GEOLOGICAL HISTORY OF THE WHITEWATER GORGE AT RICHMOND, INDIANA

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FOREWORD AND ACKNOWLEDGEMENTS

This account of the history of the Whitewater Gorge was prepared a few years ago at the request of the late Mr. Robert N. Huff who was then collaborating on studies of the gorge with the Richmond Chamber of Commerce and SPUR (Society for the Use and Preservation of Resources). Mr. Huff's interest in local geology and in the history of Richmond and surrounding areas is well known and deeply appreciated by citizens of eastern Indiana and western Ohio.

For our knowledge of the Whitewater Gorge and of the rocks exposed along its sides, we are indebted to a long line of scientists and other interested citizens both in Indiana and Ohio. Locally, some of the earliest geologic work around Richmond was done in the late 1800's and early 1900's by geologists and biologists at Earlham College. Among these the best-known are the late Joseph Moore, Allen D. Hole and David W. Dennis who used the Whitewater Gorge and surrounding territory as an out-door laboratory. This practice has continued to the present day. In recent years, leadership in glacial studies at Earlham was in the hands of the late Professor Ansel M. Gooding who trained many students inthe field as well as in the lecture hall and laboratory. Professor Gooding's published papers in this field are known throughout the country. The present writer spent many months in the 1950's, studying glacial deposits and soils in the Whitewater Valley. Professors Charles Martin and Kent Van Zant also have been active in Pleistocene studies at Earlham.

The ancient Ordovician and Silurian limestones and shales have been studied by many geologists and paleontologists from the Universities of Cincinnati, Indiana, and Ohio, and work has been contributed to the journals by these same institutions in the field of glacial geology as well. Professor Helen B. Hay recently based her Ph.D. dissertation on studies of the Ordovician rocks at Richmond. Professor R. P. Goldthwaite of the University of Ohio and his associates contributed to our knowledge of the Pleistocene of Ohio near Richmond.

I am much in debt to Margaret Collings Brown for converting my rough map and cross-section drawings into neatly legible form. For

encouragement and support in this effort I am in debt to Mr. Donald Hendricks, President of the Stanley W. Hayes Research Foundation and to Professor James B. Cope of the Earlham Biology Department. I thank Eileen Jennens, Secretary of the Earlham Geology Department, for preparing the manuscript for printing.

I acknowledge with deep appreciation all the sources that have contributed to this presentation; but I accept full responsibility for any errors of fact or of interpretation.

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The gorge of the East Fork of the Whitewater River at Richmond, Indiana was cut by glacial melt-waters in the "Richmond Beds" of interbedded Ordovician limestone and shale. Field evidence indicates strongly that the gorge was cut in no more than a few hundred years by great summer floods during a period of rapid melting of the last sheet of glacial ice to cover the region about 15,000 years ago. Excessive flooding ceased when the glacier front was melted northward and northeastward across the divides between the East Fork of the Whitewater and the Miami and White Rivers. Before the present gorge was cut, summer floods extended from the present positions of the Court House to West Fifth and Main Streets.

GEOLOGICAL HISTORY OF THE WHITEWATER GORGE

Compiled by James Thorp,
Professor Emeritus, Earlham College

THE SETTING

The city of Richmond, Indiana, straddles the scenic gorge of the East Fork of the Whitewater River, but we often overlook the gorge or take it for granted in the course of our busy lives. The Whitewater River, taken as a whole, drains practically all of Wayne County, large parts of Union, Fayette and Franklin Counties, Indiana, and much smaller parts of Darke and Preble Counties, Ohio. It comprises two main branches, known respectively as the East and West Forks which come together at Brookville in Franklin County. From there the main Whitewater flows southeastward, to join the Miami River in Ohio, and thence to the Ohio River on the border of Ohio and Indiana. Each of the two main forks has many tributaries. We are concerned here only with the East Fork and its tributaries. Customary usage labels the three branches of the East Fork by the awkward terminology: (1) "West Fork of the East Fork"; (2) "Middle Fork of the East Fork"; and (3) "East Fork of the East Fork". The first rises in northern Franklin Township and joins the main East Fork just north of the Pennsylvania Railroad bridge at Richmond; the second and third rise in Darke County, Ohio, and come together just to the southeast of Reid Memorial Hospital. For convenience, I shall refer to these as West, Middle and East Forks.

The Whitewater Gorge at Richmond is mostly on the main East Fork. One small branch begins about 275 yards above the Chesapeake and Ohio bridge, where it is only 50 feet deep and about 400 feet wide. Another small branch of the gorge starts on the West Fork, at Thistlethwaite Falls on Waterfall Road where it is about 40 feet deep. From the FAlls to the main East Fork at the Pennsylvania Railroad bridge is about three fourths of a mile. From this point southward the west face of the valley is precipitous and rises about 60 feet above the river at Main Street bridge. In this stretch, and as far south as South C Street, the east side rises in "steps" or terraces. Total width of the valley here is about 300 yards. Below

South C Street the "real" gorge begins with a width of 600 feet from rim to rim. The gorge is 80 to 85 feet deep east of the High School and about 600 feet wide. It is somewhat wider and nearly 90 feet deep at the G Street bridge. Below G Street it deepens somewhat and at South I Street is 600 to 700 feet wide at the top and 90 deep. Opposite South N Street the gorge is about 100 feet deep and 600 feet wide.

Just north of Test Road, and about two and three fourths miles south of Thistlethwaite Falls, the gorge widens to a valley about one-fourth mile wide, flanked by steep slopes on both sides. The most rugged and scenic part of the gorge lies between the G Street bridge and Test Road.

Throughout, the river in the gorge is marked by many small rapids with reaches of quieter water between. While much of the East Fork seems to be flowing not far above bedrock, well drillers for the Richmond Water Works report as much as 55 to 60 feet of interbedded gravel, sand, silt, clay and boulders just above and below the G Street bridge. This suggests strongly that the lower gorge may have been as much as 150 feet deep while it was being carved from the Ordovician limestones, clays and shales; and it seems reasonable to suppose that there may have been a series of cascades and small waterfalls at one or more stages.

The shallow stony soils on the precipitous slopes support a rather dense growth of small trees, shrubs, and wild flowers. The deeper alluvium at water's edge has a growth of larger trees among which sycamore are prominent.

ANCIENT HISTORY

A brief look at the remote geologic past may give a better understanding of more recent geologic events leading to the formation of the gorge. The earth is very old, as measured by determination of relative radioactivity of certain metallic elements in rocks of different ages. Recent studies indicate strongly that our earth was assembled originally from gases, water, dust, and fragmentary rocks of various sizes and compositions, and achieved a size much as it is now, about 4.5 to 5.0 billion (thousand million) years ago. Most people find it very difficult to imagine so great a length of time; but gases, water, dust and larger rock fragments of the universe, from which the sum and its planets were assembled, had a much earlier origin.

Astronomers and physicists now believe that all the matter of our universe was held together as an unimaginably compact and dense mass until about 20 billion (20,000 million) years ago. For reasons unknown and only vaguely imagined, this enormous mass exploded suddenly (the "BIG BANG"), sending gases, rocks and dust in all directions to from what the astronomers call "the expanding universe." Forces of gravity have organized and continue to organize these materials into galaxies of stars, nebulae, planets, dust clouds and inter-stellar gases in quantity and size so great that our whole solar system is but a microscopic speck of dust by comparison.

If we accept the foregoing as a possibly reasonable explanation for the materials that make up our earth, let us skip about nineteen billion years and consider the time that the bedrock of limestone, clay and shale in the Whitewater Gorge were laid down. About 500 to 600 million years ago, sand was being washed from what is now the Laurenian Highlands of Canada, and from regions east of here, to form what we know as the Cambrian sandstone, The sandstone, thus formed, probably lies something like 1,500 feet below the surface at Richmond and is the local foundation holding up the bedrock that appears in the walls of the gorge.

About 440 to 580 million years ago, a shallow, semitropical sea (The Ordovician) covered vast areas in what are now the United States and Canada. The sea swarmed with a large assortment of shellfish, including snails (gastropods), various clam-like creatures (pelecypods), brachiopods, segmented cephalopods (ancestral to the modern chambered nautilus); and trilobites and other arthropods (ancestral to modern crabs and lobsters.) And probably there were fish, also; but their skeletons were of cartilage and were seldom preserved as fossils. The semitropical sea was rather shallow and was marked by many colonies of corals of various species, and by extensive colonies of Bryozoa ("branch corals") some resembling real corals and some moss-like in structure. As these animals matured and died, their limy shells collected on the sea bottom and were gradually cemented in thin layers to form limestone. From time to time mud was carried into the sea from adjacent land areas, and ash from distant volcanoes may possibly have settled from the air and contributed to the sediments. The fine sediments became the "blue clay" of Blue Clay Falls, southwest of Richmond, and it can be seen in thin layers between limestone beds exposed in the Whitewater Gorge.

Of course, the warm sea abounded also in plant life, especially sea weeds (algae of various species) which were basic to the "food chain" for animal life of the times. No doubt many readers have seen and collected seashells and trilobites as well as corals and Bryozoa along the Whitewater Gorge and its tributaries. Fossils are so abundant in the Ordovician and Silurian limestones and shales around Richmond that they have become well-known around the world by geologists of many countries.

The thin-bedded limestone slabs of the Ordovician beds around Richmond have been widely used for house foundations, retaining walls and for making flagstone paths.

About 440 million years ago the semitropical Ordovician sea withdrew from some parts of the continent to form dry land; but here at Richmond the sea soon returned, with distinctive forms of animal and plant life. Limestones, formed from seashells, and interbedded clays and shales are known as beds of the Silurian period. The Silurian limestone in and near Richmond, as at the junction of Wernle and Garwood roads in Short Creek valley, and on the upper reaches of the Middle Fork of the East Fork above Middleboro, is more massive than the layers of limestone in the Richmond Ordovician beds. It is quarried in several places for building stone, for making aggregate for concrete, and for agricultural "lime."

The Silurian limestone of the Richmond area continues northward and eastward underground, to crop out around the Great Lakes and in the folded Appalachian Mountains. It is said that this is the same limestone that makes the "lip" of Niagara Falls between New York and Ontario. So we might think of the small waterfall on Short Creek at Garwood Road, and a similar one on Elkhorn Creek, as "little Niagaras"!

After the deposition of the Silurian beds, the shallow sea became clogged with mud which consolidated eventually into thin-layered shale much as one finds around New Albany, Indiana, Columbus, Ohio, and around the Great Lakes. In some regions, also, there were beds of limestone with seashell fossils. In some parts of the United States beds of this age, known as the Devonian, there are so many fossil remains of fish (mostly scales) that the Devonian has become known as "the Age of Fishes". Deposition of Devonian beds ceased about 350 million years ago; so the combined Silurian and Devonian beds were laid down over a period of about 90 to 100 million years. It is likely that the Richmond area was once covered by Devonian shales, but that they were eroded away long before the gorge came into existence. The only bedrocks exposed here now are of Ordovician and Silurian ages.

A long time after the Devonian and possibly younger beds had been deposited the rocks of this region experienced strong lateral pressure from the east and were gradually pushed and bent upward slightly in the form of an arch, known to geologists as the "Cincinnati Arch" or "Cincinnati Anticline". Gradually, over a period some million of years, the upper layers of rock were worn away by erosive forces. Any Devonian shale and younger rocks that may have been here were removed, and only Silurian and Ordovician rocks remained. These beds dip very gently eastward and westward from the center line or "axis" of the Cincinnati Arch, not far from Richmond. The slopes of the rock beds in the arch are so gentle at Richmond that one cannot detect them without instruments.

GLACIAL HISTORY

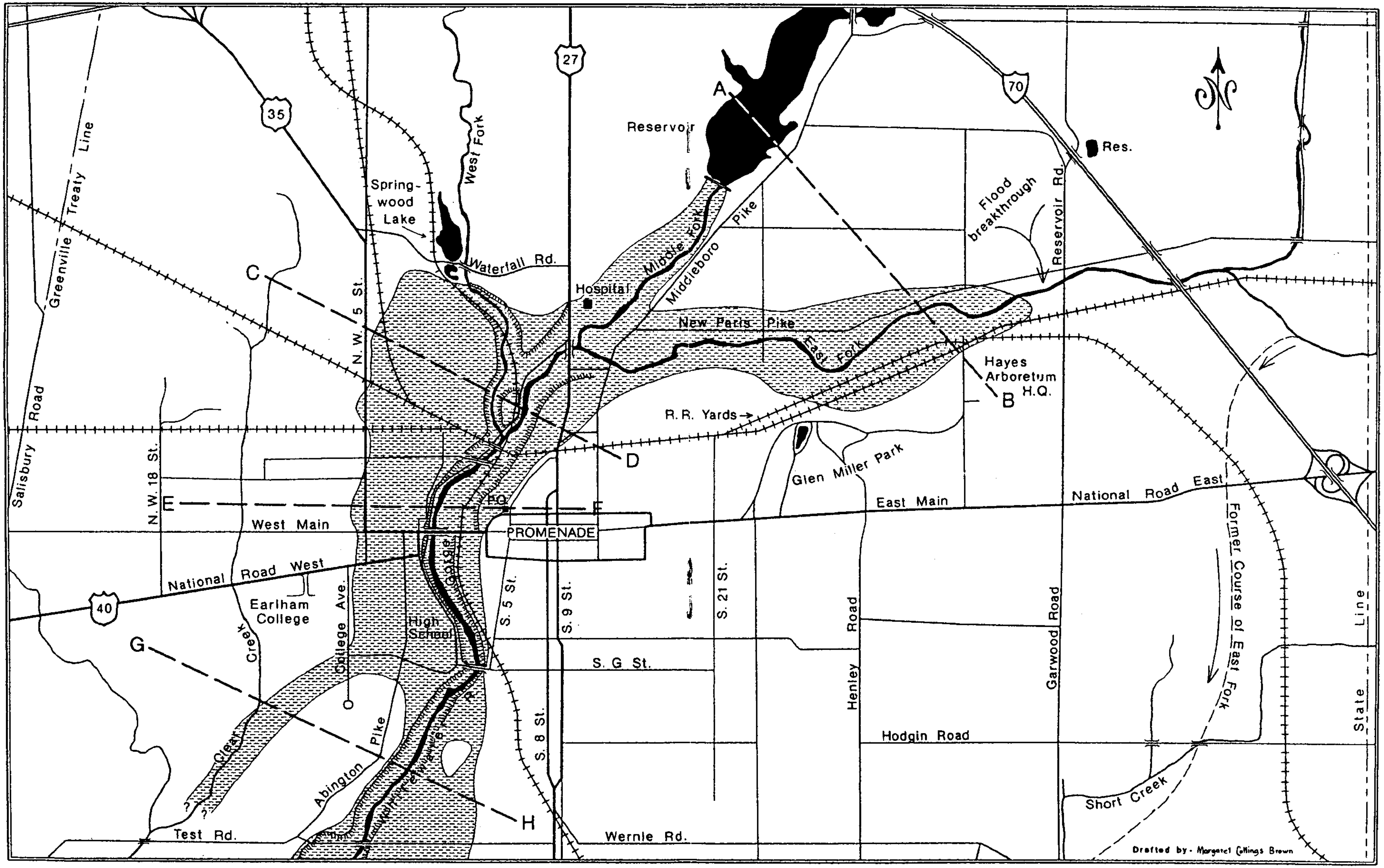
Now, let us skip over something like 350 million years from the end of Devonian time to the Quaternary period which is believed to have been initiated about two to three million years ago. The Quaternary includes the "Pleistocene" and "Recent" epochs, the first of which is commonly called the "Ice Age" and the second might be thought of as the last five to ten thousand years. Geologists believe that the Quaternary period began with climatic changes, markedly different from conditions which prevailed during the Pliocene epoch which preceded it. Causes for the climatic changes are not fully understood, and there are several hypotheses on this point. One recent hypothesis is that the solar system has passed through clouds of cosmic dust which "shaded" the earth from some of the sun's heat. We shall concern ourselves here only with events of the Pleistocene as they affect the origin of the Whitewater Gorge.

The late Professor R. F. Flint of Yale University, recognized as one of the great authorities on glaciation, stated that the development of vast continental glaciers began in northern Europe and in Switzerland probably more than 400 thousand years ago, but we have no accurate measure for the exact time. The figure from Switzerland is based on potassium-argon ratios. At that time in northern Europe and the Alps, and in northern North America, the snow-fall of winter began to exceed summer melting, so that large areas remained covered by snow throughout

the warm months of the year. As the years advanced, the snow cover became progressively thicker on the ground, and covered increasingly larger areas. First, the upper layers of snow melted slightly and recrystallized to make granular ice particles which are known to geologists and cross-word puzzle addicts as "névé" or "firn". One can see neve almost anywhere around Richmond in late winter and early spring, during alternating freeze and thaw periods. As the thickness of the névé layer increased, the fine ice particles were pressed together and recrystallized to form solid ice in the lower part of the accumulation. When the ice thickened to hundreds and eventually even to thousands of feet, it was squeezed outward from the area of greatest thickness as a bulging and slowly moving mass around the perimeter of the ice-covered region. Thus, in the mountains, "rivers" of ice, known as "valley glaciers" flowed, inch by inch, into the lowlands. One can see such valley glaciers today in the western and northwestern mountains of the continent. On smoother land, hundreds of thousands of square miles of thick "continental" ice sheets accumulated. Downward pressure forced the ice at the bottom of the glacier to move outward from areas of greatest thickness, in more or less horizontal directions, to regions where snowfall and ice-thickness were less. Where the ice reached thicknesses of many thousands of feet, as it does even now in Antarctica and Greenland, the ice at the bottom of the glacier moved indiscriminately across small valleys and hills, scouring soils and rocks from hilltops and filling valleys with rock debris.

One area of "continental" glacial ice, relevant to our local situation was in southwestern Labrador and in Quebec and Ontario, north of the present valley of the St. Lawrence and the Great Lakes. The ice at the base of the glacier picked up rocks of many kinds and used them as tools to scour the underlying bedrocks, and to grind them into sand-, silt-, and clay-sized particles. At the base of the glacier the ice became loaded and choked with boulders and finer particles. It has been estimated that the glacier was at least two miles thick in southern Ontario and in areas that are now occupied by the Great Lakes.

Continental glaciers accumulated several times in this manner and melted away following each major ice advance. Specialists in glacial geology have recognized four major "stages" of glaciation in North America and Europe, each with several sub-stages or "stades" of alternating advance and partial melt-back of the ice front. Time periods between major stages of glaciation are represented by evidences of the spread of vegetation and the development of soils from the glacial debris. Enough remnants of soils of the interglacial stages



RICHMOND, IND.   Scale: 0 ½ 1 mile   Area of glacial floods have been preserved to enable us to estimate that these stages may have lasted perhaps 20,000 to 50,000 years each -- possibly more.

Stages of the Quaternary period, or "Ice Age" usually recognized in northcentral United States and eastern Canada from oldest to youngest, are as follows: (1) Nebraskan glacial; (2) Aftonian interglacial; (3) Kansan glacial; (4) Yarmouthian interglacial; (5) Illinoian glacial; (6) Sangamonian interglacial; (7) Wisconsinan glacial; (8) post-Wisconsinan interglacial, including the present. Recent work in Iowa suggests that ice advances may have occurred before the Nebraskan glacier. The naming of the last stage in which we live, as an "interglacial" assumes that we are living in an interglacial rather than a postglacial stage. Who knows? Actually, of course, enormous glaciers still exist on earth. If they all should melt, ocean levels would rise enough to drown out all the seaports of the world! And it is reasonable to suppose that a new continental glacier will develop in Canada some time and, over a period of several thousand or tens of thousands of years, may spread southward again to the Ohio valley.

It has been possible to estimate fairly accurately the timing of the more recent glacial events by determining the amount of radioactive carbon ("carbon 14" as contrasted with carbon 12 the more common form) in old organic material in the glacial deposits. Usual methods of determination can place dates on glacial deposits somewhat more than thirty thousand years old. More elaborate methods can give rough estimates of close to sixty thousand years. Organic materials for carbon-14 dating are found in old soils and peat beds buried in the glacial deposits. Peat is formed in lakes, marshes and swamps where dead plants sink to the bottom and new plants take their places at the surface. Obviously, undisturbed peat at the base of the deposit will give older dates than peat nearer the surface. Advancing glaciers pushed across the land over prairies and forests and sometimes incorporated tree trunks, branches and even leaves. Many such organic remains have been found in the glacial deposits of Ohio and Indiana, and we have been able to give approximate dates, derived from these, for events leading up to the formation of the Whitewater gorge.

To return to a consideration of the various stages of glaciation we have no evidence at present that the earliest surely known stage of Pleistocene glaciation -- the Nebraskan -- reached as far south as Richmond, Indiana; but it did cover nearly all of Iowa, eastern Nebraska and northeastern Kansas. Apparently, the Kansan

glaciation was much more extensive. Geologists in Ohio and Indiana have demonstrated that the glacier of the Kansan stage crossed the present course of the Ohio River from just below Cincinnati, to possibly as far as New Albany, Indiana. Probably it covered more than 50 square miles in Northern Kentucky. Certainly it must have passed over the site of Richmond. I have found a few possible remnants of post-Kansan (Yarmouthian) buried soils near Richmond, covered by later glacial deposits; but the evidence is rather meager.

At the end of the Kansan stage of glaciation, the continental ice sheet melted away and a long "interglacial" (the Yarmouthian) stage, with spreading vegetation and soil formation came about. It is thought that this stage lasted for several tens of thousands of years, during which climatic conditions and vegetation were somewhat like those of the present. Much of the Yarmouthian soil was swept away during the advance of the next glacier -- the Illinoian. We are sure the Illinoian glacier passed over the site of Richmond and went farther south than Wayne, Union and Fayette counties.

As with the Kansan Stage, ice of the Illinoian Stage eventually melted away, vegetation spread over the land again and new soils were formed on the Illinoian deposits. This time of soil formation, known as the Sangamonian Stage, continued for perhaps several tens of thousands of years. As reported by Gooding and Gamble several remnants of Sangamonian soil occur southwest of Richmond -- one about a quarter mile south of Test Road on Salisbury road; two more of them about two miles up the small stream from Blue Clay Falls, and a small branch of this stream on the Bolling farm (known earlier as the Smith farm). The latter is exposed in a deep gully south-southeast of Centerville.

Remnants of the "Sangamon soils" of the Sangamonian Interglacial Stage in this area show evidence of swampy conditions, with gray soils, mottled with yellow and rusty brown. They contain pine needles, pollen grains, seeds of rushes and other swamp plants; and Gooding also found mosses that were preserved in the original position of growth. No doubt, as the glacier of the Early Wisconsinan Stage advanced, the swamps and marshes were frozen solid and covered by ice, and the glacier "skidded" over the frozen wet areas without destroying plants and soils. Most plants and soils on higher well-drained positions and not protected by ice were scoured away by the advancing glacier. When the ice melted, its burden of sand, silt, clay and gravel accumulated over the remnants of Sangamon soils.

Organic remains in the buried Sangamon soil have been tested for radio-active carbon in an attempt to determine the length of time elapsed since the soils were buried; but, by the methods used, the organic matter proved to be too old to give any good basis for estimate. A piece of wood, embedded in the earliest Wisconsinan deposit (Gooding's Whitewater drift) was reported by Gooding to have a radiocarbon age of "more than 43 thousand years". Since this piece of wood was close to the bottom of the Whitewater drift and only two or three feet above the Sangamon soil, it is reasonable to suppose that the wood is from a tree that was growing on the Sangamon soil when the Whitewater ice front was advancing southward.

Professor A. Dreimanis of the University of Western Ontario sampled organic material from beds in southern Ontario which Gooding believed to be from deposits made during the southward advance of the earliest Wisconsinan glacier. Hessel de Vries of the Rijks-University of Gronigen, Netherlands, tested this material for radiocarbon, using very elaborate and sensitive methods for the determinations. He obtained dates ranging between sixty and seventy thousand years before the present. The glacier front is thought to have advanced to the site of Richmond nearly fifty thousand years ago. This appears to be the best estimate we can make at this time for the arrival of the glacier of the Whitewater stade of the Wisconsinan stage.

The Whitewater glacier of early Wisconsinan time appears to have come from slightly west of north and probably came to a halt somewhat farther south than Liberty and Connersville. Ice of the Whitewater stade probably melted back only as far as northern Wayne County. Then there was a resurgent ice advance, this time from a northeasterly direction, that covered the Whitewater drift deposits and moved farther southward than the ice of the Whitewater stade. This "Fayette" stade of the early Wisconsinan stage was also too old to be dated by the radio-carbon method used. Based on carbon-14 figures obtained by Dreimanis in Ontario, we speculate that it may have begun somewhat more than 40 thousand years ago. In many places the Fayette deposits were covered later by silty material -- at least partly wind-laid dust (Gooding's Connersville silt). The silt supported vegetation sufficient to leave some organic material which has been dated by radio-carbon at 20 thousand years, give or take 500 years. Deposition of the Connersville silt marked the end of the Early Wisconsinan stade of glaciation and the beginning of the Late Wisconsinan stade.

The front of the first of the Late Wisconsinan glaciers advanced over the Early Wisconsinan deposits about as far as a line extending from southern Fayette County, south of Connersville, southeastward past the site of Brookville and to the Ohio line at the southeastern corner of Franklin County. Gooding correlated the deposits made by this glacier with the Shelbyville drift of Illinois and west-central Indiana.

When the Shelbyville glacier front was melting back, about twenty-thousand years ago, as measured by the carbon-14 method, the flood water cut a deep channel, sixty or more feet below the present surface, at what is now the deep gravel pit southwest of the Dana Perfect Circle factory and southward through the present Earlham College property. No doubt other channels were cut in what is now east Richmond. We do not have all the details. It seems likely that most of the deep channels around southeast Richmond had not yet been excavated at the time Shelbyville ice covered the region; and the Whitewater gorge had not yet come into existence.

The Shelbyville ice melted back rapidly, possibly as far as the present boundary of Wayne and Randolph Counties, and perhaps as far northeast as Greenville, Ohio. In a rather short time the ice front surged forward again about as far as the present Elkhorn Creek, Abington, and the northwestern corner of Union County. As the ice front advanced, melt-water filled the old deep channels with gravel and the ice slid over it. Deposits made by this re-advance of ice were correlated by Professor Gooding with the Champaign deposits of Illinois, marked by the Champaign moraine of that state and western Indiana. This sub-stade of the Wisconsinan glacier reached its maximum advance considerably less than twenty thousand years ago, and it seems that the ice stagnated at this point

Uneven melting of the stagnant Champaign ice left deep holes in it and some of these were filled with gravel by streams running on the surface of the ice. When the ice melted away these gravel-filled holes were left as small hillocks, known to geologists as "kames". Lone Tree Hill, on the Klemperer farm south of Richmond, probably was formed in this manner. The many stream channels and the Whitewater gorge itself were cut soon afterward.

GLACIAL FLOODS

Once again the ice began to melt more rapidly along its frontal border than the glacier moved forward, with a net northward retreat of the ice front. First, it melted back far enough for flood waters to cut the valley of Elkhorn Creek. Then the front "retreated" by a series of steps to a line along the north border of the present Short Creek valley. Here, at the height of summer, a flood about three-fourths of a mile wide rushed southwestward to the Whitewater. Then, successively a series of channels were cut through what is now southeast Richmond, at nearly the same height as the valley bottom of Short Creek. One of these channels came through what is now the Hayes Arboretum "garden" south of the Hayes mansion and spilled into Short Creek valley. Then the melt waters from above New Paris, Ohio, which had been following Short Creek, broke through to the main East Fork of the Whitewater at the level of the New Paris Pike along the border of the Hill cattle farm just east of Middleboro Pike. From there it followed the same grade to West Richmond about as far west as west Fifth Street (see map). At that time, floods from above the site of New Paris joined the flood coming down the Middle Fork of the East Fork and swept away much of the glacial deposits nearly five blocks west of the present gorge. At this stage, of course, there was no gorge. Flood waters extended from the present west Fifth and Main Streets almost to the site of the Court House.

The flood waters on the site of West Richmond were divided by the low ridge on Abington Pike just south of SW G Street, part going across the site of College Avenue at SW Q Street and part -- the greater part -- going southward east of the present Abington Pike. This left an unflooded area from the front campus of Earlham College northward with its cover of glacial till still intact. This till cover is about three to ten feet thick -- possibly more in places. It can be seen above the gravel in the gravel pit on NW L Street. People who live in the housing development just east of College Avenue and north of SW G Street know that the soils there are thin and lie directly on Ordovician clay and limestone. Soils are similarly thin between Abington Pike and the gorge.

It appears that the melt-water floods were unable to "find" the old filled channel southwest of the Dana factory. Instead they poured mainly across the land east of Abington Pike and peeled off layer after layer of limestone and shale where water was deepest and most swift. Below Abington the East Fork had been open long enough since the time of the Shelbyville glacier to

develop a good outlet for flood waters from the Champaign glacier, and the river had cut a valley as far upstream as Test Road before the waters had broken through north of the Arboretum and beheaded Short Creek.

Floods coming through the site of West Richmond soon became most concentrated into a narrow channel east of Abington Pike and lowered the water level enough to stop the flow across the site of College Avenue and down Clear Creek. The excavation of the Whitewater Gorge began in earnest.

The slabby structure of the limestone layers facilitated rapid erosion as long as melt-water was available to flood the streams in the warm months of the year. One might speculate that the gorge could be cut in a few hundred years. We do not know exactly how long it took. We do know that the floods were strong enough to roll and tumble slabs of limestone up to 100 pounds in weight at least as far as in a river terrace just north of Abington, where they are "shingled" between layers of gravel.

The Champaign ice melted back to the borderland between Wayne and Randolph Counties and, in Ohio, southeastward from Hollansburg (near the Indiana border), to Gettysburg and points farther southeast in Ohio. Along this line there was an approximate balance between forward movement of the glacier front and melting of ice along the front. In effect the ice front was stationary long enough for a moraine -- piles of mixed rocks, clay, sand and gravel -- to be formed. This line of irregular low hills is known as the Bloomington moraine (for Bloomington, Illinois). It is known also as the "Boulder Belt" because of the large number of boulders exposed at the surface. In Ohio geologists call this the Farmersville Moraine.

After extensive field studies Professor Gooding came to the conclusion that the boulders were concentrated at the surface when great floods of melt-water washed away the finer materials of the glacial drift and left the boulders behind. These boulders are of many kinds, most of which were transported by the glacier from Ontario, Michigan and northwestern Ohio. Most of the boulders have either been moved from the fields and piled up around farm buildings, or they have been buried so that the land can be plowed.

THE LAST GREAT FLOOD

About fifteen thousand years ago, when the Bloomington ice was melting, we have much evidence that there was a sharply marked warming of the climate. The Kankakee River in northern Indiana and Illinois carried tremendous summer floods of melt-water, and we have evidence of comparable floods in the Whitewater Valley. At the height of flood season the erosive power of streams was multiplied many times. We have already cited evidence that the Whitewater Gorge was channeled fifty to sixty feet below the present bottom of the gorge. When the super-floods subsided the gorge was partially refilled with sand, silt, gravel and clay. Subsidence of flood water was most marked when the Bloomington glacier melted back across the divides between the Whitewater and the Miami rivers, and between the Whitewater and the White Rivers.

Now, floods are fewer and much less voluminous and destructive than those of waning glacial times, and the East Fork and its three main tributaries continue very slowly to deepen their channels and adjust their gradients to the new conditions. As the river continues its work at reducing the level of the land, people of Richmond have, in the gorge, a priceless heritage of scenery, recreation potential, and geologic history which all may enjoy if we cherish it. In the country around Richmond we may be thankful that the glaciers ground up and deposited a rich mixture of rock materials from which, along with a humid temperate climate, some of the most productive soils of the world have been formed.

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