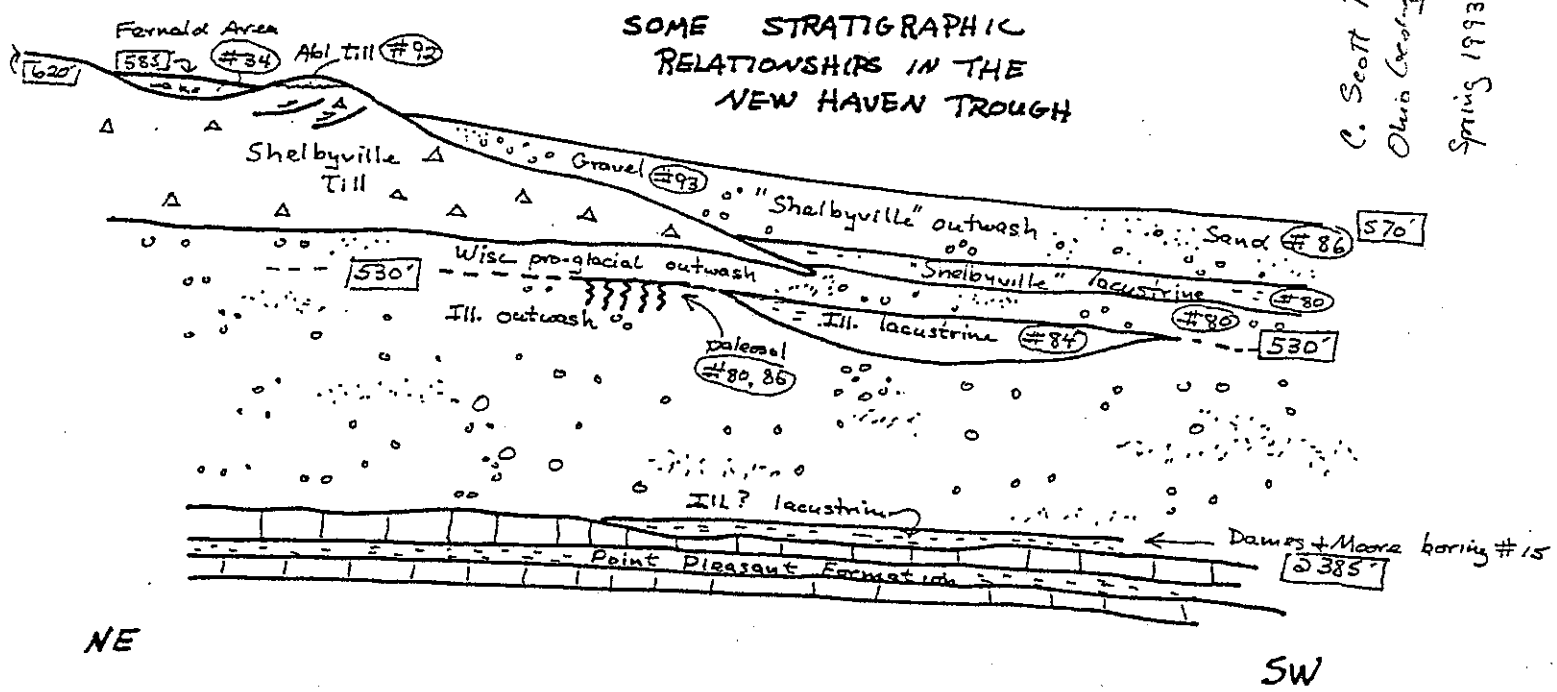


Figure 1. Relative ages and depositional environments of glacial-deposits map units. Units are mapped to a depth of 5 feet. Two units, one overlying the other and found within 5 feet of the surface, are shown as stacked units, ex., Al/Tw. Loess of unit Lk accumulated during pre-Illinoian and later glaciations. See text for descriptions of the individual units.


SOME STRATIGRAPHIC RELATIONSHIPS IN THE NEW HAVEN TROUGH
C. Scott Brockman
Ohio Geological Survey
Spring 1993
Fernald Area
620'
585'
#34
Abl. till
#92
Shelbyville Till
Gravel
#93
"Shelbyville" outwash
Sand
#86
570'
530'
Wisc. pro-glacial outwash
"Shelbyville" lacustrine
#80
#80
Ill. outwash
Ill. lacustrine
#84
530'
paleosol
#80, 86
Ill? lacustrine
Dames + Moore boring #15
Point Pleasant Formation
2385'
NE
SW