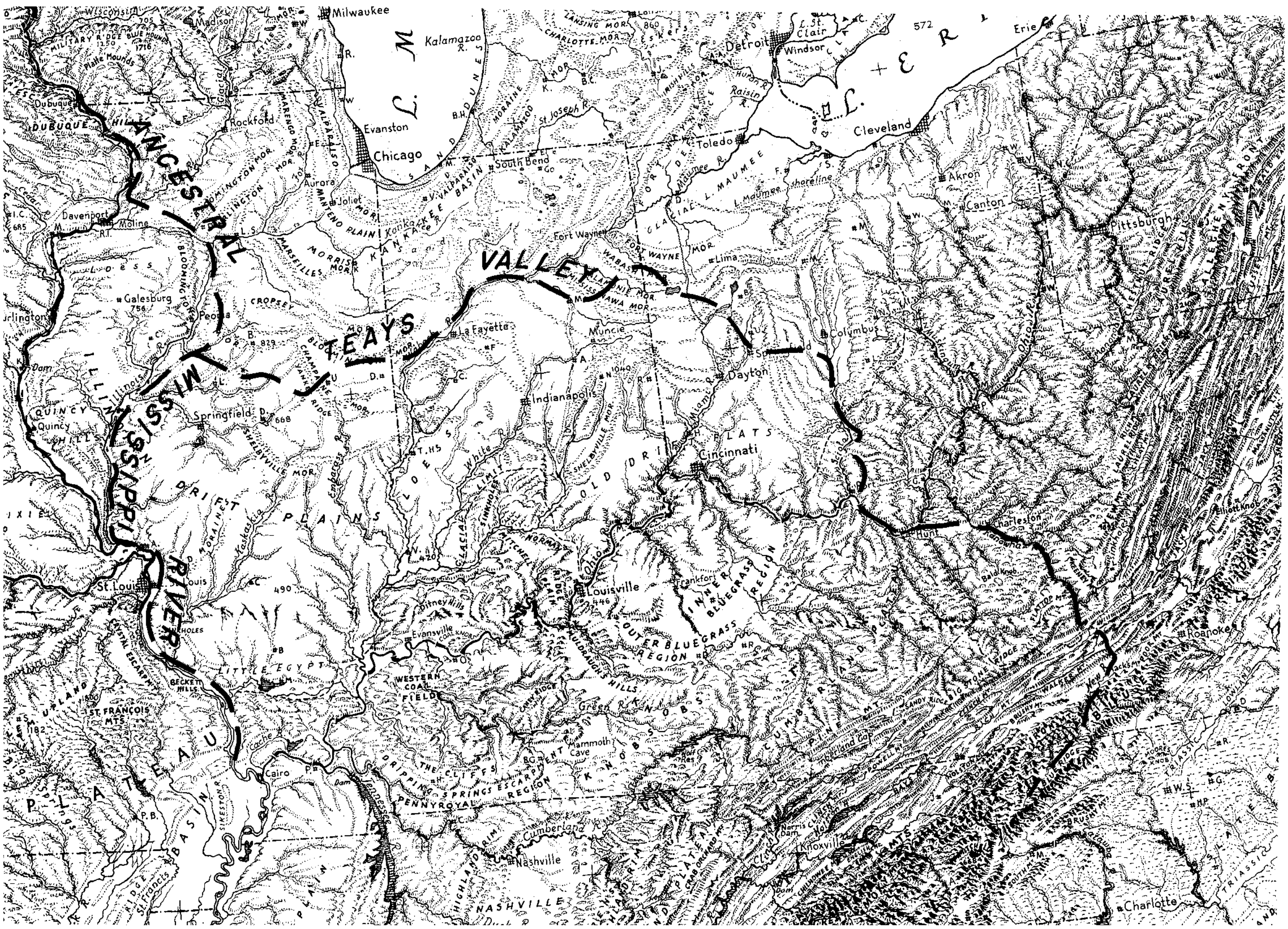
HYDROGEOLOGY OF THE LAFAYETTE (TEAYS) BEDROCK VALLEY SYSTEM NORTH-CENTRAL INDIANA



STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

HYDROGEOLOGY OF THE LAFAYETTE (TEAYS) BEDROCK VALLEY SYSTEM, NORTH-CENTRAL INDIANA

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STATE OF INDIANA
DEPARTMENT OF NATURAL RESOURCES
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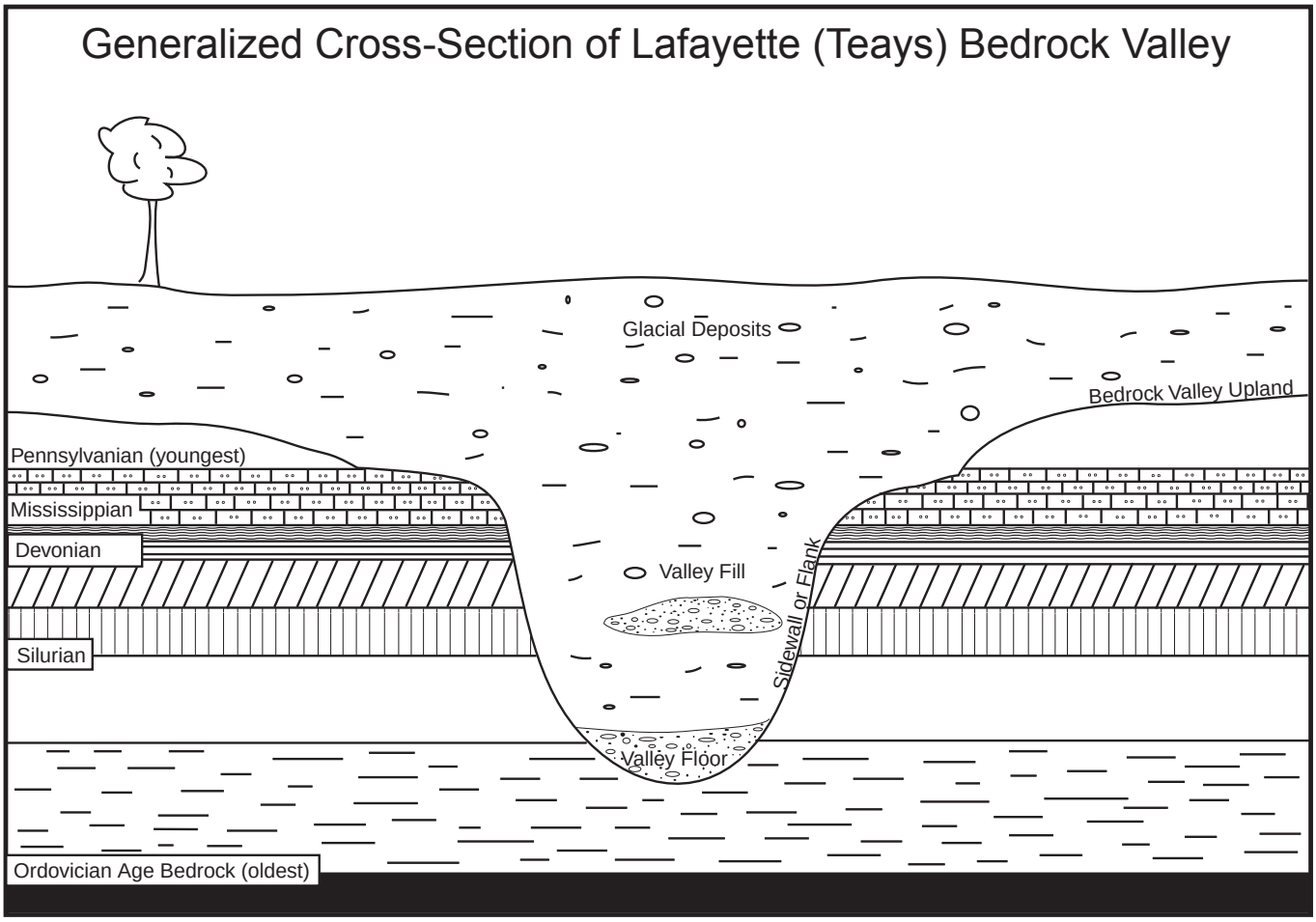
Forward

This report was completed and scheduled for publication in 1990; but due to unforeseen circumstances, was not published. The decision was made to publish the report at this time because it contains much valuable information about the Teays (Lafayette) Bedrock Valley System that is not available to the public in any other report.

Introduction

One of Indiana's most intriguing geologic features lies buried in north-central Indiana beneath up to 400 feet of glacial drift. The Teays Valley, a major drainage system that originated in West Virginia, has aroused the interest of the general public as well as scientists for more than one hundred years. Early reference to the Teays in Indiana dates back to the 1890s, when the location of the valley was of prime interest to oil and gas drillers who sought to avoid the "deep drive" or "Loblolly" area where they faced the expense and time-consuming job of setting 400 feet of well casing. In the 1980s the Teays Valley and its ground water characteristics became increasingly important to nearby communities looking for additional well field sites to meet future water demands. Long regarded by area residents as an "underground river" with unlimited supplies of ground water, this valley has been recognized as an extremely significant feature that merited detailed study in order to dispel the myths surrounding its origin and water potential, and to define the geologic composition and water-bearing capabilities of the material filling the valley. Figure 1 on the following page shows the general location of this Teays Valley study.



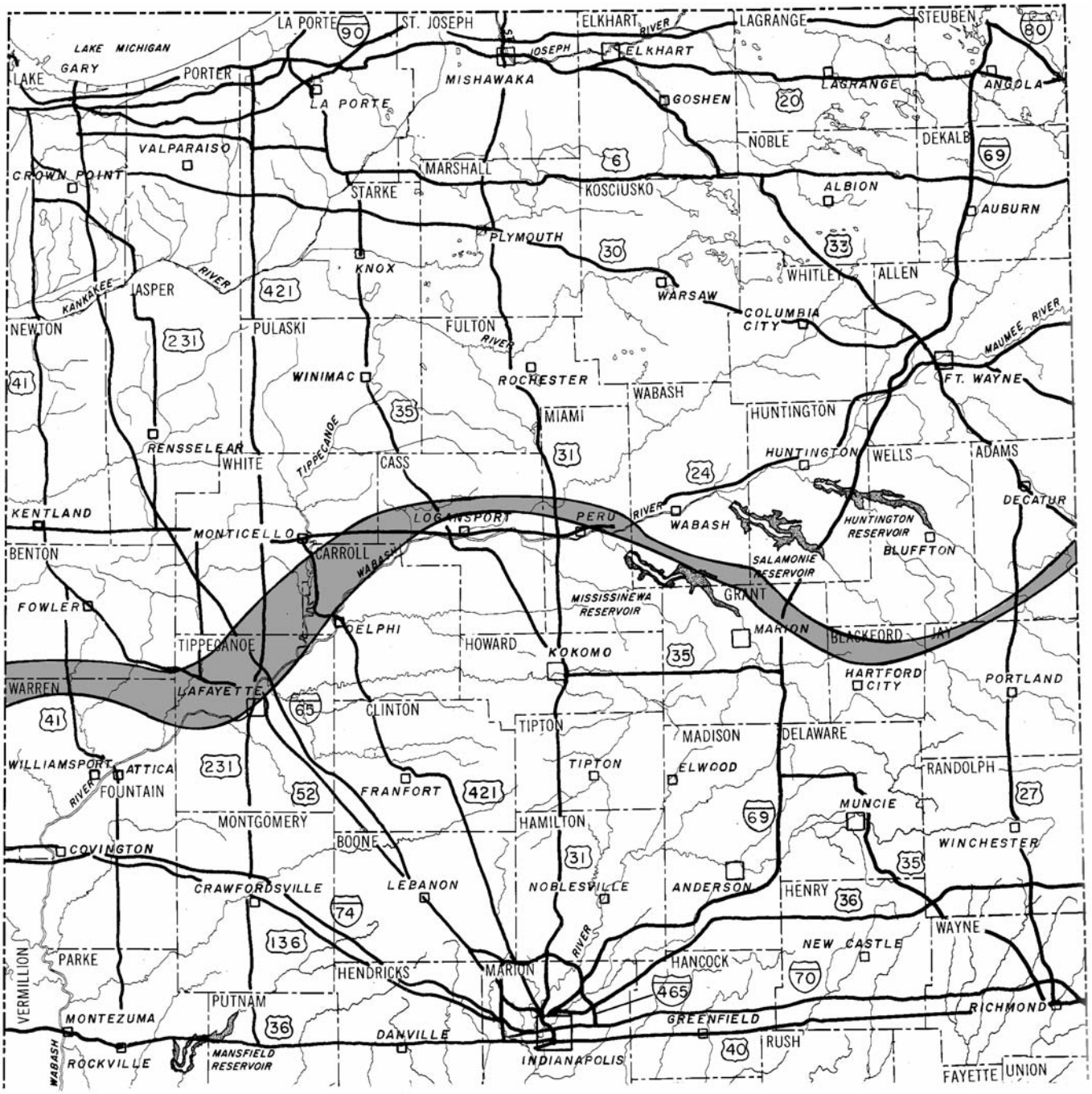


Figure 1. Location of the Lafayette (Teays) Bedrock Valley

In 1976, a combined effort by the Indiana Department of Natural Resources, Division of Water and the Indiana Geological Survey was initiated to provide accurate scientific information on the location, depth, geologic history, and hydrogeology of the buried bedrock valley. This report provides an analysis of these characteristics, with particular emphasis on the availability and occurrence of ground water. Over the past twenty years the need for ground water information has grown with the expanding water demands of cities and towns, industry, agricultural interests, and individual homeowners. A number of large water users have already used the basic data gathered during the study of the Teays Bedrock Valley, and this information has been used to locate new high-capacity wells. The deposits filling the buried valley will continue to be of significant interest to those seeking to develop new sources of ground water.

Work by both the Indiana Geological Survey (Bleuer, 1989) and the Division of Water suggests that the all-encompassing label "Teays" is a misnomer when discussing the location and characteristics of the valley in Indiana. The terminology "Lafayette (Teays) Bedrock Valley" as proposed by Bleuer recognizes the importance of the various major tributaries to the Teays and the impacts of the advances and retreats of various ice sheets on the course of the valley. Therefore, the term "Lafayette (Teays) Bedrock Valley" will be used hereafter in all references to the buried bedrock valley formerly attributed to the Teays River

drainage system in Indiana.

Purpose and Scope

This report is intended to provide a detailed evaluation of the ground-water resources of the Lafayette (Teays) Bedrock Valley in Indiana and to make information available that can be useful to develop new sources of water to meet north-central Indiana's water requirements. Recognizing the need for a detailed study of the Teays, the Ground-Water Section of the Division of Water and the Geology Section of the Indiana Geological Survey initiated a project proposal in 1975 that sought to answer many of the questions regarding the Lafayette (Teays) Bedrock Valley. The project involved a coordinated effort to:

- assemble all available water well records, seismic data, oil and gas well data, stratigraphic test hole information, and bedrock outcrop data;
- obtain new geophysical data where necessary to define the configuration of the valley and its location;
- process and field-verify new water well and petroleum exploration well records;
- drill a series of deep test holes in the valley with the ultimate goal of assessing the glacial stratigraphy and general ground-water potential;
- reappraise existing maps and interpretations in light of new data; and
- prepare a series of publications describing the morphology, glacial stratigraphy, ground-water potential, and other characteristics of the Lafayette (Teays) Bedrock Valley system.

Geography of the Project Area

The Lafayette (Teays) Bedrock Valley is present beneath portions of 11 counties in north-central Indiana and extends from Adams County at the Ohio state line westward through the state and crosses into Illinois in southern Benton County (Figure 2 and Plate 1). The valley, which enters Indiana about two miles southeast of the community of Salem in Adams County and leaves the state just south of Ambia in Benton County, traverses a distance of about 165 miles in the state. Although it exhibits a general east-west orientation, it contains two major arcing curves before resuming a westward direction in Tippecanoe County (Figure 1). Major communities near the valley are Berne, Geneva, Hartford City, Marion, Peru, Logansport, Monticello, Delphi, Lafayette, and West Lafayette.

Physiography

The Lafayette (Teays) Bedrock Valley crosses the portion of the state that lies within the Tipton Till Plain as defined by Malott, 1922 (Figure 3). The till plain is typified by a flat to slightly rolling surface that contains several narrow arcing moraines in the eastern half of the state. These areas are a result of the glacial ice lobes, which came out of the Lake Erie area some 20,000 years ago.

The only significant surface relief in this portion of the state occurs where streams have cut deep narrow valleys into the surface of the glacial deposits. Several of these streams and rivers, such as the Wabash, Mississinewa, and Salamonie originate near and are parallel to the arcing terminal moraine ridges. The most noticeable changes in elevation in the area underlain by the Lafayette (Teays) Bedrock Valley occur near the Mississinewa and Wabash Rivers where 100 feet of relief or greater is present.

Near the Indiana-Ohio state line, where the Lafayette (Teays) Bedrock Valley enters the state, the land surface elevation is about 815 feet mean sea level (msl). The highest surface elevations in the area underlain by the Lafayette (Teays) Bedrock Valley are in the range of about 925 (msl) and occur near the small community of Balbec in Jay County. The lowest land surface elevation is present near Lafayette in the Wabash River Valley where the elevation is about 520 feet (msl); it is in this area that the Lafayette (Teays) Bedrock valley begins its trend westward toward the Illinois state line. Near the Indiana-Illinois state line the present-day surface elevation is about 725 feel (msl), or approximately 200 feet higher than the land surface at Lafayette.

Geologic Setting

As the Lafayette (Teays) Bedrock Valley traverses the state from east to west, increasingly younger bedrock formations are encountered (Figure 4). Starting at the Ohio state line, the bedrock present in the base of the valley is of Ordovician Age, with

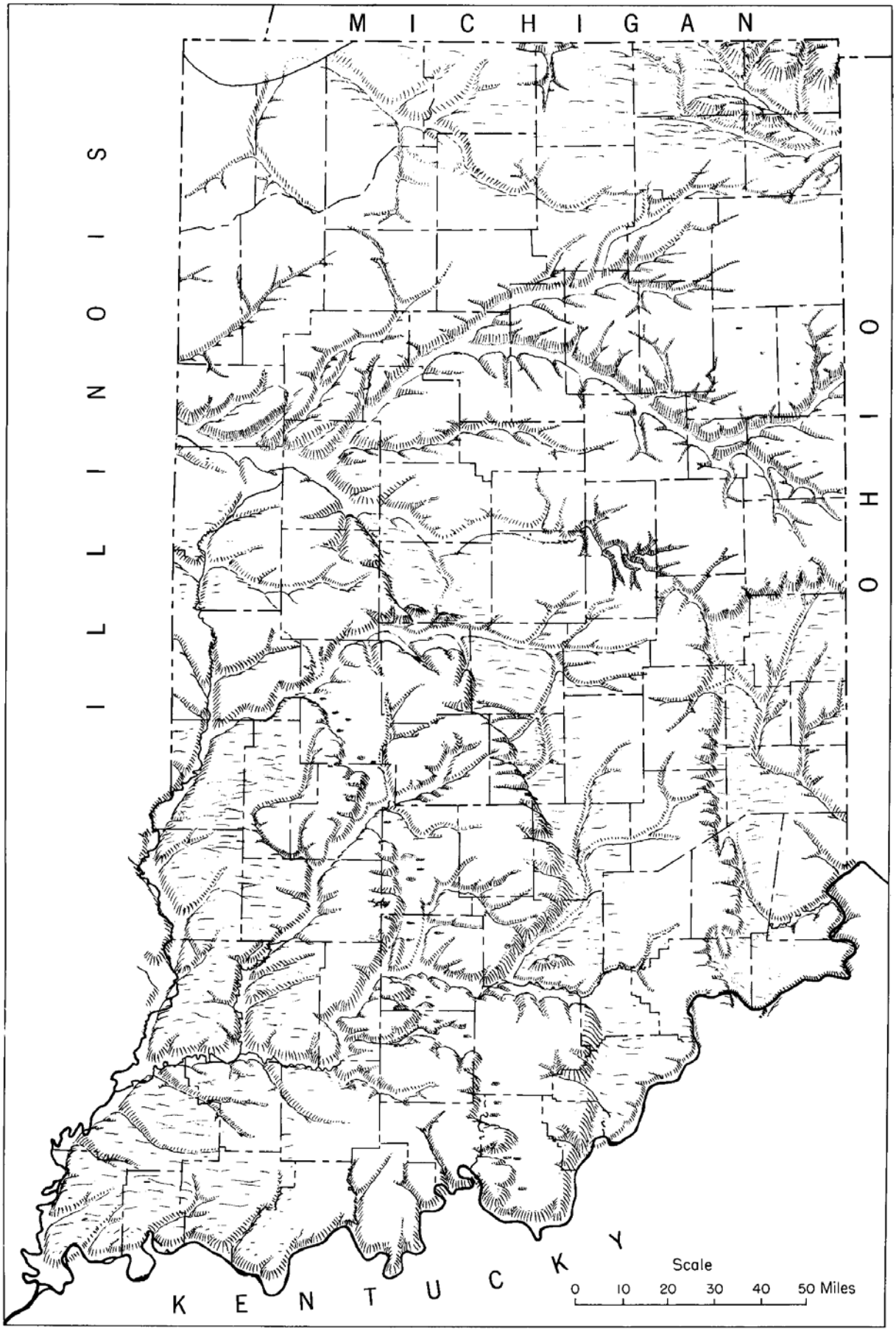


Figure 2. Physiographic diagram of Indiana showing topography at the close of the Pliocene (from Wayne, 1956)

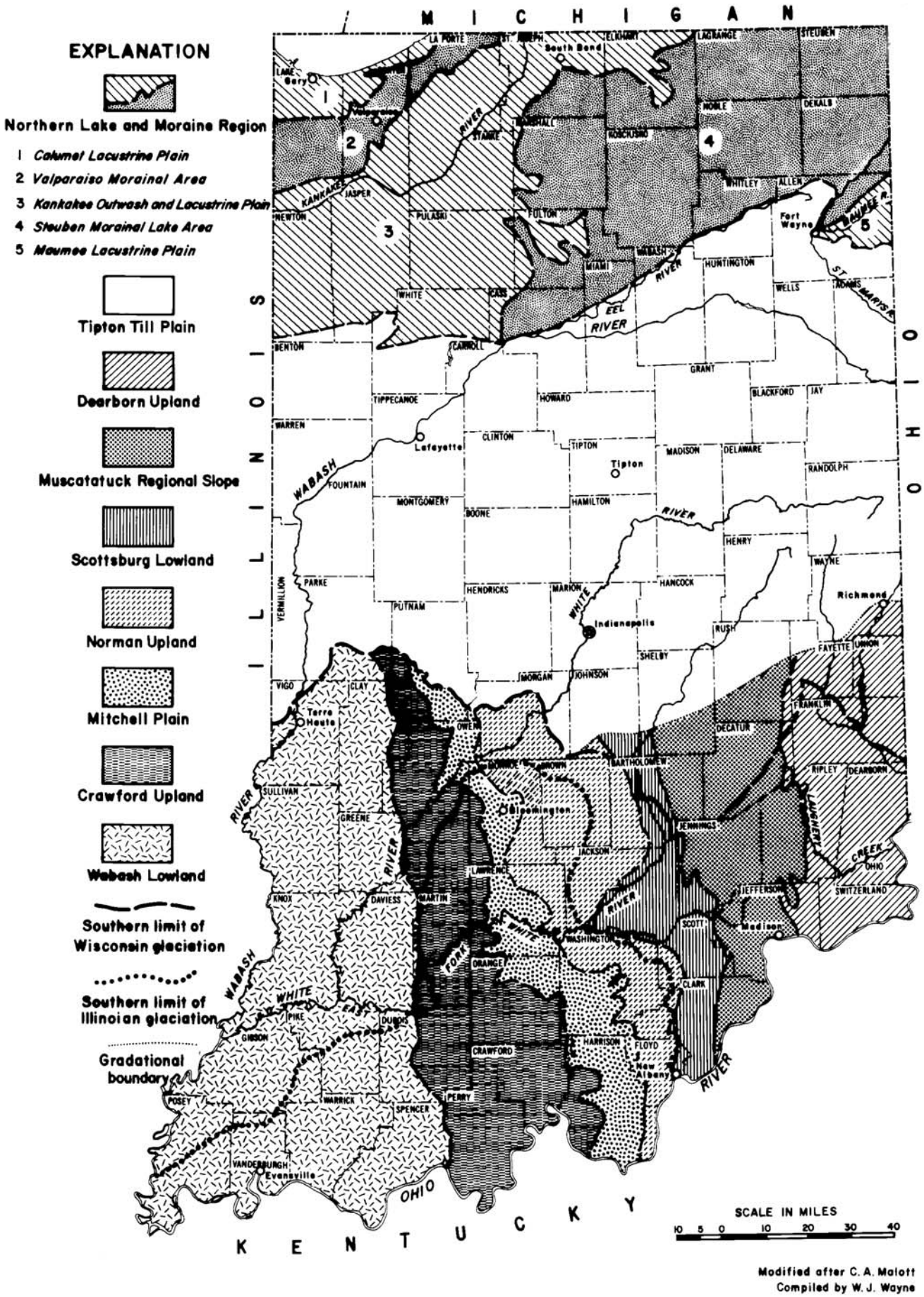


Figure 3. Physiographic regions of Indiana (after Malott, 1922, modified by Wayne, 1956)

younger Silurian bedrock forming the uplands and sidewalls of the valley. Westward into Jay, Blackford, Grant and Wabash Counties progressively younger bedrock is present in the sidewall and upland areas. Near the center of the state the Silurian bedrock still forms the valley floor and sidewall materials, but the younger Devonian limestones and shales form the uplands adjacent to the valley. In the western third of the state, lower Mississippian siltstones and shales are the major bedrock types present in the valley and sidewalls; scattered areas of Pennsylvanian sandstone, shale, and thin coal seams are present in the uplands. Contained within and overlying the Lafayette (Teays) Bedrock Valley are various types of glacial deposits. These materials consist of sand and gravel, varying textures and colors of glacial till, brownish-red to gray silt, and fine-grained lake deposits. These deposits are extremely variably in continuity and thickness, and radical changes may occur in short distances. The materials filling the valley commonly range between 200 to 425 feet thick, with a typical thickness greater than 300 feet. Wisconsinan age glacial deposits overlie essentially the entire valley, with Illinoian age and older deposits occurring at depth (Figure 5).

Bedrock Geology

Most of the following bedrock description is taken from Hill and Hartke, 1982. In the eastern portion of the state beginning at the Ohio state line, the subcrop (bedrock that occurs immediately below the glacial deposits) within the Lafayette (Teays) Bedrock Valley is composed of alternating layers of shale and limestone of Ordovician age (Figure 4). These rocks of the Maquoketa Group are found only in the deepest portions of the valley; they are present as far west as southern Wabash County.

In the area near the state line in Adams and Jay Counties, the Salamonie Dolomite forms the sidewall and upland flanks (Figure 4) of the Lafayette (Teays) Bedrock Valley. These rocks consist of dense to fine-grained, argillaceous, cherty dolomite. The Pleasant Mills Formation of Silurian Age, which stratigraphically overlies the Salamonie Dolomite, is also present in the area away from the valley. It becomes a prominent component of the upland bedrock surface near the valley in western Jay County and into Blackford and Grant Counties. The Pleasant Mills Formation consists mostly of dolomite and limestone with interbedded shale units.

In southwestern Wabash County and eastern Miami County, the Salamonie Dolomite and Pleasant Mills Formation form the floor of the bedrock valley with younger bedrock of the Wabash Formation occurring in the sidewall and adjoining upland areas. Westward into the central portion of the state in Grant, Wabash, Miami, Cass and Carroll Counties the Wabash Formation is present in the upland areas, flanks, and deeper portions of the Lafayette (Teays) Bedrock Valley. The lower part of the Wabash Formation consists of the Mississinewa Shale Member, a somewhat argillaceous, dense dolomitic siltstone. The upper part of the Wabash Formation consists of, in ascending order: the Liston Creek Limestone, a fine-grained cherty limestone; Kokomo Limestone Member; and the Kenneth Limestone Member.

In west-central Carroll County, Devonian bedrock forms the subcrop in the uplands and flanks adjoining the Lafayette (Teays) Bedrock Valley. Where the valley enters northern Tippecanoe County, bedrock of the Wabash Formation is present beneath the main valley (Figure 4). In much of northern Tippecanoe County, the bedrock present in the main valley floor is the Devonian Muscatatuck Group, consisting of the Traverse and Detroit River Formations comprised mostly of dolomite. The New Albany Shale of Devonian and early Mississippian Age, however, forms the subcrop under the Lafayette (Teays) Bedrock Valley in most of Tippecanoe County and eastern Warren County. The New Albany Shale, which is typically a black to brown carbonaceous shale, is expected to be dominantly soft greenish-gray shale further to the west.

In Benton and Warren Counties, which adjoin Illinois, the Borden Group of early Mississippian Age forms the subcrop in the area traversed by the valley. These rocks consist mainly of quartz-rich siltstone and shale, with occasional intervals of fine-grained sandstone and limestone. Pennsylvanian bedrock, composed of sandstone, shale, and lenticular coal seams form portions of the upland subcrop away from the main valley. Most of the bedrock units present in the sidewall and valley flanks are of the Borden Group of lower Mississippian age.

Preglacial History

The present day landscape of north-central Indiana bears little resemblance to that which existed when the Teays River flowed through the state. Prior to the "Ice Age" the terrain near the valley was similar in appearance to much of present-day south-central Indiana, with bedrock exposed in many places and deep narrow valleys entrenched into a hard bedrock surface. Tributary streams eroded valleys across an irregular bedrock terrain, eventually feeding into the main drainage systems that ultimately discharged into the Lafayette (Teays) Bedrock Valley. Major tributary streams include the Anderson, Metea, Wildcat, and Tippecanoe Valleys (Figure 2).

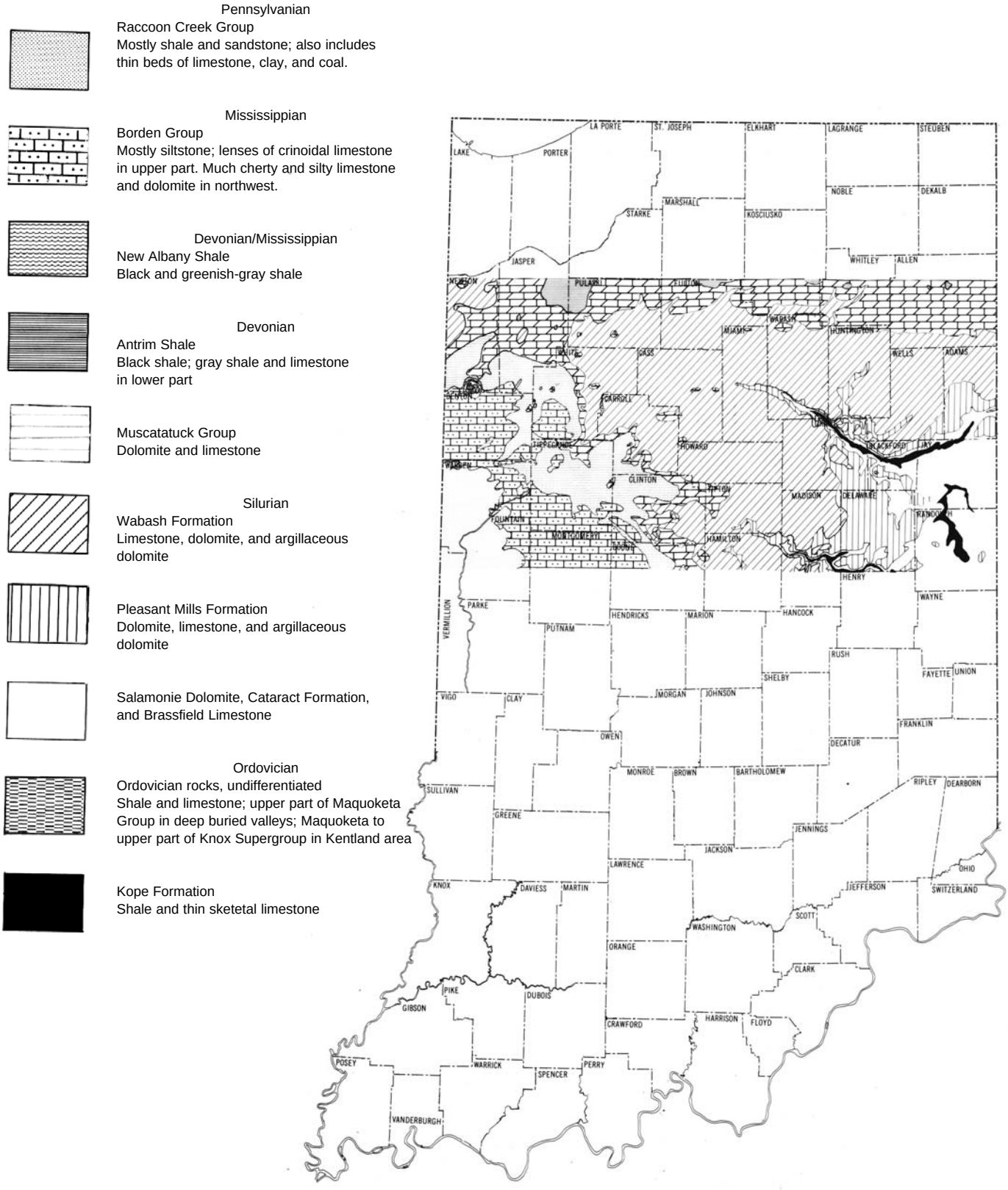


Figure 4. Bedrock geology of Lafayette (Teays) Bedrock Valley area (prepared by Indiana Geological Survey for this study)

Sand and some silt, dune sand of the Atherton Formation

Clay, silt, and sand - Lacustrine deposits of the Atherton Formation

Gravel, sand, and silt - valley-train and outwash-plain deposits of the Atherton Formation

Till - ground moraine of the Lagro Formation

Till - end moraines of the Lagro Formation: Union City, Mississinewa, Salamonie, Wabash, Fort Wayne, and packerton Moraines

Gravel, sand, and silt - ice contact stratified drift of the Trafalgar Formation; K refers to Kames

Muck, peat, and marl - paludal and lacustrine deposits of the Martinsville Formation

Silt, clay, and sand - lacustrine deposits of the Atherton Formation

Gravel, sand, and some silt - ice contact stratified drift of the Lagro Formation; K refers to kames, E to eskers

Till - ground moraine of the Trafalgar Formation

Till - end moraines of the Trafalgar Formation: Packerton-Mississinewa morainic complex, Crawfordsville Moraine, western half of Nebo-Gilboa Ridge, and Iroquois Moraine, Knightstown Moraine

Till - end moraine of the Wedron Formation; eastern half of Nebo-Gilboa Ridge, Chatsworth Moraine, Ellis-Paxton Moraine, and Illiana Moraine

Till - ground moraine of the Wedron Formation

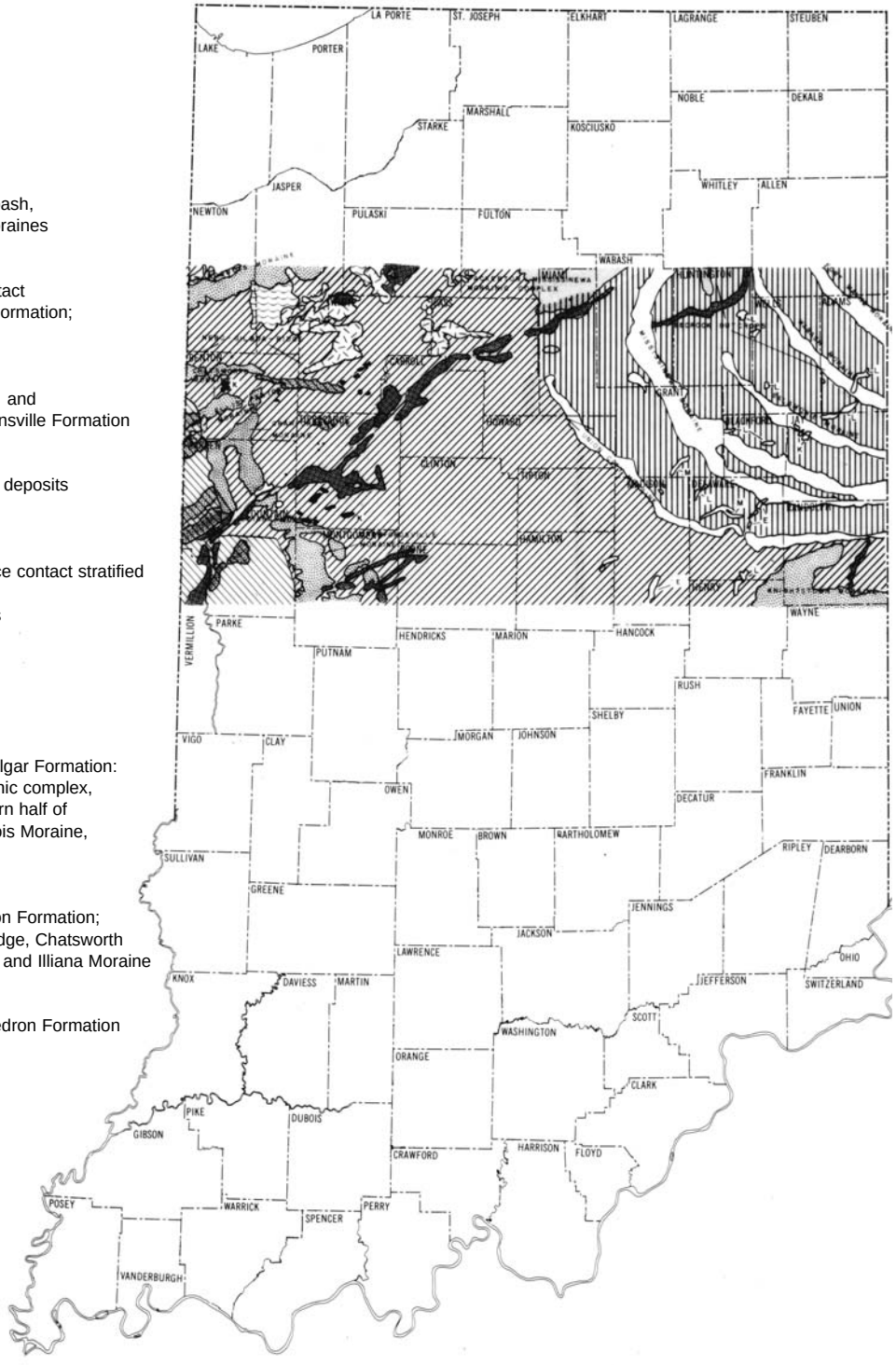


Figure 5. Glacial deposits of Lafayette (Teays) Bedrock Valley area (prepared by Indiana Geological Survey for this study)

In much of east-central Indiana the valley is gorge-like and confined to a width of one mile or less (Plate 1). In places the valley is over 300 feet below the surrounding bedrock uplands. In other areas, such as at Lafayette, the valley broadens to a width of several miles where the Anderson, Metea, Wildcat, and Tippecanoe bedrock valleys join with the Lafayette (Teays) Bedrock Valley. The Borden bedrock escarpment became a major barrier to further westward development of these streams. The reentrant condition that is present here is in many respects similar to the entrance of the East Fork White River Valley into the Borden escarpment west of Brownstown in Jackson County.

The origin of the bedrock valley (in north-central Indiana), while subject to considerable debate, appears to have had its headwaters east of the Appalachian Mountains (Bleuer, 1989) (See cover of this report). Some sources would place the headwaters as far east as North Carolina. From its headwaters it flowed westward through West Virginia, Ohio, Indiana, and finally into Illinois where it joined with the ancestral Mississippi River. Wright (1890) first used the name Teays to describe a high level abandoned valley in West Virginia located near the community of St. Albans, west of Charleston, east of Huntington.

The Teays Bedrock Valley up to St. Albans was essentially the same as the present day Kanawha and New River Valleys; however, westward it departed from the path parallel to the Kanawha and flowed via the abandoned valley southwesterly toward Huntington, West Virginia. From Huntington to Wheelersburg, Ohio the course of the Teays River is thought to be generally the same as that of the present-day Ohio River, as revealed by high-level terraces and abandoned valley remnants (Norris and Spicer, 1958). From this point on the Ohio River northwest of Franklin Furnace, Ohio the Teays took a more northward direction turning northwest toward Piketon, Ohio. It generally followed the course of the present day Scioto River Valley toward Richmondale, Ohio where it again exited the present Scioto Valley, only to subsequently re-enter about five miles south of Chillicothe, Ohio (Walker and others, 1965, Ohio Division of Water). North of Chillicothe near South Bloomfield, Ohio the valley began a new and significant trend as it left the essentially unglaciated part of its course. From this point westward to its confluence with the ancestral Mississipi River Valley in west-central Illinois, the valley is obscured by thick deposits of glacial drift. Its presence and location is only defined by available records of oil and gas wells, stratigraphic test holes, water wells, and seismic data, except in some circumstances such as at Richvalley-Peru where the present valley of the Wabash River reflects the modifications by the buried bedrock valley.

With few exceptions, evidence of this once extensive drainage system is now obliterated by thick deposits of glacial materials. Westward from South Bloomfield, Ohio the valley can be traced northwest toward London and Springfield, Ohio, and beneath the St. Mary's River Reservoir near Celina, Ohio. Through much of this portion of Ohio the Lafayette (Teays) Bedrock Valley assumes a gorge-like morphology, with valley walls descending rapidly into the deeper parts of the valley. This condition continues to the Indiana border where it enters east-central Adams County about eight miles east of Berne.

Glacial Geology

In eastern Indiana where the bedrock valley is present, from place to place the flat landscape is interrupted by a series of arcing and parallel end moraines that provide a degree of topographic variability to an otherwise monotonous expanse of till plain (Hill and Hartke, 1982) (Figure 5). From west to east the moraines consist of the subdued Union City Moraine, the Mississinewa Moraine, which overlies the Lafayette (Teays) Bedrock Valley, the Salamonie Moraine, the Wabash Moraine, and the Fort Wayne Moraine. These moraines are of the Ontario-Erie Lobe of the Laurentide Ice Sheet, of Wisconsinan Age; and are part of the Lagro Formation that is typically composed of a silt loam to silty clay till and is finer-grained than the underlying Trafalgar Formation. The Lagro Formation was deposited during late Woodfordian time, from 15,000 years before present (B.P.) to 14,000 years B.P. (N.K. Bleuer, oral communication, 1982). The Trafalger Formation, a silty, pebbly till, was deposited in the central part of the state and overlies the bedrock valley. In the western part of the state underlain by the bedrock valley, older morainal deposits are present that are attributed to the Lake Michigan Lobe, which dates to 17,000 to 18,000 years B.P. (N.K. Bleuer, personal communication, 1982). These moraines, as noted earlier, are capped in places by the Trafalgar Formation. Thus the surficial deposits in the areas underlain by the bedrock valley are of Wisconsinan Age.

In the central segment of the valley, the predominant surficial glacial feature is a level to slightly undulating glacial till plain as expressed by the Trafalgar Formation. The Tipton Till Plain is the predominant physiographic province, and only in Cass County, where a portion of the Packerton-Mississinewa Moraine complex edges into the area adjacent to the buried Lafayette (Teays) Bedrock Valley, does a change in the normal surficial glacial sequence occur.

The Trafalgar Formation, a Wisconsinan Age sandy loam to loam till, is the most extensive unit in the west-central portion of the state and is generally present in the form of a ground moraine. The Trafalgar Formation is of eastern derivation and caps portions of the older morainal systems including the Nebo-Gilboa Ridge and Chatsworth Moraine. The lack of typical arcuate terminal moraines coupled with extensive (up to 50 miles long) fluted forms, relict sub-ice channel features, and numerous ice-

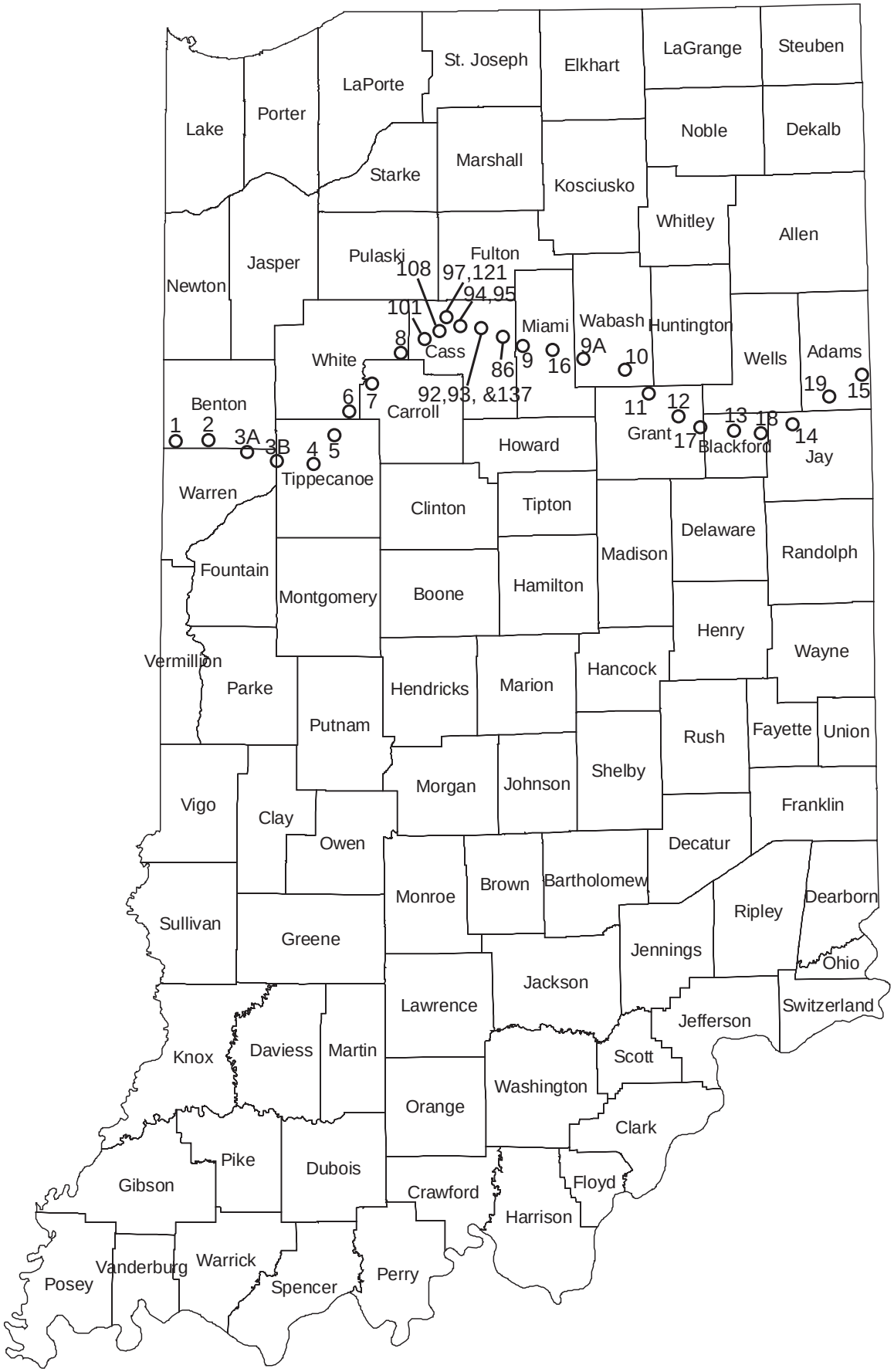


Figure 6. Location of test holes drilled for Lafayette (Teays) Bedrock Valley study and Logansport study of U.S. Geological Survey, 1981

flow indicators suggest that the glacial ice advance responsible for deposition of the Trafalgar Till was non-lobate in this part of Indiana. Because of the complex interrelationships, overlaps, and variation in composition of the glacial deposits, the interested reader is directed to the various studies by Bleuer (1974, 1975, 1989) and Hill and Hartke (1982).

The deposits of the Tipton Till Plain and the various morainal deposits have essentially obscured all evidence of the existence of the Lafayette (Teays) Bedrock Valley in the western part of the state. This area is generally characterized by a flat to gently rolling ground moraine that is locally dissected by the Wabash River, Tippecanoe River and other major streams. Several Wisconsinan end moraines are present in Warren and Benton Counties; they include the Nebo-Gilboa Ridge, Chatsworth Moraine, Ellis-Paxton Moraine, Illiana Moraine, and Crawfordsville Moraine. Only the Crawfordsville Moraine is not attributed to a Lake Michigan Lobe ice sheet (Hill and Hartke, 1982). That moraine defines the western limit of the most recent advance of the Ontario-Erie Lobe into west-central Indiana and is breached by the Wabash River along the Warren-Fountain County line.

In the eastern part of the state, streams of consequence including the Mississinewa, Salamonie, Wabash, and St. Mary's River mark the distal ends of the Mississinewa, Salamonie, Wabash, and Fort Wayne Moraines. These ice margin streams drain much of the northeastern portion of the state.

In none of the test holes drilled for this project was there any indication that the materials filling the valley were anything other than of Pleistocene Age (Figure 6). Any pre-glacial materials present in the valley had either been removed or reworked by glacial deposition.

The complex interrelationships of the glacial deposits that overlie and fill the Teays Valley are discussed by Bleuer (1989) in a report entitled "Historical and Geomorphic Concepts of the Lafayette Valley System (So-Called Teays Valley) in Indiana".

Lafayette (Teays) Bedrock Valley
Fill Composition and Ground-Water Potential

In any review of the ground-water potential of the Lafayette (Teays) Bedrock Valley system in Indiana, one quickly becomes aware of the widely held perceptions of the general public regarding the availability of ground water within the buried valley. The history of the valley dating back to the 1890s is replete with stories concerning the encounters that drillers have had with the thick glacial deposits filling the valley. Terms such as "deep drive" and "Loblolly" were often used to refer to the thick drift conditions in the valley in east-central Indiana. From the layman's viewpoint, these thick deposits contain an unlimited amount of water, and hardly any discussion of the Lafayette (Teays) Bedrock Valley is entered into without mention of an underground river and the connotation of the amount of water that goes with it.

What are the facts regarding the occurrence of ground water within the Lafayette (Teays) Bedrock Valley? To begin with, water in the valley is not part of an underground river. The water present is found within granular deposits of sand and gravel. The movement of the water within these deposits is only a slow trickle, generally at a rate of movement of less than five feet per day. Also, the valley is not a discharge point for the regional ground water as some believe, nor does ground water flow down the valley like a river as has been suggested. Water-level maps prepared for the area surrounding the valley reveal that no discernible effect is exerted by the valley's water-bearing formations on the regional ground water flow pattern (Plate 2). Water in the ground-water systems typically passes slowly through the valley-fill deposits and discharges some distance away at the land surface into the major streams and rivers of the area.

One of the major objectives of this study was to determine the ground-water potential within the Lafayette (Teays) Bedrock Valley and the prospects for finding appreciable amounts of water. The data gathered suggests conditions ranging from poor to excellent, depending upon the specific area and the volume of water needed. The valley in eastern Indiana presents a mixture of conditions varying from poor to excellent for obtaining wells yielding 500 to 1,000 gallons per minute (gpm) or more. Yields in the central segment of the state range typically from fair to good, and the western third of the state exhibits generally good to excellent conditions for obtaining high-capacity wells.

In the following pages a review of the expected ground water prospects is given for various segments of the Lafayette (Teays) Bedrock Valley across the state, starting at the Ohio state line and proceeding westward to Illinois. Cross-sections for each area accompany the discussion to illustrate the geologic and hydrologic conditions present. Figure 6 shows the location of test holes used for this study.