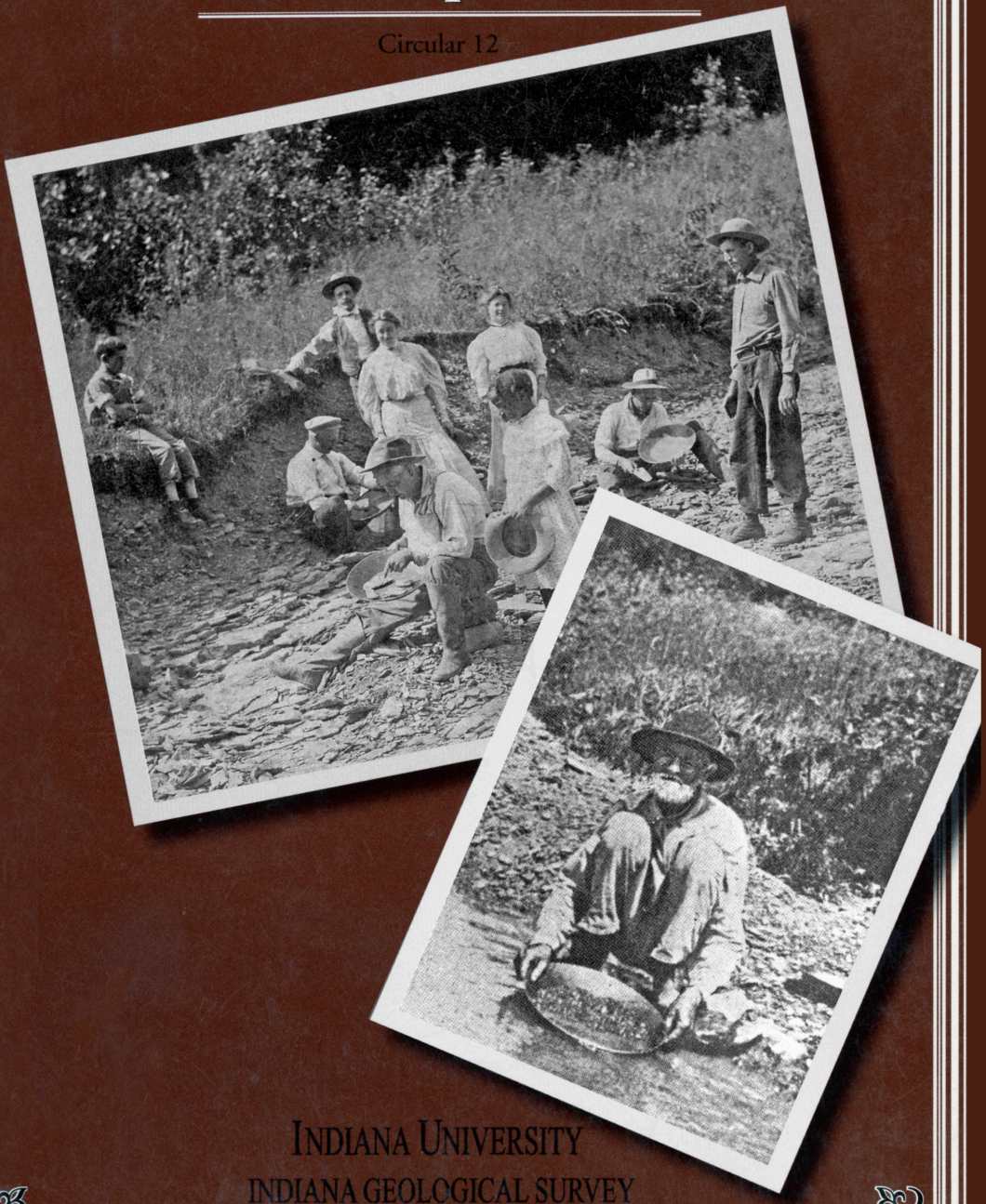
Gold and Diamonds in Indiana

An Update

Circular 12



INDIANA UNIVERSITY
INDIANA GEOLOGICAL SURVEY

Staff of the Indiana Geological Survey

Administration (812) 855-5067
John C. Steinmetz, Director and State Geologist
John R. Hill, Assoc. Director for Administration
Amanda Wilson, Administrative Secretary and Licensing Coordinator
Charlotte A. Smith, Business Manager
Helen Stephenson, Financial Records Associate
John Rupp, Asst. Director for Research

Center for Geospatial Data Analysis (CGDA) (812) 855-7428
Sally L. Letsinger, Hydrogeologist and Assistant Director of CGDA
Chris Dintaman, Geologist and GIS Specialist
John Haddan, Field Laboratory Specialist
Virginia Haddan, Secretary
Denver Harper, Geologist and GIS Analyist
Kevin M. Spindler, Hydrogeologic Modeler
A. Chris Walls, Geographer and GIS Specialist

Coal and Industrial Minerals Section (812) 855-2687
Nelson R. Shaffer, Geologist and Section Head
Agnieszka Drobniak, Coal Geologist
Kristi Carlson, Secretary
Walter A. Hasenmueller, Geologist
Christina James, Geological Technician
Erik P. Kvale, Sedimentologist
Maria Mastalerz, Coal Geologist
Rebecca Meyer, GIS/Database Analyst
Todd A. Thompson, Sedimentologist
Licia A. Weber, Geologist
Amzie Wenning, Geological Technician

Education Extension (812) 855-1337
Jefferson R. Kirby, Education Coordinator

Environmental Geology Section (812) 855-7428
Nancy R. Hasenmueller, Environmental Geologist and Section Head
N. K. Bleuer, Glacial Geologist
Steven E. Brown, Glacial Geologist
Marni Dickson, Research Geologist
Jennifer Olejnik, Geologist
Virginia Haddan, Secretary
Robin F. Rupp, Geologist

Geochemistry Section (812) 855-2687
John B. Comer, Geochemist and Section Head
Tracy D. Branam, Geochemist
Kristi Carlson, Secretary
Margaret V. Ennis, Geochemist
Ronald T. Smith, Geochemist

Photography and Imaging Section (812) 855-1370
Barbara T. Hill, Section Head
John M. Day, Photographic Specialist
Donna M. Webb, Secretary

Physical Facilities and Field Services Section (812) 855-3596
Samuel S. Frushour, Section Head
Jay E. Arnold, Field Foreman
Donna M. Webb, Secretary

Technology Transfer Section (812) 855-3951
Richard T. Hill, Section Head
Deborah A. DeChurch, Editor
Janis Fox, Sales Office Manager
Kathleen Griffin, Network Support Specialist
David Held, Cartographic Specialist
Paul N. Irwin, GIS/Database Analyst
Wei Qin, Database Administrator
Kathryn R. Shaffer, Mineral Statistician
Kimberly H. Sowder, Cartographic Coordinator
Reneé Stubenrauch, Cartographic Specialist
Donna M. Webb, Secretary

Subsurface Geology Section (812) 855-5412
John A. Rupp, Geologist and Section Head
Sherry K. Cazee, Sample and Core Library Supervisor and Secretary
Brian D. Keith, Petroleum Geologist
Premkrishnan Radhakrishnan, GIS Specialist
Wilfrido Solano-Acosta, Research Geologist
Charles W. Zuppann, Petroleum Geologist

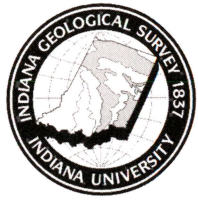
Research Affiliates
Lewis M. Brown
John B. Droste
Henry H. Gray
Edwin J. Hartke
Norman C. Hester
Noel C. Krothe
Greg A. Olyphant
Richard L. Powell
Carl B. Rexroad

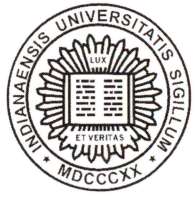
For sale by Publication Sales, Indiana Geological Survey
611 N. Walnut Grove, Bloomington, Indiana 47405-2208
phone: (812) 855-7636
e-mail: IGSinfo@indiana.edu
Web site: http://igs.indiana.edu

Gold and Diamonds in Indiana: An Update

By John R. Hill
Historical text by Willis S. Blatchley

Indiana University
Indiana Geological Survey Circular 12





Bloomington, Indiana: 1988, revised 2005

Author

John R. Hill is the Associate Director for Administration
of the Indiana Geological Survey.

Historical Text

Text in italics is by Willis Stanley Blatchley,
State Geologist of Indiana from 1894 until 1910.

Cover photos: The Bradford family of Indiana on a gold-panning outing (photo courtesy of Bradford Woods, Indiana University Outdoor Center); "Uncle" John Merriman, the veteran Brown County gold hunter, at his favorite work.

Contents

Illustrations

Gold And Diamonds in Indiana: An Update

By John R. Hill
With historical contributions by Willis S. Blatchley

INTRODUCTION

Since its first reprinting in 1963, Willis S. Blatchley's *Gold and Diamonds in Indiana* has been a best seller of the Indiana Geological Survey. Much of the appeal of Blatchley's report derives from the novelty of its topic. Most people do not think of the Midwest as an area in which either gold or diamonds are found. The mention of gold usually brings to mind a grizzled old prospector up a gulch on the back side of some lonely mountain in Colorado or a team of gold seekers along Bear Creek near Dawson, Alaska. Indiana gold, although not plentiful, has been found in sufficient quantities, mostly along streams in Morgan and Brown Counties, to keep interest in recovering the yellow metal alive for more than 135 years. *Gold and Diamonds in Indiana* has also gained popularity because it was written in 1903—a time when the gold-producing areas of Indiana were relatively unspoiled and scenic and life moved at an enviably slower pace than it does today.

Because of the attraction of the original *Gold and Diamonds in Indiana*, as much as possible of that manuscript has been preserved. Improvements in our understanding of the origins of gold and diamonds are reflected in a new chapter that treats that subject. Like Mr. Blatchley's original, this report is intended not as a treatise on gold mining in Indiana but as a guide for the amateur gold panner who enjoys nature and the challenge of finding a few grains of gold along one of southern Indiana's scenic-upland streams.

GOLD PROSPECTING — THE EARLY DAYS

David Dale Owen (1859, p. 60) in his *Report of a Geological Reconnoissance of the State of Indiana* stated that "none of the precious metals are likely to be found in Indiana, unless in minute portions in the bowlder drift, or in small quantities in combination with other metals; ...." Although he did not confirm the existence of Indiana gold, Owen did accurately place its association with the glacial drift of the state. In 1846 David Christy wrote a letter to Dr. John Locke of Cincinnati in which he stated (1848, p. 33): "At Edinburgh, and along the hills of Blue river, fine specimens of iron pyrites, or fool's gold, are found in great abundance in the Black Slate. Many persons

here, as elsewhere, being deceived by this metal, have been busied in hunting for gold and silver mines."

But the earliest printed record of gold recovery in Indiana appeared in the Franklin Institute Journal for June 1850 (Anonymous, 1850, p. 417). The account stated:

> Professor Frazer read to the meeting (of the Franklin Institute, May 17, 1850) a letter from Prof. T. A. Wylie, of the University of Indiana, announcing the discovery of gold in the vicinity of that place, and exhibited specimens of the gold, and the black sand in which it is found. "The gold has been found in the beds of the rivulets in Morgan County, about twenty miles northeast; in Jackson County, about twenty miles southeast; in Brown County, about twenty miles east, and in Greene County, about fourteen miles west of Bloomington, as well as at certain intermediate points, but not in the immediate vicinity. Where it has been found it is always in connection with a black sand which the washers call 'emery.' This sand is found at the bottom of the streams, usually at the upper end of the sandbars, or on the margins of the streams where there is a sudden turn, and in such places as it would be naturally deposited on account of its density. The coarse gravel is sifted and washed in the usual way until nothing remains but the dense black sand. On examining closely with the microscope, there are to be perceived interspersed through it red particles of different shades, and some few yellow and green particles; of the red particles some appear to be merely colored quartz, while others are plainly distinguished by their crystalline form as garnets, and some of the darkest probably pyrope. The black particles are readily separated into two sorts by the magnet. Those attracted by the magnet, which amount in some specimens to 5 per cent. of the whole, are evidently magnetic oxide of iron. The remaining black grains agree precisely with Dr. Thompson's description of titanate of iron or menaccanite." The gold is in flat scales, a good deal resembling in its appearance that from California.

Richard Owen (1862, p. 83) reported gold in Henry County along the Blue River at its confluence with "a small stream and a mill-race, . . . about eight miles from Newcastle . . . ." He (1862, p. 98) also referred to "considerable samples of gold" derived from a creekbed "between two and three miles from Delphi." Owen's report detailed gold finds in Clinton, Boone, Morgan, and

Brown Counties. He correctly deduced the Canadian source of the gold and further observed that the kinds of gold-bearing rock usually found within the drift were quartz-rich granites.

With the advent of the annual reports of the Indiana Geological Survey came the systematic reporting of the geologic features and resources of the state. The annual reports were a collection of individual reports of geologists and naturalists under the direction of the State Geologist. Although the format of the series varied from one to another, each was based, more or less, on the geologic reconnaissance of various counties. The discovery of gold and occasional diamonds in a number of Indiana counties did not escape the attention of the geologists, but it was usually treated as a curiosity rather than a discovery of economic significance.

Gold at several localities was reported in the First Annual Report of the Geological Survey of Indiana (Cox, 1869). Frank Bradley (1869, p. 170–171) cited minor gold production in Vermillion County in sec. 32, T. 17 N., R. 10 W., but he said that it was "not in sufficient quantities to pay fair days' wages for washing it."

Rufus Haymond (1869, p. 190) reported that in the northwestern part of Franklin County, in Laurel and Posey Townships, along Sein Creek and its branches, gold was disseminated in the alluvium in very small particles. Haymond noted that "a common panfull of gravel and sand, when washed out, generally shows from two to three particles of gold in thin scales."

In 1872 John Collett wrote that he had found traces of gold in Pike County, and also in 1872 Robert Warder reported traces of gold in Dearborn and Ohio Counties. Both Collett and Warder described the typical gold finds as "minute" and not occurring in paying quantities.

John Collett (1874c, p. 224) made this amusing observation about gold panning in Warren County: "At Gold branch of Pine creek, N. W. qr. Sec. 23, T. 22, R. 8, on a gravel bar formed of debris washed from the boulder drift, a quantity of gold, reported at $70, was collected. An energetic Californian can 'pan out' from $1 to $1.25 per day at this, and several other gravel bars in the county. An equal amount of labor expended at any ordinary avocation, will bring better returns."

The first extensive discussion of gold production in Indiana appeared in the Sixth Annual Report (Cox, 1875) and centered on Brown County. John

Collett, the investigating geologist, in his thorough discussion of the subject (1875) covered origins of gold, areas of most likely production, gold fineness, and dollar values of gold produced from the county. Until Blatchley's report in 1903, Collett's work in Brown County was the most thorough. Borden (1876) reported traces of gold in Jennings County along the south fork of the Muscatatuck River, and Collett (1876) reported minute scales of gold in Vanderburgh County at Priests Bluff in sec. 19, T. 17 N., R. 11 W. Gold was found in Owen County along Fish, Lick, and Rattlesnake Creeks, and traces of gold were also discovered mostly along the streams around Crawfordsville in Montgomery County (Collett, 1876).

In the Eighth, Ninth, and Tenth Annual Reports, Cox (1879) cited gold-producing areas along Laughery Creek in Dearborn and Ohio Counties and mentioned an abandoned sluice works about a mile northwest of Hartford. Cox also reported that one of several diamonds found in Brown County weighed 4 carats. Most references to gold were restatements of earlier work by John Collett and others.

George Sutton published *The Gold-Bearing Drift of Indiana* in 1882. He summarized and quoted extensively from the old annual reports. His paper is of little scientific value, but it is a reasonable summary of work before 1883.

Ryland T. Brown, writing in the *Thirteenth Annual Report* (1884), reviewed the gold-prospecting history of Morgan County. He also discussed the origins of the gold, but his theories differed little from those of his predecessors.

In the *Seventeenth Annual Report* Maurice Thompson (1892) reported gold in the crevices of the Devonian limestone that floored Deer Creek near its mouth in Carroll County. This is the first reference to gold recovery from bedrock crevices.

But it is the celebrated *Twenty-seventh Annual Report* (Blatchley, 1903) that has stood as the definitive work on gold and diamond occurrences in Indiana. A later section in this report retains Blatchley's accounts of gold and diamond finds by county as published in 1903. *Gold and Diamonds in Indiana* was reprinted verbatim from Blatchley's original report (fig. 1).

In 1906 Blatchley (1907) conducted a series of quantitative tests on the gold yield of large samples of lowland sediments from various localities in northern Morgan County. The tests were made on land owned by Dr. Clark Cook (sec. 30, T. 13 N., R. 1 E). Twenty-five holes were dug to bedrock

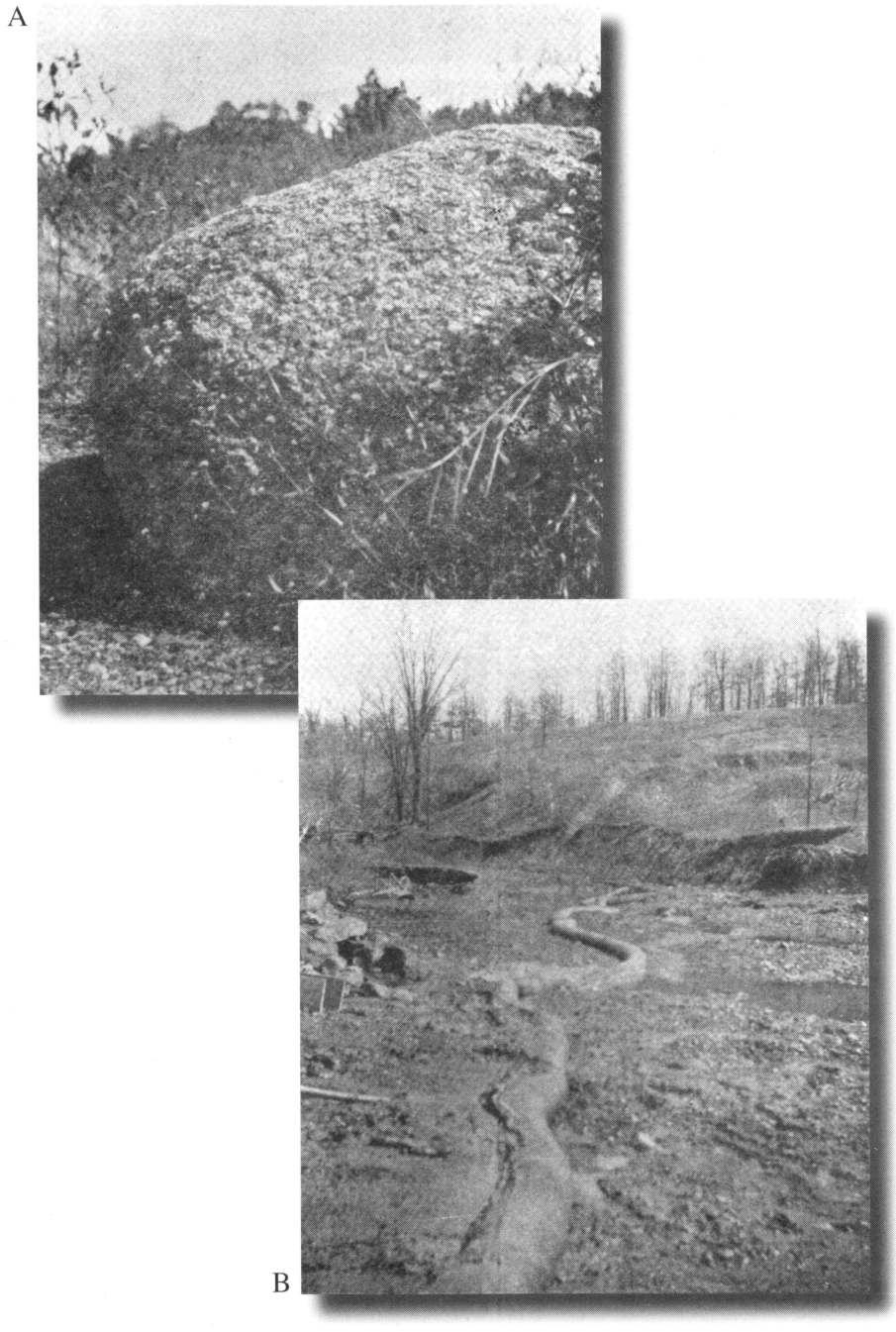


Figure 1. A, Large gneissoid boulder in the valley of Gold Creek, Morgan County. B, Iron pipes and hose used in sluicebox operations on Highland Creek, Morgan County, in March 1903. From Blatchley (1903).

along a strip of stream-bottom land on the Cook property. From each hole 75 pounds of gravel was carefully panned: 25 pounds from the bottom of the hole, 25 pounds from the middle, and 25 pounds from the top of the gravel bed. Random gravel samples from the holes were added to bring the aggregate sample weight to 1 ton. Blatchley concluded that the 1-ton sample contained $1.54 worth of gold and, at that rate, yielded 77 cents per cubic yard of alluvial sediment.

He also speculated that a company having sufficient capital backing, an adequate water supply, and machines capable of extracting 90 percent of the gold washed could make a profit in parts of Brown and Morgan Counties. At least two groups believed him, as illustrated below. Whether or not Blatchley really believed it was possible to make a living mining Indiana placer gold is uncertain, but he clearly had a touch of gold fever.

Glenn Culbertson (1916) briefly discussed minor gold finds from streambeds of southwestern Jefferson County. A man panning the streams in that area was reported to have earned from a dollar to a dollar and a half for several weeks' work. Culbertson noted that black sand could be seen along almost any roadside gulley of the county but that paying quantities of gold were not likely to be found.

W. N. Logan (1922b) prepared a summary of gold and diamond production in Indiana that was taken mostly from Blatchley's work. Logan accurately described the known gold-bearing igneous and metamorphic rocks of the Canadian Shield area of Quebec and Ontario. He was the first geologist to publish his speculations about the possible origins of the gold from within Indiana. He suggested potential mineralization along fault planes and possible hydrothermal injection at structural anomalies like the Kentland Dome, although he clearly stated that the Kentland feature was devoid of such mineralization. The concept of a local origin for diamonds especially is intriguing and is discussed later in this report.

In 1921, Claude Hafer, writing in the *Engineering Mining Journal*, spoke in glowing terms of the richness of the Indiana drift gold. He credited Blatchley's astute prediction that significant gold deposits would be found in Canada and elaborated on the subject. Having spent the better part of two summers panning and sluicing the Indiana "gold fields," Hafer was unable to show significant production at any locality. Although Hafer did not tell where he washed the sediments, it is possible that he worked in Morgan County along tributaries of Sycamore and Lambs Creeks.

The *Handbook of Indiana Geology* (Logan, 1922a) contains a sketchy review of existing literature about gold and diamond occurrences in Indiana, but it lacks all worthy detail of the subject. The partial listing of gold-related publications, however, is of some value.

E. R. Smith (1946) related an interesting anecdote about a state inspector of concrete aggregates who was involved in the construction of U.S. Highway 40 in Putnam County. Sand and gravel were being dredged from Big Walnut Creek, washed in a portable flume, and graded to aggregate. Twice a day the inspector put a strip of brussels carpet 27 inches by 48 inches in the washing flume. When the washer was stopped at noon and in the afternoon, he took out the strip of carpet, dried it by the fire, and beat it over a piece of brown paper. At the end of 5 weeks he had more than $250 worth of gold, together with much quartz and magnetite sand.

Smith was given three grains of gold washed from Mosquito Creek just south of Putnamville by a teenage boy. This is the only published account, to my knowledge, of gold taken from Mosquito Creek.

The most recent study by the Indiana Geological Survey on gold and diamond occurrences was that of Erd and Greenberg (1960). The authors cited Blatchley's 1903 report for the largest nugget ever found (132 grains). The Erd and Greenberg report contains a useful table that lists the 25 counties from which gold was reported and the appropriate references.

The foregoing discussion has been restricted mainly to Indiana Geological Survey contributions to our knowledge of gold and diamond occurrences in Indiana. What follows is a history of the subject by county. Most of the following documentation is taken directly from Blatchley (1903) and is printed in italics. I have added to Blatchley's county files wherever additional information has been available.

BROWN COUNTY

The northern boundary of this county is about 30 miles nearly due south of Indianapolis. The county is bounded east by Bartholomew, south by Jackson and Monroe, west by Monroe and north by Morgan and Johnson counties. It contains an area of 320 square miles, the surface of which is very broken, except in the southeastern corner, where there is a large area of level table land. The "Knobs" of southern Indiana, stretching northward from Floyd County, attain in "Weed Patch

Hill," south of Nashville, the county seat, their highest elevation—1,147 feet above sea level. (Weed Patch Hill is thought by many persons to be the highest point in Indiana, but it is exceeded by a number in Randolph County—the actual height of the most elevated one measured being 1,234.4 feet above tide. This is what is known as the "Summit" on the Peoria Division of the Big Four railway, between Green's Fork and Martindale Creek. Several hills south of the "Summit" are thought to be 50 feet higher, so that the highest point in the State is about 1,285 feet above tide, or 138 feet higher than Weed Patch Hill.)

Salt Creek, the principal stream of Brown County, is composed of three main branches, the "North," the "Middle," and the "South" forks, which unite near the southwest corner of the county, and flow thence through Monroe and Lawrence into East White River. Thus almost the whole watershed of the county, together with a considerable portion of Jackson on the south, is drained by this stream. Bean Blossom Creek has its source in the northeastern part, its principal tributaries in northwestern Brown being Bear and Lick creeks, both flowing nearly south. Just across the northern boundary in Morgan County, and in a valley nearly parallel with the county line, is Indian Creek, flowing in a general western direction. High ridges surround Brown County on all sides, while from east to west and southwest three similar ridges traverse the county, all connecting on the divide near Trafalgar, in Johnson County. The first and most northern constitutes the southern bluff of Indian Creek, and is called "Indian Creek Ridge;" the second, south of Bean Blossom is known as "Bean Blossom Ridge," the third, passing nearly through the middle of the county, is named "Central Ridge." All these ridges slope gently to the south and west but present steep faces to the north and east.

The bed rock composing the body of most of the ridges and hills of Brown County is a soft, bluish knobstone shale, which weathers readily into a plastic clay. In places beds of sandstone occur; while the crests of the hills are capped with a chert-like bed of Keokuk limestone with its characteristic accompaniment of "geodes." This limestone forms the surface rock in the eastern part of Monroe County, and its presence on the tops of the hills of Brown shows that this county was once covered by a level surface of limestone continuous with that of Monroe to the westward. The valleys of the county, now containing its richest soil, have been eroded by flowing streams, leaving the strata of the hills as

they were originally deposited by sedimentation in an ocean which covered this region ages before the dawn of the "Glacial Period."

Only the northern third of Brown County is within the glaciated or drift area. The northwestern part of Hamblin Township and the greater portion of Jackson Township are covered with drift accumulations as far south as Bean Blossom Ridge, the drift being found on the slope of this ridge nearly 200 feet above the water in the stream. Boulders of granite, gneiss and jasper, three to five feet in diameter, occur frequently in this region. In the Salt Creek Valley, northeast of Nashville, but little drift was seen. Bean Blossom Ridge, then, marks the southern limit of the first and only glacial invasion of Brown County, and it is only north of this ridge that gold in anything like paying quantities has ever been found in the county. Collett, in his "Report on Brown County," (Geological Survey of Indiana, 1874 [1875], *pp. 77–110) calls attention to this fact, and says:*

> *"Against and upon this wall-like ridge the stranded ice seems to have been continually massed; and, melted by each recurring summer's sun, it sent torrents of water south across the county, wearing slight depressions in the ridges, as at Low Gap and the source of Greasy Creek, bearing fine sediment, some gold dust and black sand, and but few or no pebbles or boulders. This flood was long continued—first flowing clear across the county, at a high level, and even across parts of Jackson—next following the synclinal axes of the underlying rocks, it excavated South and Middle Forks of Salt Creek, and finally following another synclinal, adopted the direct line of dip by the North Fork.*

"During this time the underflow from the glacier was also working a channel in the disintegrating shale along the east side of the county, by Bean Blossom, and finally left the interior basin of the county subject only to the action of its own water-shed. Down these side cuts to White River immense bodies of water, bearing some ice with boulders and gravel, have flowed. The long continued melting of ice loaded with the most enduring debris of the Laurentian rocks, as greenstone, quartzite, quartz, gold and magnetite, deposited large quantities of these imported materials in Bean Blossom Valley. The rapid current of the ice water would naturally carry down stream the lighter sand and gravel, and sort out and leave behind the heavier rocks, gold

and magnetite in considerable quantities. Afterwards as the ice foot withdrew toward the north, this melting, sorting, sifting process was carried on north of Indian Creek Ridge, for a longer time, as is indicated by the greater width and depth of that creek valley, where gold and the heavier minerals will only be found beneath the present surface, which is largely built up above the bed rock."

The earliest mention of gold in Brown County which I can find in print, other than that of Professor Wiley above quoted [Author's note: The part of Blatchley's report referred to here has been omitted, but this same quote appears on p. 2], *is that of Richard Owen in 1862 (Geological Reconnoisance of Indiana, p. 119), which is, in part, as follows:*

"The chief interest of Brown County attaches to its gold region, which we were enabled to examine advantageously. Although some prospecting has been done on 'Bear Wallow Hill,' on head waters communicating through Lick Creek to Salt Creek, as also in what they term the gravel of Greasy Creek (a deposit of disintegrated shales), the main localities in which success has attended the gold washings in this county are on Hamblin's fork of Salt Creek, three-quarters of a mile in a direct line from the west limit of Bartholomew near Mt. Moriah postoffice. Here we found extensive preparations in the way of sluices and hose, rockers and 'long toms,' picks and shovels, etc. Notwithstanding the rain, we panned out enough to convince ourselves that the black sand in many of the pockets contains a considerable amount of gold particles.

Occasionally they pan out flat scales worth from a dollar to a dollar and a quarter. Judging from what I saw here and elsewhere in Indiana of the gold localities, I should venture the opinion that the gold is invariably associated with drifted quaternary materials, derived from a matrix, which finds its mountain home at least from 400 to 600 miles distant, and more probably double that distance, in a northerly direction."

Collett, in his "Report on Brown County," treats the subject more in detail. In part, he says: "Gold is found in the bed or on the bars of all the brooks that flow into Bean Blossom from Indian Creek Ridge, and on the streams which flow from the foot of the "drift backbone" in the northeast corner of the county, as South Bean Blossom, North Salt Creek, etc. Fine dust and minute scales may be found further within

the county wherever black sand and small pebbles indicate former currents of ice water, even as far south as Elkinsville. Single individuals, at favorable points, by hard, patient labor, have been able to make from $1.00 to $1.50 per day. Companies and careless workers have not averaged more than 25 cents per day. During the excitement a few years since, several companies took leases, made sluiceways and prepared long toms and rockers. The returns were not satisfactory. It is probable that the best "pay dirt" lies at the deepest part of the rocky trough in which the creeks now have their course. By bores the line of greatest depth may be ascertained, and by shafting the richest dirt possibly in paying quantities—may be brought to the surface. Reasoning from the facts observed, this would be true of Bean Blossom, and especially, from its greater width and probable great depth, also of Indian Creek Valley. This is mentioned as a reasonable deduction, warranted by the facts and not for the purpose of exciting a mining fever. It is estimated that the amount of gold found in the county to date (1874) will equal $10,000 in value, and the best nugget weighed at one dollar and ten cents (Geological Survey of Indiana, 1874 [1875], *p. 107)."*

During our trip in May, 1902, Mr. Royse and myself drove over the greater portion of Jackson and Hamblin townships, which form the northern third of Brown County. We conversed with a number of men who do little else than pan gold along the streams, and incidentally "panned" in a number of places ourselves. In the gutters along the roadsides, especially those on the ridges below the top level of the drift, the black magnetic sand could be seen in quantity. Our first panning was done one-half mile west of Georgetown, the material being taken 15 feet above the level of a fork of Bean Blossom Creek. The residue showed a quantity of black sand and four "colors" of gold. Another pan taken from the creek bed showed 11 colors. Mr. Royse has had assayed a conglomerate found in the hillsides and bluffs along this and neighboring streams, with a result of $1.40 per ton, flour gold. This conglomerate is formed of iron oxide, pebbles, geodes and pieces of shale cemented together with carbonate of lime, and lies just above the shale composing the hills.

The valleys of the streams in Brown County are, as a rule, much narrower than in Morgan County. Along each side of the stream is a strip of bottom land of varying width, composed of gravel, clay and soil, the gravel resting upon the bed rock or blue shale. It is this gravel, next to the bed rock, that is richest in gold. Most of the surface of these strips

is cultivated, and the owners will not allow the "gold hunters" to pan except in the beds of the streams. These beds have most of them been washed many times in succession, a new supply of gold being eroded during each freshet from the gravel beds along the banks. These beds, which form the base of the lowlands or cultivated bottom lands of the valleys, were formed during the melting of the glacier, when the streams flowing through the valleys were much wider and stronger than now. The gravel and sand composing them was then deposited, and the soil, for the most part has been formed since then by decaying vegetation and annual overflow.

After every freshet the children seek gold along the rocky bottom of each rill and stream and often find pieces worth 25 to 40 cents. Much of this is found lodged in minute crevices at the bottoms of small waterfalls. I was told that two boys, just east of Spearsville, had sold $42 worth in a single season, which they had thus gathered along the smaller tributaries of the north Branch of Salt Creek. [Author's note: One of the two boys mentioned here was John Dine, father of Morris and Herman Dine, who live on the family homestead near Spearsville in northern Brown County.]

One of the best known and most reliable gold hunters in Brown County is W. J. Merriman, better known as "Uncle John" Merriman. [See fig. 2.] *He is 69 years of age, has panned gold more or less each year for 49 years, and has done little else for the past 20 years. He resides near a branch of Lick Creek, about six miles northwest of Georgetown, and has washed gold along every stream in northern Brown and part of Morgan counties. The largest "nugget" he ever found was taken on Bear Creek and weighed 132 grains, valued at $5.50. He has found a number of pieces which ran as high as $1.00 to $1.25 in value; but most of what he secures is in the form of "colors" or minute flattish particles. He states that the coarsest gold in Brown County is found in what is known as "Gosport Hollow," a tributary of Bear Creek. He also estimates that the gravel beneath the soil of the lowlands will average 25 cents per cubic yard in gold.*

On two different occasions Mr. Merriman has kept a careful account of the results of a month's work Sundays excluded. One month yielded him $34; the other, $40. He claims that he can average $1.25 a day during the panning season, which runs from March to November, except in

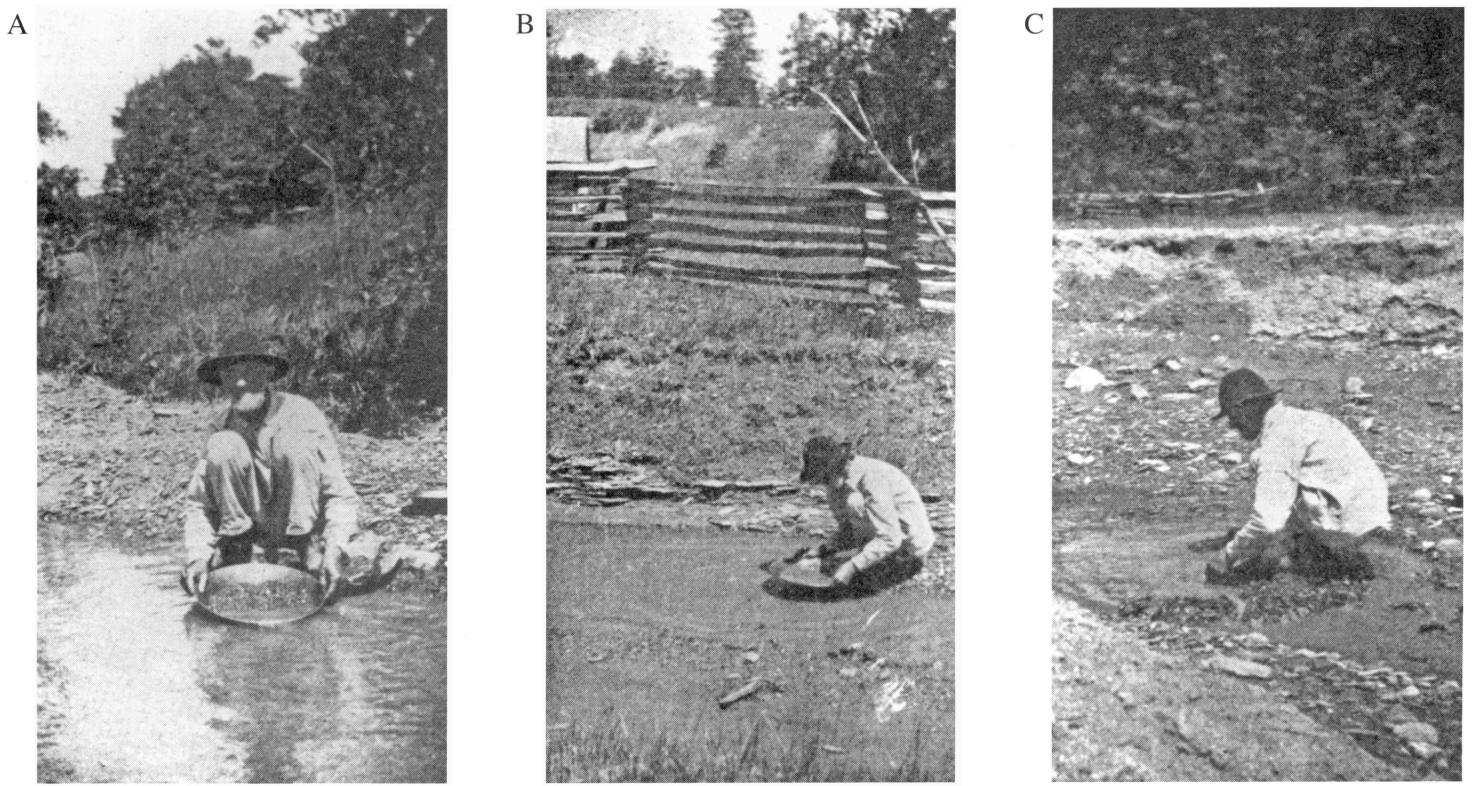


Figure 2, A. B. and C. Uncle John Merriman, the veteran Brown County gold hunter, at his favorite work. In B and C are seen the typical lowland deposits of gravel resting on the bedrock, which here is the Knobstone shale. From Blatchley (1903).

times of summer drought. During his panning he has found several diamonds, which will be mentioned on another page.

We took dinner with Mr. Merriman and then accompanied him along the creek below his home. Armed with a trowel, gold pan and small basin, his only working outfit, he began operations by scooping up with his trowel a pan full of sand and gravel. After thoroughly mixing it with water by stirring it for a minute or two, he began the process of "panning," or washing. In fifteen minutes he had reduced it to a tablespoonful of black sand in which were 14 colors, or fine particles of gold. The next pan yielded 24 colors, and the third one 16, one of which was large enough to make a noise when it fell against the bottom of the pan. The residue of black sand and gold in each pan was dumped into the small basin, to await a complete separation at some future time. The thought came to me while watching "Uncle John" at his pan, as it has many times since, "If a man, by working thus, ten hours a day, can secure $1.25 from gravel picked up in the bed of a stream, what could be done with advanced machinery working on the richer virgin beds of gravel which underlie the lowlands of all the valleys hereabouts?"

Leaving "Uncle John" at his favorite labor, we drove across to Spearsville, in the northwestern corner of Hamblin Township, noting on the way the black sand in many places in the roadside gullies. From Spearsville we went three miles in a southeasterly direction along one of the tributaries or sources of Salt Creek. Here we found at work another gold hunter, W. W. Young, who has spent many years in the mining regions of the west, but for the past five years has been washing gold in Brown and Morgan counties. On the day we met him, he had dug to the shale or bed rock a trench 24 feet long, two and a half feet wide and six inches deep, along a bar at one side of the bed of the stream. From this he had taken almost $2.00 worth of gold. Another man who had worked alongside of him, but who was inexperienced, had secured but 40 cents worth. Young, as well as most other gold seekers of Brown and Morgan counties, scouts at the theory of the gold being brought in by glaciers. He declared that "it was born and raised right there."—in other words that it was native to the rocks, but he has never been able to find a vein of it to prove his assertion.

Mr. Young showed me a report from the United States Mint at Philadelphia, dated July 12, 1901, showing that the mint had received from

him 14.05 ounces of gold, the fineness of which was 909½. For this he received $250.07, aside from the charges of $1.56 for melting and refining. Silver to the amount of 61 cents was found as a natural alloy of gold, by the mint authorities. He stated that he had panned this gold in nine months' time, working probably three-fourths of the period. The quality of the drift gold found in Indiana is of the best, as it will average 22 or more carats, as against 16 to 18 for California gold, and 14 to 16 for Klondike gold. The largest piece found at any time by Mr. Young, weighed sufficient to bring $2.00.

At least 70 square miles of northern Brown County lies within the drift-covered gold-bearing region of the "First Glacial Invasion." The gold occurs in the clay, gravel and sand beneath the soil on the hills, and more abundantly in the gravel deposits which underlie the lowlands in the valleys. The latter will probably not aggregate more than three or four square miles of this area, for the streams are small and the valley narrow. It is in this gravel of the lowlands, if anywhere in the county, that advanced processes of placer mining could be made profitable. The question of a permanent water supply would be a serious one, as most of the streams are dry several months in summer. By constructing permanent dams in several of the valleys enough water could probably be conserved to tide over the dry season. There is no doubt but that large quantities of gold exist in the county. Only a person experienced in hydraulic and placer mining, who is conversant with the latest improved machinery for that purpose, will be able to state whether the process of its separation can be made a profitable one.

The Dines are among the best-established families in Brown County, their roots going back at least four generations. This author spent time panning with two of the Dine brothers, Morris and Herman, in 1985. They demonstrated how quickly an accomplished gold panner can reduce a panful of stream sediment to a few colors in just minutes. In about 2 ½ hours, the brothers panned a total of 45.76 milligrams of gold. At the time, gold was selling for $320 per troy ounce, which translated into net earnings of 39 cents. Morris Dine said that what the recovery was typical for a 2½-hour investment of time and he counseled me to simply "tell it like it is."

Stories, old and new, abound about lucky finds of big nuggets and good days with a pan, but none can top the experiences of the men who attempted to make money at commercial-level gold recovery. According to Herman Dine a retired Army major named Pittman came to the upper Salt Creek Valley in

about 1924 with a gold-processing machine and a shaker table that was powered by a Model T Ford engine. His success (or failure) remains uncertain. In 1932 the Succor Flour Company partly financed the building and operation of a gold machine of grand proportions for its day. The 48-ton machine had a cubic-yard dragline that was made in Indianapolis by the Engineering Metal Products Company at a cost of $28,000. Herman Dine and one of his brothers worked with the engineer, Gene Williams of Kansas City, for about 3 years. Dine said that they were never able to run more than 2,000 yards of materials through the machine because it continually broke down. With this machine, and a smaller one that worked better, the crew extracted about $10,000 worth of gold before abandoning the project.

The third effort at commercial gold recovery from Brown County began in April 1983. The Maryland-based Great Lakes Metals Company applied for a special zoning exception to operate a placer-gold mining operation in Pense Hollow (east of Spearsville)—an area that had been worked for gold during the 1930s. Great Lakes Metals asked for permission to operate on 220 acres of land zoned forest and recreational. The land was owned by Mr. Aloysius Meyer. As conceived, the project was to have been carried out in stages over a 2-year period, each phase being carefully monitored by the Brown County Plan Commission. After months of deliberation and public hearings, the Plan Commission's Board of Zoning Appeals gave the green light, but it imposed numerous restrictions, such as the prohibition of chemicals (for example, mercury), operation-time restrictions, and strict reclamation requirements that must follow the standards of the Indiana Department of Natural Resources Division of Reclamation.

Three men operated the portable recovery equipment. Stream sediments were fed to the device by bulldozers, and the fines recovered from the shaker table of the operation were removed by pickup truck. One of the workmen at the site reported that they were operating with $50,000 worth of equipment, which he described as "a drop in the bucket" by today's standards. The machine required 30,000 gallons of water per day to sieve the gravel through the separator.

The project failed for a variety of reasons, chief of which was the lack of rain necessary for the operation—a potential problem recognized by Blatchley (1903) as imposing severe limitations on any commercial gold-recovery program. Ironically, the summer of 1983 was one of the driest on record.

CARROLL COUNTY

A very brief account of gold found in Carroll County, although omitted by Blatchley, was given by Richard Owen (1862, p. 98): "Between two and three miles from Delphi, considerable samples of gold have been washed, from the Drift in the bed and bank of the creek, a locality well meriting further examinations."

CASS COUNTY

This county lies about 85 miles a little west of north of Indianapolis. It contains 420 square miles, and is wholly within the drift-covered area, but the Devonian and Niagara limestones outcrop in a number of places along the Wabash and its large tributary, Eel River, which joins it at Logansport, the county seat. In the vicinity of Logansport, numerous beds of gravel ranging in thickness from one to 32 feet, lie immediately above this bed rock. From one of these beds, near the northern part of the city, Dr. Robert Hessler has secured a number of small flakes of gold. These were picked up, incidentally, without panning, and go to prove that gold is widely distributed in the drift gravel deposits of the State. Most of these deposits are, however, so deeply buried beneath clay, sand, soil and other material that there is no way of determining the presence of gold and no way of securing it were it present in large quantity. It is only along the edges of the moraines or in places where the gravel deposits rest on outcrops of bed rock, that the gold-bearing gravel is accessible.

CLARK COUNTY

This county lies in the southern part of the State, opposite Louisville, Kentucky. The first glacial invasion covered its northeastern third as far south as Charlestown. From near Fourteen Mile Creek, three and a half miles northeast of this place, Rudolph Bastian has recently sent me a quantity of black magnetic sand containing large numbers of small garnets and a few grains of free gold. He states that he has opened up a shaft 15 feet in depth in a hill composed of soil, sand, clay and gravel, a section of the shaft being as follows:

	Feet.
Soil, yellow	2
Sand, black magnetic	4
Clay, blue	6
Sand, white	2
Clay, blackish	1

In the black sand of the stratum, he states that he can find numerous particles of gold in every panful which he washes. The black sand and garnets are finer than those found farther north, and it may be that the deposit is but the diluvium or wash from the streams which flowed from the melting glacier of the Brown County region.

CLINTON COUNTY

Owen (1862, p. 113–114) noted gold in Clinton County while in the company of several men from Frankfort: ". . . we visited the gold locality on the Kilmore branch, which heads on Indian prairie and runs into the south fork of 'Wild Cat.' We found it [the gold], as expected, in a pocket of Drift; and partly from the yellow and blue clay in the bank, a foot or two above the stream, and partly from the later quaternary arenaceous deposits in its beds, one of our party, who had washed gold in California, and another, who had worked at the Pike's Peak 'Diggings,' panned out several fragments of pure gold, chiefly in flat scales."

DEARBORN AND OHIO COUNTIES

These counties lie along the Ohio River in the southeastern corner of the State. The edge of the Great Illinoian, or first glacier which invaded Indiana, passed through Ohio County. [Author's note: These deposits, although pre-Wisconsin in age, are not necessarily Illinoian.] *Dearborn County is, therefore, wholly covered by the drift of that glacier, and lies within the interval separating its border from that of the Wisconsin boundary. Boulders are common in each of the counties and a piece of native copper weighing 26 ounces was found near Tanner's Creek, Dearborn County, a number of years ago. Of the presence of drift and gold in the two counties Prof. E. T. Cox has written: "The most remarkable prolongation of glacial drift southward is seen in Dearborn and Ohio counties, Indiana, and Boone County, Kentucky. In the two first-named counties the drift is found in greatest force along the hillsides bordering Laughery Creek, resting upon the bluish clay shale beds of the Hudson River group, and 150 feet above the bed of the stream. The entire drift deposit is fully 50 feet thick, and is made up of the usual material, stratified clays, sand and gravel, above which there are numbers of massive granitoid boulders. One of these boulders I estimated to contain over 100 cubic feet.*

"The lower bed of sand and gravel, which rests upon the Silurian bluish clay shale, contains a portion of gold dust, and gold washing has been carried on here in a small way for some years. When I visited this locality, about one mile a little north of west from Hartford, Ohio County, there was to be seen the ruins of what had been extensive preparations for washing this gold sand in sluice-boxes, but the scheme had fallen through for want of funds and the confidence of those who had at best lent it but feeble financial support.

"Dr. George Sutton, accompanied me from Aurora, and we went to Mr. Miller's house, close by, and had him bring his spade and a tin pan, and try to wash out some gold in our presence. After scraping off a small portion of the surface, a spade full of gravel and sand was thrown into an old pan with coarse holes in the bottom and the fine material that would pass through the holes was sifted out into the washing pan. In a few moments Mr. Miller succeeded in separating some particles of gold mixed with a quantity of black, magnetic sand. There is no means of getting water to this place in sufficient quantity and at a reasonable cost, but if hydraulic washing could be resorted to it is possible that considerable gold might be washed out. It is not my object, however, in saying this much of the drift gold in the vicinity of Hartford, to incite capitalists to take hold of the property with a view of profitable mining, but to call attention to the fact that gold is found there, and as one of the evidences that the whole deposit has been brought from ancient rock beds that are not found in places south of the great lakes, and that it is veritable glacial drift. This is not the only spot where gold has been found on this creek. I am told that it has been washed out of the sands on the opposite side of Laughery Creek, in Dearborn County, on the farm of Preston Conway (Geological Survey of Indiana, 1878 [1879], *p. 106)."*

In 1882, Dr. George Sutton, of Aurora, who had accompanied Professor Cox to the gold-bearing deposit described above, wrote of it as follows:

"Along the valley of Laughery Creek, a stream which enters the Ohio River a few miles below the mouth of the Miami, may be seen deposits of auriferous drift. They are not stratified like the terrace formations seen along our rivers, but lie in irregular accumulations along the valley. At the bottom of the small streams that have cut across this drift

are seen deposits of black sand which principally consist of magnetic iron ore. It is in this sand that gold is found. Seven miles from the mouth of Laughery may be seen a deposit of this drift about a mile and a half in length, nearly half a mile in width, and about 100 feet in thickness. Some portions of this Laughery drift are so rich in gold that it is seen with the unaided eye, and almost pays a fair remuneration for washing it. My attention was directed a few weeks since, by the owner of the farm on which this drift is found, to a small excavation which had been made in washing for gold. It was by measurement six feet long, five feet broad and about two feet deep. He informed me that from this place $8.00 worth of gold had been obtained, and that a man had washed from the drift on his farm gold to the value of $16.50. The gold is found in the form of dust, flattened scales and small nuggets. Only that which could be seen with the unaided eye was saved ("The Gold-bearing Drift of Indiana," in Proceedings of the Association for the Advancement of Science, XXX, 1881 [1882], *pp. 177–185)."*

In a recent letter, Dr. J. B. Miller, of Laughery, Ohio County, one of the owners of the farm near Hartford on which the gold occurs, gives the following account of the attempts at washing the gold since the time of Dr. Sutton's visit: "In 1885 we leased the mine to a company, which prospected for about eight or ten days and took out $8.00 worth of gold, but they had not sufficient water, and could not raise enough money to put in pumping works and force the water to a reservoir on the top of the hill. The owners themselves afterwards worked the mine for three days and took out $6.00 worth of gold, but had not sufficient water to run it half the time. We used a sluice box, and if we had had water, we could have made $1.50 a day per man, just from surface mining. This gold is on three farms in Ohio County, and one in Dearborn County. The soil is black, sandy, and consists of freestone and boulders, no limestone, but much conglomerate, run together by action of heat. The limestone is all around it but none on the gold producing land; you can see gold on the large stones on a sunny day. We never tried to go to bed rock, but intend to sink a shaft this coming fall. The largest piece of gold which we found was the size of a grain of wheat. It is mostly in fine scales, but of a very fine quality."

FRANKLIN COUNTY

This county lies northeast of Dearborn County in the southeastern part of the State; and wholly within the bounds of the "First Glacial Invasion." Drift from the Wisconsin Glacier also covers the northwestern corner, and the northeastern third, as will be seen by the accompanying map. [Author's note: Blatchley's glacial map has been omitted; see p 1.] *Of this drift and of the presence of gold in the county, Dr. Rufus Haymond has written: "The superficial material resting upon the rocks consists mostly of yellow clay, mixed more or less with small pieces of broken limestone, gravel from primitive rocks, and, in a few localities, almost pure gravel is found, in others sand, and frequently sand and gravel mixed. In no instance upon the uplands or tops of the hills do the bed rocks penetrate through these materials, and we find them only where the drift has been worn away by the action of the streams. The drift varies from four to five feet to 40 or 50 in thickness upon the uplands. The slopes of the valleys and side hills seem to be covered with drift similar to that upon the high grounds, but not of equal thickness. Boulders of granite, hornblende, greenstone, syenite, gneiss and, in fact, of almost every species of metamorphic rock, are found all over the county, upon the highest as well as the lowest grounds. They are always found upon the surface and never beneath, except under slides or where gravel in the terraces has been washed over them. A single piece of native copper has been found in the county, weighing about six pounds. It was no doubt transported with the drift from Lake Superior, as it was rounded, and bore other evidences of attrition.* [Author's note: The assumed origins of the above-described erratics is partly in error. A more northeasterly source is suggested by recent glacial research. See the section on origins of the gold on p. 37.]

"In the northwest part of the county, in Laurel and Posey townships, upon Sein Creek and its branches, gold is generally disseminated in very small particles. A common panful of gravel and sand, when washed out, generally shows from two to three particles of gold in thin scales. None has ever been found larger than a grain of wheat. Though so generally disseminated, it is doubtful whether the quantity is sufficient to pay the expenses of washing it out. Gold has also been found upon Little Duck Creek, and here, as elsewhere, is found associated with black sand ("The Geology of Franklin County," in Geological Survey of Indiana, 1869, pp. 185, 190)."

GIBSON COUNTY

A single sentence, which appeared in the Fifth Annual Report (Collett, 1874a, p. 418), recorded the discovery of gold in a few water wells: "Native gold and galena imported by the boulder ice, have been found in small lots in wells near the center of the ancient trough of the Wabash; the former in nuggets weighing from two to three grains." Whether the gold was found in Wisconsin or pre-Wisconsin drift is conjectural. Surface gold-bearing deposits have not been reported in Gibson County.

GREENE COUNTY

> *This county lies west and south of the center of the State. The border of the first or Illinoian Glacier passed in a northeast-southwest direction through its eastern half. The only mention of gold within the county which I can find recorded, is that of Prof. T. A. Wylie in the Journal of the Franklin Institute where he mentions gold as occurring with black sand in Greene County.* [Author's note: The Wylie letter is quoted in its entirety on p. 2.]

HARRISON COUNTY

Although Collett (1879) mentioned a supposed gold find 2 miles south of Bridgeport along the Ohio River, confirmation of gold in Harrison County is wanting. If gold was found there, it probably was in thin layers within remnants of glacial valley-train deposits that line parts of the Ohio River valley wall and along short tributaries to the Ohio.

HENRY COUNTY

Richard Owen (1862, p. 82–83) noted that "gold is washed abundantly from the quaternary gravel drift near the mouth of a small stream and a mill-race, emptying about eight miles from Newcastle into Blue River; . . . ."

JACKSON COUNTY

> *Lying below Brown County and south of the central portion of the State is Jackson, a county comprising 520 square miles. The border of the Illinoian glacier passed through its eastern half, and alluvium from that glacier covers much of the county. Gold has been found in a*

number of localities, chief among which is the bed of a stream on the farm of George A. Waggoner, near Freetown. Scales and particles to the value of about $5.00, which had been panned from the gravel and sandbars of this branch, were brought to my office by Mr. Waggoner in 1899. From his statement I should judge that the gold is not present in sufficient quantity in any part of Jackson County to pay for working, other than by panning by parties who have little else to do.

JEFFERSON COUNTY

In this county, which lies in the southeastern part of the State, along the Ohio River and wholly within the boundary of the Illinoian drift, gold has been found, as far as known, only on a stream about six miles north of Madison, the county seat. From the gravel in this stream, Mr. Clement J. Raffanf, of China, sent me several small quartzite boulders which contained free gold. These boulders, he states, were found in small numbers in the gravel bars, and attracted his attention on account of the yellow particles in them. He has made no attempt to pan gold from the gravel of the stream.

JENNINGS COUNTY

This county comprises 375 square miles of southeastern Indiana. It lies wholly in the interval separating the boundaries of the Illinoian and Wisconsin drift areas, that of the latter just touching its northwestern corner. The only record of gold within its bounds which has come to my notice is that made by W. W. Borden, who prepared a report on the geology of the county, and is as follows: "Some particles of gold have been panned from the bed of the south fork of the Muscatatuck. This gold was found in combination with the black sand washed down from the glacial drift of the uplands. The excitement occasioned by its discovery was very great at the time, and some useless labor was spent in sinking a shaft, as the drift and accompanying gold dust was foreign to the State (Geological Survey of Indiana, 1875 [1876], *p. 178)."*

KNOX COUNTY

Rare finds of "minute nuggets of copper, lead and gold, imported by the boulder flood, . . ." were reported by Collett (1874b, p. 367).

MONTGOMERY COUNTY

This county lies in the western-central part of the State, about 45 miles northwest of Indianapolis. The main stream flowing through it is Sugar Creek, which enters south of the northeast corner and passes diagonally across the county in a general southwesterly direction. It has a number of tributaries which, with their branches, are fed by springs which flow out of the great masses of clay, gravel and other drift material which form a thick bed above the underlying sedimentary rock. This drift belongs mainly to the Wisconsin sheet, as the county lies wholly within the bounds of the second glacial invasion. Professor Collett, in his report on the geology of the county, has given an interesting account of the effects of this glacier upon the surface of the county, in which he says: "The boulder drift deeply covers the eastern, northern and northwestern parts of the county, bearing internal evidence of its origin, as polished, striated and rounded pebbles and rocks imported from the Laurentian beds north of Lake Superior. When long concentrated by currents of water some notable deposits of gold dust and magnetite occur, associated on account of their approximate specific gravity, on the bars and riffles of the water courses (Geological Survey of Indiana, 1875 [1876], *p. 370)."*

Again he says that just above the Iran Bridge across Sugar Creek, about a mile west of Crawfordsville, is a great mass of boulders capped with lacustrial silt. The violent washing process that sorted these huge boulders, ground and pulverized some of the crystalline rocks, and considerable quantities, more than fifty dollars worth of gold dust and magnetite have been "panned" out by amateur collectors, on the ford bar.

Near the junction of Lye and Sugar creeks in the northeastern part of the county, he states that "on the land of Mrs. J. Naylor, Section 6 (T. 19 N., R. 3 W.), Mr. Edwin Cadwallader has collected several dollars worth of gold in flat scales, each pan showing 'color' (Geological Survey of Indiana, 1875 [1876], *p. 407)."*

Figure 3 (on opposite page). Sluiceboxes used in separating gold from gravel along Highland Creek, Morgan County, Indiana, in March 1903. From Blatchley (1903).

MORGAN COUNTY

Morgan County lies just southwest of Marion County, near the center of the State, and comprises 409 square miles. It is bounded on the north by Hendricks and Marion, on the east by Johnson, on the south by Brown and Monroe and on the west by Owen and Putnam counties. The West Fork of White River flows diagonally through the county from northeast to southwest, and, with its tributaries, drains the entire area except the northwestern corner, from which three small streams pass westwardly into Eel River. The principal tributaries of White River from the north, along whose beds and lowlands most of the gold of the county occurs, are White Lick, Sycamore Creek and its tributary, Gold Creek, Highland Creek [fig. 3], *Lambs Creek, Burkhart's Creek, Fall Creek and Butler's Creek. Each of these streams has a number of smaller branches running into it, which are fed by springs. Most of them are dry in part of their courses during a portion of each summer.*

The northern third of Morgan County, in which most of the gold occurs, is covered by the drift of the second or Wisconsin Glacier, and the gold is a part of that drift. In the southern part of the county the drift is that of the first or Illinoian glacier, which embraced all the territory now included within the county. Of the Wisconsin drift Dr. Brown, who made a careful survey of the county, wrote as follows: "On the northwestern side of White River, in the northern tier of townships, the drift is deep and continuous, with its base of blue clay, and its upper member of yellow clay, with water-worn pebbles interspersed and an occasional boulder of granite on the surface. Some of these are very large. On Section 4 (T. 12, R. 2) I measured a boulder of flesh-colored granite, whose dimensions were: Length, 15 feet 4 inches; greatest breadth, 13 feet; heigh t above ground, 11 feet 9 inches. South of an irregular line from Brooklyn to Eminence, the boulders almost entirely disappear, and, with them, the upper drift also leaving an irregular deposit of blue clay, constantly broken by the deep ravines which lay bare the underlying strata and cut the country into knobs (Thirteenth Annual Report Indiana Department of Geology and Natural History, 1883 [1884], *p. 79)."*

The "Lake" or valley, ranging from one to five miles in width, which extends from a little north of Eminence in a northeasterly direction past Hall and Monrovia, marks the point where the southern margin of the Wisconsin glacier rested for a long period, and down this valley

much of the water from its melting ice was carried. The Indian Creek Valley in the southern part of the county was likewise the resting point of the southern edge of the Illinoian glacier. From each of these glaciers, whose crests doubtless towered far above the hills which prevented their farther movement southward, rapid streams flowed and bore down the gravel, clay and sand, with their accompanying gold, now found in beds beneath the lowlands of the present existing streams.

Of the gold of Morgan County, Dr. Brown wrote: "In the year 1850, some returned California gold miners observed the characteristic black sand in the ravines of northern Morgan County and immediately commenced "prospecting." They found gold in the tributaries of Sycamore and Lamb's creeks, and some of the more skillful miners were able to wash out $2.00 or $3.00 worth of gold per day for several weeks. But the excitement of an actual "placer mine" in Indiana brought together so many fortune hunters that every ravine was directly occupied and the sands were soon washed out, and the "gold fever" subsided. Within the last few years the excitement has been revived, and gold washing, to a limited extent, has been resumed, paying from 50 cents to $1.00 per day. The gold is in very thin scales or in almost invisible grains, and is remarkably free from alloy of any kind.

"The origin of this gold is a geological problem of some importance, as the underlying rock is of comparatively recent date and shows no indications of trap dykes, quartz veins, or other geological disturbances. The only rational solution of the problem appears to be that which refers the gold to the blue clay, which is the lowest member of the drift. Where the clay forms the summits or sides of the hills, it is washed into gulches by the rains. The lighter and finer particles are borne onward with the current, while the heavy black sand and gold lodge among the rocks in the bottom. Fortunes, however, will never be made by gold mining in Morgan County (Thirteenth Annual Report Indiana Department of Geology and Natural History, 1883 [1884], *p. 81)."*

In our trip over a portion of northern Morgan County in May, 1902, Mr. Royse and I first saw black sand in the roadside gullies about one-half mile northwest of White River, in Section 17 (T. 12 N., R. 1 E.) and, washing a panful of gravel, found several colors of gold. From here we passed northwestwardly to Wilbur, stopping in a number of places along the west branch of Highland Creek, to prospect with our

pans. From the gravel underlying a strip of lowland along the creek, about a mile south of Wilbur, we washed several pans, one of which yielded 41 colors, and all of the others from 10 to 20 each.

From Wilbur we passed eastward across the ridges to the breaks of Sycamore Creek. Here the best known of the Morgan County gold seekers, Wm. Stafford, or "Wild Bill" Stafford, as he is more commonly known, has washed gold for 30 years. He spent one afternoon with us along Gold Creek, a tributary of Sycamore. One pan which he washed contained 64 colors, several of which were larger than grains of wheat. He showed us one place on this stream where he and a partner secured 272 pennyweights of gold between March 3rd and June 17th, by using a three and a half foot rocker. He stated that where one can get an average of 20 colors to the pan, it will always pay to run a sluice box or rocker. On the Thos. Staton farm along Gold Creek (northwest quarter and southwest quarter Section 27, 13 N., 1 E.), now belonging to Moses Gunter, six pans of gravel washed on April 8, 1903, yielded $1.25 in gold.

Like most other gold hunters of Brown and Morgan counties, Stafford washes only the bars of the streams, paying no attention to the gravel deposits underlying the lowlands, mainly because the soil above this gravel is cultivated and the owners forbid its disturbance. He says that it pays much better to work out and pan a whole bar, sweeping the bed rock and cleaning out all the cracks where the coarsest gold has lodged, than to pan a little here and there as many do. The tyro can make but 25 to 40 cents a day panning along the streams of this region; the old experienced washer, $1.50 to $1.75 per day. He showed us a piece of gold whose value was $4.70, which was the largest he had ever taken.

During our investigations in Morgan County we gave especial attention to the lowlands bordering Highland, Sycamore and Gold Creeks and their tributaries. In most places these lowlands are composed of two to three feet of gravel resting upon the blue shale or bed rock. Above the gravel is a foot or two of clay and above this a sandy or alluvial soil, ranging in depth from six to 12 inches, on which crops of corn and other cereals are raised. The streams, whenever full and swift, erode out a portion of the gravel, with its accompanying gold, carry it forward and build up bars farther down their courses. In this manner the annual supply of gold particles in and along the immediate

stream beds is added to, or replenished, when lessened by the workings of the gold hunters.

About 45 square miles of northern Morgan County are overlain with the gold bearing drift. Mr. Royse has made practical tests of the material in a number of the lowlands of this area and has proven that it runs from 30 to 80 cents per cubic yard in gold.

The most thorough of these tests was made on the land of Dr. Clark Cook, Section 30 (13 N., 1 E.), just north of the postoffice of Brey. Here 25 holes were dug through a strip of lowland to bed rock, the average depth being 3 feet 9 inches. From each of these holes 75 pounds of gravel was carefully panned, one-third being taken from the top, one-third from the middle and one-third from the bottom of the gravel stratum. In addition, miscellaneous gravel from the holes was added to bring the total up to 2,000 pounds. From this, gold to the value of $1.54 was secured. Allowing 3,000 pounds as the weight of a cubic yard of gravel, and deducting two-thirds for soil and clay, which were barren of gold, but must be handled, he had 77 cents per cubic yard for the matter composing the lowland. [Author's note: Before 1934, the price of gold was $20.34 per troy ounce. From 1934 to 1968, the price of gold was fixed at $35 per troy ounce. As of midsummer 1985, Blatchley's figure of 77 cents per cubic yard converts to $12 per cubic yard.]

In the winter and spring of 1903, a small dam of logs and stone was built across the east fork of Highland Creek, which runs through Dr. Cook's farm. The water which collected above the dam was guided through 550 feet of 8-inch iron pipe and 150 feet of canvas hose, and was used in tearing down and forcing through sluice boxes, a portion of the lowland clay and gravel deposits, near where the above mentioned tests were made. Three sluice boxes, each 30 feet in length, were constructed, with mercury at the bottom to catch the flour gold. The fall from dam to sluice boxes was but four to six feet, dependent upon the stage of water above the dam. This water supply was usually sufficient to allow working only a few hours a day, and before the final clean-up, a great freshet washed out both dam and sluice boxes, so that no definite results were obtained. The capital invested was too small to make a practical test of the richness of the deposits. It is understood that Dr. Cook will construct a more permanent dam, higher up the stream, and renew his efforts to determine just what the placer deposits will yield.

I visited the site of this embryo hydraulic plant on March 26, 1903, and found a number of gentlemen from a distance who had been attracted by the newspaper articles regarding the work. Among them was Adam Linn, of Tucson, Arizona, a miner in California and Oregon since 1854. He had made for a Chicago company a careful investigation of the lowland deposits of the surrounding region, and stated that the gold was more abundant than he expected. He gave it as his opinion that these deposits would yield from 25 to 40 cents per cubic yard, and thought that it would well pay to pipe in water 20 to 30 miles, provided a company could control a thousand or more acres of the lowlands. Otherwise, the expense would be greater than the output.

In the southern part of Morgan County, gold also occurs along all the streams. In what is known as "Dead Man's Hollow," in Washington Township, seven miles south of Martinsville, on a tributary of "Little Indian Creek," George Boardman, of Martinsville, and three other parties, washed out $8.00 per day with a "blanket rocker" for a short time in February, 1903. Mr. Royse went down a week later, and panned in a number of places in this and intersecting hollows, securing 5 to 40 "colors" in every pan. He estimates the lowlands to equal in richness those of the northern part of the county.

In western Morgan County, in what is known as the "Burkhart Settlement," Ashland Township, four to five miles northwest of Paragon, the gold is equally abundant in the lowlands along the streams. John Merriman, the veteran Brown County gold seeker mentioned above, here once secured 264 colors, by actual count, in one pan.

From what I could see and learn, there is little doubt but that these lowlands of Morgan County are richer in gold than those of similar tracts in Brown County. The valleys in northern Morgan are also wider and more extensive than in the gold bearing portion of Brown. The accompanying illustrations will show the manner in which the lowlands bordering Gold Creek are composed. If in the western States similar deposits which yield only 12 to 20 cents per cubic yard pay for working, as it is claimed they do, I see no reason why, with improved dredges and machinery, these gravel deposits of Morgan County would not also pay. While Dr. Brown was doubtless right in saying "that fortunes will never be made by mining gold in Morgan County" under the methods in vogue when he wrote, those methods have materially changed, and what was considered worthless ore or placer deposits in

the West a score of years ago, are now yielding riches to many men. Gold is undoubtedly present in Morgan and Brown counties, and perchance some day a mining engineer with experience and up-to-date machinery will prove that it is present in paying quantities.

OHIO COUNTY

Information concerning gold occurrences in Ohio County is as sparse as the gold itself. Robert B. Warder (1872) cited efforts by Dr. Dorsey of Hartford to find gold in the drift of Ohio County. Dorsey supposedly found one small particle of gold from two panfuls of sand, but he did not say where.

OWEN COUNTY

Collett (1876) referred to gold-dust shows along Fish, Lick, and Rattlesnake Creeks, and the so-called "flat woods" channel of White River. He did not elaborate as to the exact localities or the amounts of gold that were found.

PIKE COUNTY

In an earlier annual report Collett (1872, p. 284) stated: "Small quantities of gold and copper are found in the modified drift and clays of the glacial age. The particles are minute and of no importance." He went on to report numerous stories of Indian lead and silver mines that were circulated by the locals. As with all of the other Indian mines reported elsewhere in Indiana, none has ever been located.

PUTNAM COUNTY

This county lies south of Montgomery, and about 40 miles due west of Indianapolis. It is wholly within the "Illinoian drift" area, and the border of the Wisconsin drift passes from northwest to southeast across its center. In the valley of a small stream flowing into Big Walnut Creek, two miles east of Bainbridge, some prospectors found gold about 40 years ago, and washed out several dollars' worth. My boyhood days were passed near this place, and I have often seen the holes which they had excavated. In November, 1902, I took a gold pan to the place, and with the aid of Ami Michaels, who now owns the land, washed out a number of colors, one panful of gravel producing 11. Mr. Michaels found quite a thick bed of the black magnetic sand in a well which he sunk near this spot. The gold does not probably exist in paying quanti-

ties in this region, but its presence is undoubted. [Author's note: See Smith's report (1946) for more information about gold production in Putnam County.]

SULLIVAN COUNTY

Sutton (1882, p. 184) merely cited Sullivan County as having produced small quantities of gold. He did not elaborate as to where the gold was found or in what amounts it was collected.

VANDERBURGH COUNTY

Lies in the southwestern corner of the State, on the Ohio River, and wholly outside of the drift area. Collett, in his report on this county, says that "very minute quantities of gold and nuggets of copper are sometimes found. They were imported with the modified detritus of the glacial drift (Geological Survey of Indiana, 1875 [1876], *p. 294)."*

VERMILLION COUNTY

Bradley (1869, p. 170–171) reported minute quantities of gold in the glacial drift, but the gold was "not in sufficient quantities to pay fair days' wages for washing it."

WARREN COUNTY

This county lies on the western border of Indiana, north of the center of the State, and wholly within both drift areas. Of the presence of gold within its bounds, nothing is known beyond what Collett has written as follows: "Virgin copper and gold are found in small quantities. These metals, with small nuggets of galena, were imported from the north with the rocks of the boulder drift. At Gold Branch of Pine Creek, N. W. quarter Section 23 (22 N., 8 W.), on a gravel bar formed of debris washed from the boulder drift, a quantity of gold, reported at $70, was collected. An energetic Californian can 'pan out' from $1 to $1.25 per day at this and several other gravel bars in the county. An equal amount of labor expended at any ordinary avocation will bring better returns (Geological Survey of Indiana, 1873 [1874c], *pp. 224, 244)." Besides the above mentioned counties, gold has been found in minute quantities in Gibson and Pike, both lying along the border of the drift*

area, and in Sullivan, which lies in the interval separating the borders of the Illinoian and Wisconsin areas.

Enough has been said to show that gold doubtless occurs in every county within the drift area, but it is very improbable that it is accessible in paying quantities in any except Brown and Morgan; and there only under improved methods of separation.

DIAMONDS IN INDIANA

The first part of this section is taken directly from Blatchley (1903) in keeping with our desire to preserve as much of his original report as possible. As in the preceding section, Blatchley's work appears in italics.

While panning gold from the gravel and sand in the beds of the streams of Brown and Morgan counties, a number of small diamonds have been found by the gold seekers. I have seen eight of these and have credible information concerning several others. The earliest printed mention relating to any of them which I can find is that by Prof. E. T. Cox, as follows: "There have also been found in the drift of Brown County several diamonds, one of which weighed four carats. On Little Indian Creek, in Morgan County, Mr. J. J. Maxwell found, some ten years ago, a diamond which weighed three carats. These are interesting facts, and point to the existence of a true diamond field somewhere in the beds of crystalline rock to the north (Geological Survey of Indiana, 1878 [1879], [p.] *116)."*

A second record occurs in the Report on Morgan County, by Dr. R. T. Brown, as follows: "Two diamonds have been found in the drift of the Indian Creek valley. One is now in possession of Mr. Harry Craft, a well-known jeweler of Indianapolis. It is cut and set. It had a weight of three carats in its rough state. It was found near Morgantown. The other is somewhat larger and is uncut. It is in the possession of Mr. Maxwell, who resides three miles south of Martinsville. It was found on his farm. Both of these stones appear to have had an original connection with the drift of Indian Creek Valley (Thirteenth Annual Report Indiana Department of Geology and Natural History, 1883 [1884], *p. 83)."*

The Maxwell diamond, mentioned by both Cox and Brown, is evidently the same, but they do not agree as to its weight. It was found in Washington Township, on Goss Creek, one of the tributaries of Little Indian Creek, in 1863, by Peter Davis, an old gold hunter, and by him sold to Mr. Maxwell. The diamond is without a flaw or blemish, and of a greenish hue. It is now owned by Mrs. James Maxwell, of Martinsville, Indiana.

Dr. George F. Kunz, in his work, entitled "Gems and Precious Stones of North America," states that "two diamonds have been on exhibition for several years at the store of Frederick N. Herron, Indianapolis, and are reported by him to have been found at some locality in Indiana. They are perfect elongated hexoctahedrons of two carats each. The stones are genuine diamonds, but the particulars of their occurrence and discovery have not been obtained, and therefore nothing definite can be stated regarding them."

Besides these references, I have heard of the following Indiana diamonds which I have not seen: One George M. Tuterrow is said to have found two diamonds about 20 years ago while panning gold on Lick Creek, Brown County. One of them was sold in Indianapolis, and the other for $15 to a jeweler named Butler in Morgantown. He is said to have resold it for $75.

Mr. John Merriman, the pioneer gold hunter of Brown County, before mentioned, states that he sent several small diamonds which he had taken in Brown County to New York about 18 years ago. They were returned to him with the statement that they were genuine diamonds, but were too small to cut. He afterwards gave them to Harry Craft, a jeweler of Indianapolis. Mr. Merriman has since found four small ones, which I have seen. He also reports that a Mr. Blevin found a diamond on the headwaters of Salt Creek, in northeastern Brown County, for which he received $50.

The diamonds which I have seen from Brown and Morgan counties are as follows:

I. The Stanley Diamond. Found in September, 1900, by Calvin Stanley, on a branch of Gold Creek, Morgan County, in Section 28 (13 N., 1 E.), three miles northwest of Centerton and three miles west of Brooklyn. It was found in the bed of the stream at the base of a high cliff of blue shale, while panning gold. The stone was an octahedron

of four and seven-eighths carats weight, with a yellow tinge, and had a small black spot, not quite central. Mr. Stanley showed it to jewelers at Mooresville and Brooklyn, and in time sold it to Mr. Royse, from whom it was purchased by C. E. Nordyke, of Indianapolis. The latter gentleman had it cut in Cincinnati into two stones. Their color is a peculiar greenish yellow and their weights are one and one-eighth and one and one-sixteenth carats respectively.

As noted on a previous page, the place where this diamond was found is along the border of the newer or Wisconsin drift area. It thus corresponds to the Kettle Moraine localities of Wisconsin, in which most of the drift diamonds of that State occur.

II. The Young Diamond. The second largest diamond which I have seen from Indiana was found by W. W. Young, a gold hunter mentioned above, in 1898, on Lick Creek, Brown County, four and a half miles south from Morgantown. It is an oblong dodecahedron of the "silver cape" variety; i. e., between white and yellow in color, and weighs one and twenty-one-thirty-seconds carats. It is a very clear or "pure water" stone, without flaw or carbon speck, and is still in possession of its finder.

III. An almond shaped, pink hexoctahedral stone, weighing but one-eighth carat, was found by John Merriman on Lick Creek, Brown County, and is now in the possession of Chas. Nordyke.

IV. A small yellow hexoctahedral stone, weighing three-sixteenths carats, found by Mr. Merriman on Lick Creek, is now in the possession of R. L. Royse.

V. A small light brownish-yellow hexoctahedron, weighing five-thirty-seconds carats and found by Mr. Merriman on the same creek, is also in the possession of Royse.

VI. A blue rhombic dodecahedron, weighing eleven-sixteenths carats, was found by Mr. Merriman on Gold Creek, Morgan County, in the vicinity of the place where the Stanley diamond was found. It is now owned by Royse.

VII and VIII. Two small, pinkish diamonds, weighing one-eighth carat or less each, were taken near Brey, Morgan County, in May, 1903.

> *They were secured by Mr. Royse from the tailings below the sluice boxes operated on the farm of Dr. Clark Cook.*
>
> *It will thus be seen that four of the diamonds came from the "older" or Illinoian drift, and four from the "newer" or Wisconsin drift. The minerals found associated with these diamonds have been mentioned on a preceding page. The diamonds, like the gold, are not native to Indiana, but came in as glacial drift from some point in British America.*

In 1912 F. Doyle found a diamond at the junction of Gold Creek and Sycamore Creek in Morgan County. The stone, which weighed 2.28 carats, was a flattened hexoctahedron with strongly curved faces and was colored by a dark chrome-green spot near its surface (Sterrett, 1913, p. 1,039). Sterrett (1913) reported, via Messrs. Bradford and Royse, the discovery of five diamonds on Gold and Highland Creeks in Morgan County.

J. W. Cornett of Martinsville found a diamond in Brown County on Lick Creek in 1916. The gem weighed 1.48 carats. According to Schaller (1919, p. 892), the stone was a rounded rhombic dodecahedron that had surface pits aligned more or less with its crystallographic development.

From 1916 until 1950, reports of diamond finds in Indiana were largely repetitions of previous publications, primarily Blatchley's works. Blank (1935) prepared such a summary. In 1950, however, Frank B. Wade reported an interesting find in Miami County near Peru. The stone weighed 3.93 carats and measured 14 by 9 by 3.2 mm. It was water white and completely free of scratches.

Erd and Greenberg (1960, p. 24) summarized the physical properties of many recognized diamonds as follows: "Diamonds with dodecahedral and hexoctahedral? habits have outnumbered the octahedral stones found in Indiana. Many of the crystals are flattened on the octahedron; twinning on this face is common. The faces commonly are curved and striated. Indiana diamonds are white, yellow, and pale shades of greenish yellow, brownish yellow, brown, pink, blue, and green." Unfortunately the three diamonds that used to be on display at the Indiana State Museum (Erd and Greenberg, 1960, p. 26) have been either lost or stolen since 1960.

In the late fall of 1984 Mr. Paul Lewis of Rochester, Indiana, sent a tiny diamond specimen to me for identification. The stone, as corroborated by a gemologist with Exmin, Inc., of Bloomington, was indeed a diamond. It weighed

only a fraction of a carat and was pale yellow. Mr. Lewis found the stone while panning for gold with his granddaughter on his farm near Rochester.

It is almost certain that for every confirmed diamond find, dozens of stones have probably gone unreported or even unnoticed. To date, I am only aware of about 38 confirmed diamond finds in Indiana; all but two of them have come from either Brown County or Morgan County. If you find a natural diamond in Indiana, take it to a jeweler, a geologist, or a gemologist for positive identification and evaluation. Also, let us know about it by writing to the Indiana Geological Survey, 611 North Walnut Grove, Bloomington, IN 47405-2208.

ORIGINS OF GOLD AND DIAMONDS

Although there is little dispute as to the glacial derivation of gold and diamonds in Indiana, questions concerning the ultimate source areas of the precious metals remain. Most of the gold deposits have been placers either in alluvial sediments or in glacial outwash. Diamonds have been found exclusively in reworked glacial deposits.

GOLD

The Paleozoic sedimentary rocks overlying the Precambrian basement complex range in thickness from about 3,500 feet in east-central Indiana to as much as 14,500 feet in Posey County in southwestern Indiana. Gold has been found only in trace amounts in the Paleozoic rocks in Indiana. Possibly, although unlikely, hydrothermal mineralization, including gold deposition, of limited parts of these rocks could have occurred at some time before the onset of the Quaternary Period (Pleistocene Epoch). There is also a remote chance that one or more of the sedimentary formations derived from the erosion of igneous and metamorphic rocks could contain lithified placer deposits of great antiquity. The most probable origin for Indiana gold, however, is that it was carried by the continental glaciers of the Pleistocene Epoch (pl. 1) from its home in the ancient crystalline rocks and overlying soils of the Canadian Shield.

Willis Blatchley's concluding remark in the original *Gold and Diamonds in Indiana* (1903, p. 47) stated: "It is not improbable that within the next quarter century a new El Dorado will be discovered among the igneous rocks of this far northern region, which will be as rich in gold and precious stones as any heretofore known to man." Although this statement has proved to be somewhat overstated, it is nevertheless essentially correct. The famed Por-

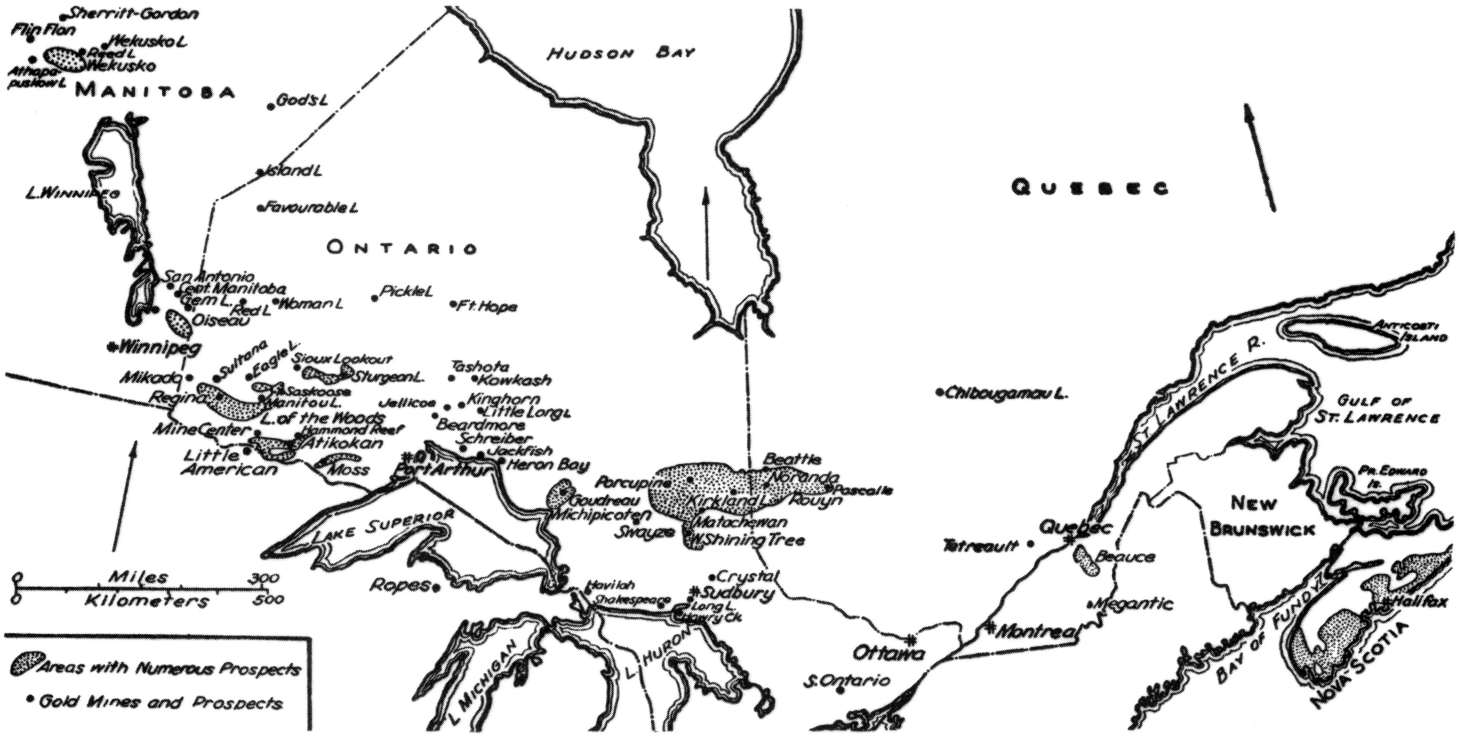


Figure 4. Map showing areas of gold occurrence in Quebec, Ontario, and part of Manitoba. From Emmons (1937 p. 39).

OVERSIZED DOCUMENT

Now located at end of publication.

cupine and Kirkland Lake gold-mine districts (see fig. 4) were discovered in 1909 and 1911. Even before Blatchley's day, however, gold was mined in the Southeastern Ontario district near the north shore of Lake Ontario. The Howry Creek, Long Lake, Shakespeare, and Havilah districts line the north shore of Lake Huron. Even the Upper Peninsula of Michigan boasts a few small gold mines, the most famous of which was the Ropes Mine near Marquette. Between 1882 and 1897 the Ropes Mine produced about $750,000 in gold and silver (Emmons, 1937). The occurrences of gold in these southern regions of Quebec and Ontario and in the Upper Peninsula of Michigan are directly in the flow paths of parts of the Pleistocene ice sheets.

Although our present understanding of both glacial processes and the history of glaciation in Indiana has improved greatly since Blatchley's day, much work remains to be done before we can say with certainty that all of the Indiana gold came from Canada. Fragments of certain rock and mineral types that are known to occur only outside Indiana are found in glacial deposits of varying age throughout most of the state. Known as erratics, these rock fragments are derived from sedimentary rocks and Precambrian igneous and metamorphic units. Each rock type has its own peculiar signature. The igneous and metamorphic rocks of the Canadian Shield, for example, can be divided into two general types by certain minerals that are of fairly uniform proportions in each. The eastern (Grenville Province) type is composed of rocks that contain a relatively high proportion of red and purple garnet and magnetic minerals, such as magnetite. The western (Superior Province) type is composed of rocks that have low concentrations of garnet and magnetite but relatively high concentrations of epidote.

By studying the mineral content of the sand-size particles within the various till sheets in Indiana, geologists have been able to determine the direction from which the ice that brought about their deposition came. For example, gold-bearing streams in Morgan and Brown Counties head in till that is known to have an eastern (Grenville) Canadian source. We know from ice-flow reconstructions for the Wisconsin ice sheets (fig. 5) that the glacial movement that deposited the uppermost till units in Morgan County came into Indiana by way of the Lake Erie basin and Ohio. The ice may have crossed the gold-producing areas of Tetreault, Megantic, and southeastern Ontario, but it is more likely to have been diverted from a more southerly flow across the Long Lake-Shakespeare-Havilah region.

The older (pre-Wisconsin) till sheets, such as the one in which Salt Creek heads in northern Brown County, probably derived from a source in an

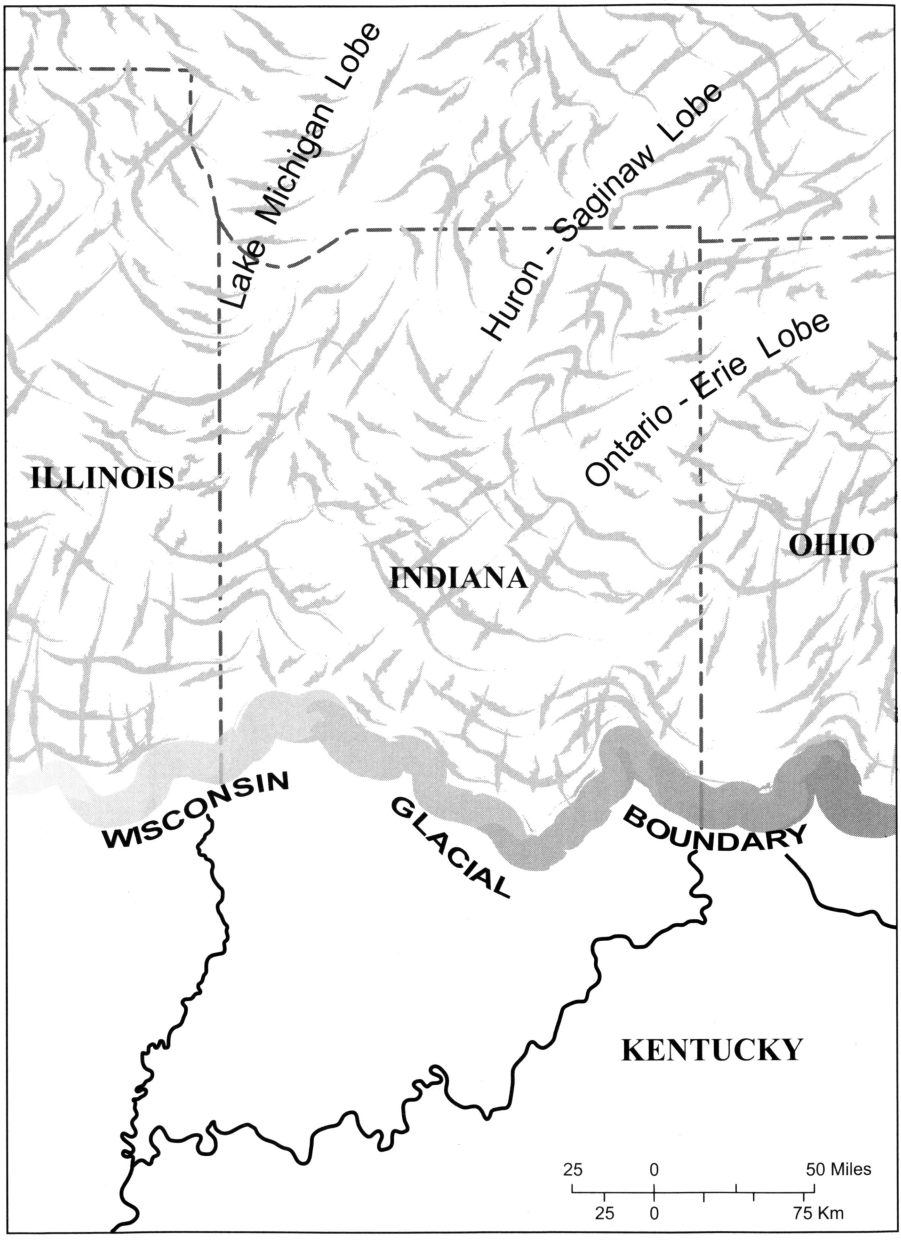


Figure 5. Map of part of the Midwest showing the major ice lobes of the Wisconsin ice sheet. Modified from Harrison (1963).

eastern Canadian province. Again, we know that gold-bearing rocks lie along the inferred glacier-flow path. Erratics that have traveled as far as 300 miles are not uncommon in glacial tills (Flint, 1971). The sand-size fraction of a given rock, crushed to that size during glacial transport, is typical of the mineral types that make up the parent rock. Most of the gold found in Indiana has been reduced to sand size and has been sorted from the broad size ranges found in till by running water. It is reasonable to expect that gold-bearing rocks and sediments occurring in southern Quebec and southeastern Ontario reached southern Indiana—at least in the sand-size fraction, and possibly larger. Unless we consider the possibility of a much closer bedrock origin in Michigan or Ohio, for example, the transport of large erratics from a Canadian source is evident because of large granitic and metamorphic boulders scattered throughout the glacial drift as far south as the Ohio River. There are a few isolated reports of gold nuggets weighing as much as 2.5 ounces that were found along creekbeds in Brown County. Even a casual examination of a glacial-till exposure is convincing evidence that ice transport does not always pulverize glacially borne sediments to sand, gravel, and mud. Some very large boulders have been known to survive ice moves of 250 miles or more.

The origins of Indiana gold are clouded as much by the complexity of the state's glacial history as any other factor. The major Wisconsin glaciations began as flow from vast ice domes centering over the Hudson Bay and central Quebec areas. The history of deposition and erosion of earlier glaciations remains uncertain.

Our best understanding of Indiana glaciation is restricted to the Wisconsin because sediments of this stage are the freshest in weathering and postdepositional erosion. Seven distinct Wisconsin glacial events have been recognized in various parts of Indiana. Gooding (1975) described five glacial advances with at least partial intervening retreats in eastern Indiana. Wayne (1963) and Bleuer and others (1983) have defined four glacial advances in parts of west-central and central Indiana, and complex overlapping and intertonguing relationships of these tills are evident particularly in west-central Indiana. The two oldest tills described by Gooding (1975) apparently do not have correlative units anywhere else in Indiana.

Four glaciations have been recognized for pre-Wisconsin time; two of them occurred during the Illinoian Stage, and two occurred during the Kansan Stage (Gooding, 1963, 1966; Wayne, 1963). The older (pre-Wisconsin deposits have been altered to varying degrees by later glaciations during which ice has ground over and removed parts of the drift, and the remaining sediments

have been further changed during interglacial and postglacial time by running water, wind, and slope settling. In some places every trace of the earliest glaciations have been removed by later ice advances; the remnant of the older deposits has been incorporated into the more recent, so that the latter has retained only masked characteristics of the former.

For example, glacial till that was deposited by one of the pre-Wisconsin glaciations may have been deposited by an ice lobe that originated in and traversed Ontario and Michigan before entering Indiana. That till would have contained at least some rocks and minerals that reflected a northern or Superior Province source. A much later glaciation, say during Wisconsin time, could then have flowed across Indiana from a northeasterly source and carried with it minerals and rocks typical of Quebec (eastern, or Grenville Province, source). As the eastern-source ice flowed over the older till it could easily have incorporated and mixed northern-source and northeastern-source deposits. The end result would be a mixture that was not typical of either area. This concept of deposition, reincorporation, and redeposition not only takes place between till sheets of differing age but also occurs throughout the progress of an ice sheet from its origin to the area of its maximum extent. Therefore, the till and outwash deposits left behind by a particular glaciation reflect not only the kinds of materials found near the source of the ice but also those materials over which the ice has passed.

For this reason, glacial geologists rely on a combination of tools in an effort to understand the origins and ages of glacial deposits. Indicators such as the grooves and striae cut into exposed bedrock tell us the general direction from which the ice came. Similar striae cut into boulders exposed at the upper surface of an existing till sheet can also be used as direction indicators. Grooves and striae can mislead the unwary, however. A glacier might begin its trek from an ice dome centering over James Bay by flowing southward and from there turn and flow southwestward or westward in response to changes in local topography or local thickening and thinning of the ice. Before striae can be used as meaningful indicators of regional flow patterns, the geologist must take many readings from a large area so that an average flow direction can be reconstructed.

Elongate cobbles, pebbles, granules, and sand grains will align either parallel or perpendicular to ice-flow direction. Therefore, pebble-orientation analysis (often called fabric determination) is another useful tool that tells the direction from which the ice came. Fabric analyses, like striation determinations, require many readings from different localities to reconstruct regional ice-flow patterns properly.

Gross landform features, such as terminal moraines and linear grooves and ridges impressed on the till surface, are also useful indicators of ice-flow direction, but only at regional-map or aerial-photograph scale. Along the Wisconsin glacial boundary and southward in the area of pre-Wisconsin drift, these kinds of features are poorly developed or lacking altogether. Those parts of Morgan and Brown Counties noted for their relatively abundant gold placers fall within glacial terrain that lacks morainic development and obvious linear features. Although the tills in this area are of supposed northeastern source, we have no evidence to support this supposition. The soft Borden Group rocks that underlie the glacial deposits in this area do not take striations as do the harder limestone and dolomite surfaces elsewhere. Nor do we have mineralogic analyses of the tills to which we can refer.

Application of the above analyses to Wisconsin glacial deposits revealed three principal flow paths of the Laurentide Ice Sheet for deposition of the various till units of that age. One that was essentially southward along the axis of the Lake Michigan basin is appropriately called the Lake Michigan Lobe. Another that entered Indiana from Michigan in a southwesterly direction is called the Huron-Saginaw Lobe. The third, called the Ontario-Erie Lobe, partly followed the axis of the Lake Erie basin. Ice movement within these lobes was by no means synchronous but happened at different times and at different rates throughout Wisconsin time. In west-central Indiana, for example, till deposited by the Lake Michigan Lobe (northern source) was overridden by ice of the Huron-Erie Lobe. This ice deposited till that was typical of its Grenville Province origins. We may reasonably expect that similar flow patterns existed in pre-Wisconsin time, but we cannot now demonstrate them as we can those in the younger drift of Wisconsin age.

A glance at the gold-occurrence map of Canada (fig. 4) suggests, however, that locality of the ice source is not critical in accounting for the way that the gold got to Indiana. Gold deposits are scattered all over southern Canada. The most important factors, those that may never be resolved, concern the method of glacial erosion and deposition. Not all glaciers erode their beds. Most cold-based ice sheets, for example, are frozen to their beds, and movement takes place within the ice layers above the ice base. According to White (1972), the late Wisconsin Laurentide Ice Sheet had a frozen bed over Hudson Bay, so that no erosion occurred there, and only erosion of the permafrost zone is postulated for the Canadian Shield area. This model may be applicable to the earlier glaciations that deposited the basal tills of Brown County, for example.

But the mechanisms by which an ice sheet erodes its base are extremely complex and require knowledge of ice temperatures, rate of ice movement, climatic input, amount of liquid water entrapped within the sediments beneath the ice, surface topography beneath the ice, and physical and chemical properties of the ice. These factors are not readily deduced for pre-Wisconsin glaciations that occurred as long as 300,000 years ago or more. The most logical sources for Canadian gold are those closest to us. The southeastern Ontario, Havilah, and Shakespeare fields are the most likely if a bedrock source is assumed.

The Canadian gold-producing areas of preglacial times probably appeared much different from what they do today. Millions of years of erosion throughout the area of the Canadian Shield would have strongly weathered the existing bedrock and probably produced highly oxidized residual soils. A process known as supergene enrichment could have refined existing gold in the weathered part of the bedrock.

One mechanism of supergene enrichment involves the dissolution of gold by the downward percolation of ground water laden with sulfides and chloride salts. The gold chloride solution attacks carbonates, chalcocite, and other minerals that reduce its acidity; as a result very pure gold is precipitated (Emmons, 1937). At least parts of southeastern Ontario have rocks that contain hydrothermal sulfide veins, and younger Paleozoic rocks (Silurian evaporites) in the area should contain sodium chloride and other chloride salts. The reaction of the salts with gold in the regolith could have precipitated a pure form of gold on contact with the underlying sulfide veins.

Another kind of supergene enrichment that involves the activity of microorganisms on auriferous soil has been documented in the Livengood area of Alaska (Watterson, 1985). The process involves the dissolution of gold by the action of microorganisms that serve as nuclei for the growth of the crystalline gold. The earliest glaciations of eastern and central North America would probably have removed the upper rock mantle and soil. If the supergene-enrichment hypothesis is correct, it could help to explain the exceptional purity and relatively greater concentrations of the gold found in the oldest glacial deposits of Indiana.

Fluvial-sorting processes may also account for high-purity gold. By this mechanism the pure gold is separated from its various lighter alloys (for example, electrum and gold tellurides) by stream sorting according to the specific gravity of its sediment load. Stream sorting, however, need not have occurred after deposition of the gold-bearing drift. The very pure gold may

have been incorporated in the ice from presorted placer deposits in Canada or older glacial outwash deposits in Michigan, Ohio, or even Indiana. Gold is not restricted to the oldest glacial drift in Indiana. Traces of the precious metal have been found in streams whose sources are in glacial till of mid-Wisconsin age. But by far the largest gold concentrations derive from the older glacial sediments laid down by some of the earliest glaciers to leave the Canadian Shield area.

John Collett (1875, p. 107) reported that gold of 24-carat purity had been removed from streams in northern Brown County. Blatchley (1907, p. 69) wrote that gold qualities had averaged 22 carats or more for samples found in Brown County, Morgan County, western Johnson County, and northern Jackson County. Erd and Greenberg (1960) reported that gold from Brown County had ranged in specific gravity from 16.8 to 18.5 and that according to a U.S. Mint report of 1901, a sample of Indiana gold has shown a fineness of 909½ (1,000 fineness is pure gold). Supergene enrichment of the source gold and transport separation may account separately or in conjunction for the exceptional purity of the Indiana placer gold. But the necessary information for a definitive answer to this question is lacking.

DIAMONDS

Diamonds, like gold, have traditionally been thought to have come to Indiana from the Canadian Shield by glacial transport. Interestingly, the greatest number of midwestern diamond finds have been in Indiana. Christopher Gunn (1968) cited 34 diamond discoveries in Indiana, 25 in Illinois, 16 in Wisconsin, two in Michigan, two in Ohio, two in New York, and one in Ontario. Since his report at least four additional diamond finds have been reported for Ohio (Hansen, 1985). The wide dispersion of the localities in which diamonds have been found indicates multiple bedrock sources for the stones and the complex glacial-transport mechanisms outlined above. Some geologists have hypothesized that the diamonds may have local sources within or adjacent to the states in which they are found and also that the rocks containing them, although transported by glacial ice, have not been moved far from their points of origin.

Diamonds form at great depth within the earth where temperatures exceed 1,000° Celsius and pressures may exceed 90 kilobars (90,000 times the pressure of the earth's atmospheric pressure). The main source of primary diamond is an igneous rock called kimberlite (named for the South African town

of Kimberley that is famous for its diamonds). Other sources recognized in the literature are igneous breccias, andesite, and contact metamorphic rocks—each an insignificant economic source (Chandler, 1964).

Kimberlite consists mainly of peridotite (an igneous rock composed mostly of olivine and pyroxene) but also contains phlogopite, ilmenite, magnesian garnet, enstatite, and chrome diopside. Kimberlites containing diamonds form at depths ranging from 62 to 186 miles, the zone where temperatures and pressures are conducive to diamond evolution (Cox, 1978). Diamond-bearing kimberlites reach the earth's surface by narrow volcanic pipes called diatremes. Fluid movement through the pipe is thought by some workers to attain extremely high velocities and by others to be very slow.

The basis for these widely divergent theories is the presence in the kimberlite of rounded detached blocks of bedrock that were broken from the rock through which the molten kimberlite passed. These rock fragments, or xenoliths, can be very large. Therefore, the energy required to carry them to the surface requires either a very rapidly moving fluid stream or a slow, very viscous one. The kimberlite pipe widens toward the top and can be as small as a few tens of feet in diameter or as large as a mile in diameter. Dikes radiating from the pipe can be as small as an inch across. Therefore, locating a kimberlite by magnetic maps, geochemical prospecting, and scattered borehole data can be like looking for the proverbial needle in a haystack. Furthermore, kimberlites are composed of mineral species that weather very rapidly in the northern midcontinent climate; olivine (the dominant mineral in peridotite) heads the list of easily eroded mineral types. Most people, including many geologists, would probably not recognize the weathered kimberlite rock, which is quickly oxidized to a clay-rich yellowish soil. Less well oxidized kimberlite is bluish, and unweathered kimberlite, a rare find in most locales, is a hard dark-gray or blue rock with structures that are typical of its igneous origin (Cox, 1978).

Even though the igneous and metamorphic basement rocks of Indiana are covered by 3,500 to more than 13,000 feet of sedimentary rock, diamond-bearing kimberlite pipes may have intruded through the entire Paleozoic section and cropped out on the preglacial bedrock surface. If intrusion has occurred at one or more localities in Indiana or in Ohio and Michigan, the earliest glaciers could have incorporated diamonds from the weathered kimberlite and scattered them through the drift along the glacier-flow path.

Because more than 80 percent of the bedrock surface of Indiana is covered by glacial deposits, finding a kimberlite pipe would be unlikely. Even if one were exposed in the driftless part of Indiana, the yellowish-clay residual would probably not be recognized as a weathered kimberlite deposit.

Only about 10 percent of existing kimberlites contain diamonds, and in places where there are diamonds, they are so small in quantity that it takes 20- to 50-ton samples to determine the grade (Gunn, 1968). The greatest concentrations of diamonds occur as weathered lag deposits.

Diamond is the hardest naturally occurring mineral (10 on the Mohs hardness scale). It therefore survives the rigors of glacial and stream transport with less degradation than other minerals of similar dimensions. Some writers believe that surface pits on drift diamonds are the result of glacial transport, but the origin of the pits is uncertain. They could be etch pits induced by chemical alteration at the point of origin.

Gunn (1968) suggested that if a more local source for the diamonds was anticipated, indicator trains and fans of kimberlite minerals (for example, chrome diopside, magnesian ilmenite, and pyrope garnet) should be sought. He stated that the lack of success in finding such fans in the past was due as much to the paucity of people looking for them as the absence of these minerals from the region. Cannon and Mudrey (1981) reported an exposed kimberlite pipe in upper Michigan that they called the Lake Ellen kimberlite (sec. 27, T. 44 N., R. 31 W.). The pipe is elliptic in shape and strongly magnetic. Kimberlites like the Lake Ellen are thought to be possible sources for at least some of the drift diamonds that have been found in Wisconsin in the past century. But the Lake Ellen kimberlite is not known to be diamond bearing. Cannon and Mudrey speculated that a number of cryptovolcanic structures found in Wisconsin and upper Michigan could have formed as a result of kimberlite intrusion. The Kentland anomaly near Kentland, Indiana, may have had a similar origin, but ultrabasic intrusives have not been discovered within any of the disturbed Paleozoic sediments at Kentland.

The thought of "home-grown" diamonds is intriguing indeed and certainly not to be ruled out. Although evidence for a true diamond-bearing kimberlite in Indiana, Ohio, Michigan, or Wisconsin has yet to be found, the discovery of at least one kimberlite deposit in Wisconsin suggests that local sources for diamonds are not as unreasonable as once thought.

FINDING GOLD

Pure gold has a specific gravity of 19.3 and is gold yellow. Its color is only partly diagnostic because impurities, such as silver, copper, and tellurium, can impart color variations from orange-red (copper alloy) to white-metallic gold (silver alloy). Gold is very soft; its hardness is only 2.5 on the Mohs scale. The exceptional malleability and specific gravity of gold make it easy to differentiate from iron pyrite (fool's gold). Even a tiny fleck of gold can be dented and folded with a sharp knife point or needle. Iron pyrite, in contrast, is hard and brittle. Furthermore, gentle washing of gold and pyrite along the side of a gold pan will quickly float away the pyrite, and the much heavier gold will be left behind. Small flakes of biotite mica that have been partly weathered to a golden color may also be mistaken for gold, especially when the flakes are wet. Because gold is insoluble in acids except aqua regia (a mixture of nitric and hydrochloric acids), it is easy to distinguish from sulfide ores of similar appearance (for example, pyrite, marcasite, and chalcopyrite).

Indiana gold, with one possible exception, has been found as placer deposits in postglacial river sediments, in outwash deposits of glacial origin, and in bedrock crevices beneath a creekbed. Richard Owen reported finding some gold in a pocket of drift and partly in the "yellow and blue clay" of a streambank in the Frankfort area (Owen, 1862, p. 113). Whether or not the "drift" mentioned by Owen was actually till is unknown. The ability of a glacier to reduce large boulders to fine sand, silt, and clay is well known. The grinding forces within the ice serve as an efficient arrastra (a device used to crush rock and therefore to free entrapped gold) for reducing gold-bearing rocks to their constituent minerals. Nevertheless, with rare exception, the distribution of the gold through glacial till is so sparse that only concentration of the element by running water is essential to the production of notable amounts. Stream sorting of the extremely varied sediment sizes in till is the same mechanism that isolates gold in placer deposits around the world. It makes little difference whether the gold comes from a bedrock source in the high Sierras or from upland-till deposits in Indiana, running water does the work of separating the gold according to its specific gravity and the laws of stream dynamics.

Finding placer deposits in gold country is mostly a matter of determination, but a working knowledge of how streams carry and deposit their sediment load is also useful. Gold keeps the company of other mineral deposits of similar density and particle size. That is why it is almost always found in "black sand" deposits—the black sands composed of magnetite, ilmenite, rutile, garnet, and other relatively heavy minerals. Because gold is dense, it settles

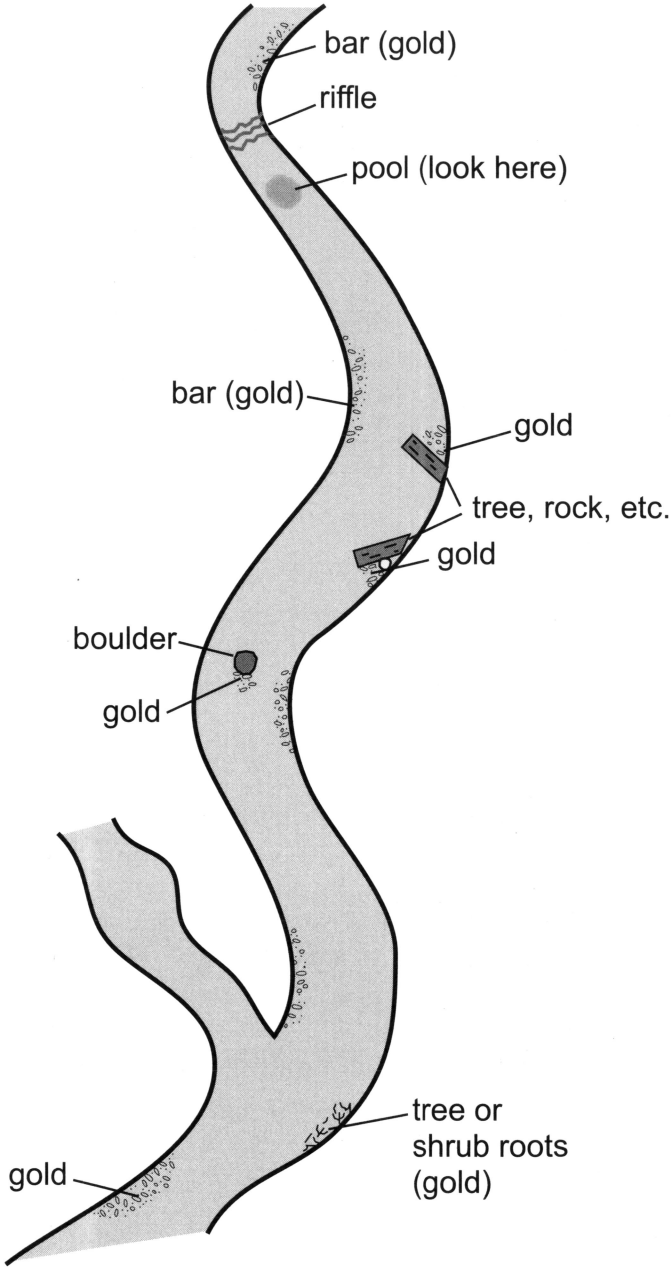


Figure 6. Typical occurrences of gold-bearing sediments along a meandering stream.

out of the stream load nearer to its upland-till source than do other sediments of similar particle size, such as sand-size feldspar, quartz, and epidote.

Streams, like other energetic forces in creation, accomplish work by the most efficient means. Therefore, waterflow in a stream channel is not constant in either velocity or direction. It flows alternately at faster then slower velocities, all the while making changes in flow direction that create the serpentine channel path known to all. On the inside of a stream bend (meander), the current slows (fig. 6). The greater the meander size, the slower the stream velocity relative to its velocity on the outside of the bend. As you might suspect, the areas of slower streamflow are also places of sediment deposition—including that of gold. As gold moves along with the other constituents of the bedload, it follows the shortest path moving from inside bend to inside bend. The gold-bearing black sands can usually be panned from sediments on the inside of meander bends.

Any other factor that reduces stream velocity also contributes to gold deposition. A boulder in the stream channel of sufficient size provides shelter on its downstream side for gold deposits. Projections from the channel bottom or banks that slant upstream have deposits on their upstream side, and those that point downstream have sediment accumulations on their downstream side.

Tree roots, grass, weeds, and moss are excellent gold traps. Digging about the roots of a willow tree can almost always produce a few colors in the pan if there is any gold to be found in that reach of the stream.

Most streams in southern Indiana that produce notable quantities of gold do so in their headwater reaches where flow is intermittent. Therefore, productive gold-panning ventures are limited to seasons of high rainfall or immediately after an all-day rain during an otherwise dry season. In southern Indiana the early spring and middle to late fall are usually wet, whereas the summer months of July and August are dry. Panning in the early spring and late fall has the added advantage of reduced vegetative cover along the streambanks. (And the poisonous snake population is less likely to be encountered in cooler weather.)

Once you have found the ideal spot, fill the pan about three-quarters full of stream sediments. Most of the gold-producing streams are on or near bedrock—especially near their headwaters. The gold usually settles out along the bedrock surface or in joints and crevices in the rock. Therefore, you should dig as deeply as possible into the alluvial materials.

Submerge your sediment-filled pan in water about a foot deep and stir the contents of the pan with your hand, breaking the larger clods of mud and sand as you do. Remove the large debris, including cobbles and wood fragments, being careful to wash them over the pan to catch any free gold that might be clinging to the surface. Try not to lose any of the fine sediments. With the pan full of water, tilt it away from you and move it back and forth in a slightly elliptic motion. Dip the pan into the water again and slowly withdraw it, allowing the water to flow over the edge. This process will carry away the lighter sand-size particles, silt, clay rootlets, etc., and leave a residue of the heavier sand including gold.

Continue the process outlined above until only a mixture of black sand remains. The black sand consists of magnetite, rutile, ilmenite, garnet, epidote, and lesser amounts of other heavy minerals. The gold flecks are easy to spot. The next step requires removal of the black sand so that only the gold is left behind. Expert panners are able to gently wash the black sand away by placing a small amount of water in the pan, tipping the pan away at a 30° angle, and slowly moving the pan back and forth until all of the sand is gone. The gold can then be recovered from the lip of the pan by moistening the tip of your finger with your tongue and pressing your finger onto the gold particles. The gold is then transferred to a small water-filled vial by holding your finger over the vial opening and shaking it several times.

If you have difficulty reducing the sediments to gold alone, try removing the visible gold with tweezers or a wet cotton swab. If you wish, you can transfer the gold-bearing black sands from your pan to a widemouthed jar and remove the gold at home at your leisure.

A powerful magnet is useful for removing the magnetite and ilmenite from the black sand. Dry the black sands on a smooth, flat nonmetallic surface. Passing the magnet through the dry sand will quickly remove the magnetic minerals. By using a very fine artist's brush and a magnifying glass or a microscope, you can pick out the gold. The use of mercury for amalgamating the fine gold is not recommended. Mercury is a deadly poison, even in trace amounts.

Where bedrock is exposed along the stream-channel bottom, gold may be trapped in the exposed joints. A good syringe or other suctioning device can be useful for extracting any gold that may have settled in the fissures—particularly those oriented transverse to streamflow.

People usually ask if metal detectors are useful for finding gold. The answer to that question is a qualified yes. The VLF/TR (Very Low Frequency/Transmitter-Receiver) is very sensitive to electrical conductivity. Because gold is one of the best known conductors, the VLF metal detectors can detect gold even in areas where other conductors, such as iron compounds, are present. The primary difficulty in using the metal detector to locate gold is the sparsity of the precious metal and its low concentration with respect to other conducting minerals. The operator would have to be very skilled in using the metal detector and have a lot of experience discriminating between the different types of background "noise." The device is useful, however, for locating black-sand deposits.

Gold has been reported from as far north in Indiana as Cass County and as far south as Vanderburgh and Harrison Counties. Diamond finds are rare but are known from Fulton, Miami, Morgan, and Brown Counties. The most likely locales in which to find both gold and diamonds are northern Brown County and Morgan County.

Gold panning and diamond hunting is prohibited in all state parks and even recreational prospecting is no longer possible on any state-owned land. Some private land owners may be willing to allow an individual or a family to pan along creeks that traverse the private property. To avoid the embarrassment of being asked to leave for trespassing, the gold panner is advised to ask permission of the property owner before beginning to pan.

REFERENCES CITED

Anonymous, 1850, [untitled]: Franklin Institute Journal, v. 19, ser. 3, no. 6, p. 417.

Blank, E. W., 1935, Diamond finds in the United States, pts. 5 and 6: Rocks and Minerals, v. 10, no. 3, p. 23–26, 39–40.

Blatchley, W. S., 1903, Gold and diamonds in Indiana: Indiana Department of Geology and Natural Resources Annual Report 27, p. 11–47 [reprinted in 1963].

_____ 1907, Gold and diamonds: Indiana Department of Geology and Natural Resources Annual Report 31, p. 68–72.

Bleuer, N. K., Melhorn, W. N., and Pavey, R. R., 1983, Interlobate stratigraphy of the Wabash Valley, Indiana: Midwest Friends of the Pleistocene, 30th Field Conference, Guidebook, 136 p.

Borden, W. W., 1876, Jennings County: Indiana Geological Survey Annual Report 7, p. 146–180.

Bradley, F. H., 1869, Geology of Vermillion County: Indiana Geological Survey Annual Report 1, p. 138–174.

Brown, R. T., 1884, Geology of Morgan County: Indiana Department of Geology and Natural History Annual Report 13, pt. 1, p. 71-85.

Cannon, W. F., and Mudrey, M. G., 1981, The potential for diamond-bearing kimberlite in northern Michigan and Wisconsin: U.S. Geological Survey Circular 842, 15 p.

Chandler, H. P., 1964, Industrial diamond—A materials survey: U.S. Bureau of Mines Information Circular 8200, 149 p.

Christy, David, 1848, Letters on geology: giving an outline of the geology of the West and Southwest together with an essay on the erratic rocks of North America: Rossville, Ohio, J. M. Christy, Printer, 83 p.

Collett, John, 1872, Geology of Pike County, Indiana: Indiana Geological Survey Annual Reports 3 and 4, p. 239–287.

_____ 1874a, Geology of Gibson County: Indiana Geological Survey Annual Report 5, p. 383–422.

_____ 1874b, Geology of Knox County: Indiana Geological Survey Annual Report 5, p. 315–382.

_____ 1874c, Geology of Warren County: Indiana Geological Survey Annual Report 5, p. 191–259.

_____ 1875, Geology of Brown County: Indiana Geological Survey Annual Report 6, p. 77–110.

_____ 1876, Geological report on Vanderburgh, Owen, and Montgomery Counties, Indiana: Indiana Geological Survey Annual Report 7, p. 240–422.

_____ 1879, Geological report on Harrison and Crawford Counties, Indiana, 1878: Indiana Geological Survey Annual Reports 8, 9, and 10, p. 291–522.

Cox, E. T., 1869, First annual report of the Geological Survey of Indiana, made during the year 1869: 240 p.

_____ 1875, Sixth annual report of the Geological Survey of Indiana, made during the year 1874: 287 p.

_____ 1879, Eighth, ninth, and tenth annual reports of the Geological Survey of Indiana, made during the years 1876–77–78: 541 p.

Cox, K. G., 1978, Kimberlite pipes: Scientific American, v. 238, p. 121–130.

Culbertson, Glenn, 1916, The geology and natural resources of Jefferson County: Indiana Department of Geology and Natural Resources Annual Report 40, p. 223–239.

Emmons, W. H., 1937, Gold deposits of the world with a section on prospecting: New York, McGraw-Hill, 562 p.

Erd, R. C., and Greenberg, S. S., 1960, Minerals of Indiana: Indiana Geological Survey Bulletin 18, 73 p.

Flint, R. F., 1971, Glacial and Quaternary geology: New York, John Wiley, 892 p.

Gooding, A. M., 1963, Illinoian and Wisconsin glaciations in the Whitewater basin, southeastern Indiana, and adjacent areas: Journal of Geology, v. 71, p. 665–682.

_____ 1966, The Kansan glaciation in southeastern Indiana: Ohio Journal of Science, v. 66, p. 426–433.

_____ 1975, The Sidney interstadial and late Wisconsin history in Indiana and Ohio: American Journal of Science, v. 275, p. 993–1,011.

Gunn, C. B., 1968, Relevance of the Great Lakes discoveries to Canadian diamond prospecting: Canadian Mining Journal, v. 89, no. 7, p. 39–42.

Hafer, Claude, 1921, Placer gold in Indiana: Engineering and Mining Journal, v. 111, p. 1,023.

Hansen, M. C., 1985, Additional notes on Ohio diamonds: Ohio Geology Newsletter, Winter, p. 1–4.

Harrison, Wyman, 1963, Pages from the geologic past of Marion County: Indiana Geological Survey Circular 9, 23 p.

Haymond, Rufus, 1869, Geology of Franklin County: Indiana Geological Survey Annual Report 1, p. 175–202.

Indiana Geological Survey, 1979, Map of Indiana showing unconsolidated deposits: Miscellaneous Map 26.

Logan, W. N., 1922a, Gold, *in* Handbook of Indiana geology: Indiana Department of Conservation Publication 21, p. 1,053–1,054.

_____ 1922b, Gold in Indiana: Indiana Year Book for 1921, p. 227–235.

Owen, D. D., 1859, Report of a geological reconnoissance of the State of Indiana; made in the year 1837, in conformity to an order of the legislature: Indianapolis, John C. Walker, 63 p.

Owen, Richard, 1862, Report of a geological reconnoissance of Indiana, in Owen, Richard, Report of a geological reconnoissance of Indiana, made during the years 1859 and 1860 under the direction of the late David Dale Owen, M.D., State Geologist, 240 p.

Schaller, W. T., 1919, Gems and precious stones: U.S. Geological Survey Mineral Resources of the United States, 1916, pt. 2, p. 887–899.

Sterrett, D. B., 1913, Gems and precious stones: U.S. Geological Survey Mineral Resources of the United States, 1912, pt. 2, p. 1,023–1,060.

Smith, E. R., 1946, Sand: Indiana Academy of Science Proceedings for 1945, v. 55, p. 121–143.

Sutton, George, 1882, The gold-bearing drift of Indiana [abs.]: American Association for the Advancement of Science Proceedings, v. 30, p. 177–185.

Thompson, Maurice, 1892, Geological and natural history report of Carroll County: Indiana Department of Geology and Natural Resources Annual Report 17, p. 171–191.

Wade, F. B., 1950, Another rough diamond found in Indiana: Gems and Gemology, v. 6, p. 249–250.

Warder, R. B., 1872, Geology of Dearborn, Ohio, and Switzerland Counties: Indiana Geological Survey Annual Reports 3 and 4, p. 385–434.

Watterson, J. R., 1985, Microorganisms and gold, *in* Organics and ore deposits: Denver Region Exploration Geologists Society Second Symposium, p. 10.

Wayne, W. J., 1963, Pleistocene formations in Indiana: Indiana Geological Survey Bulletin 25, 85 p.

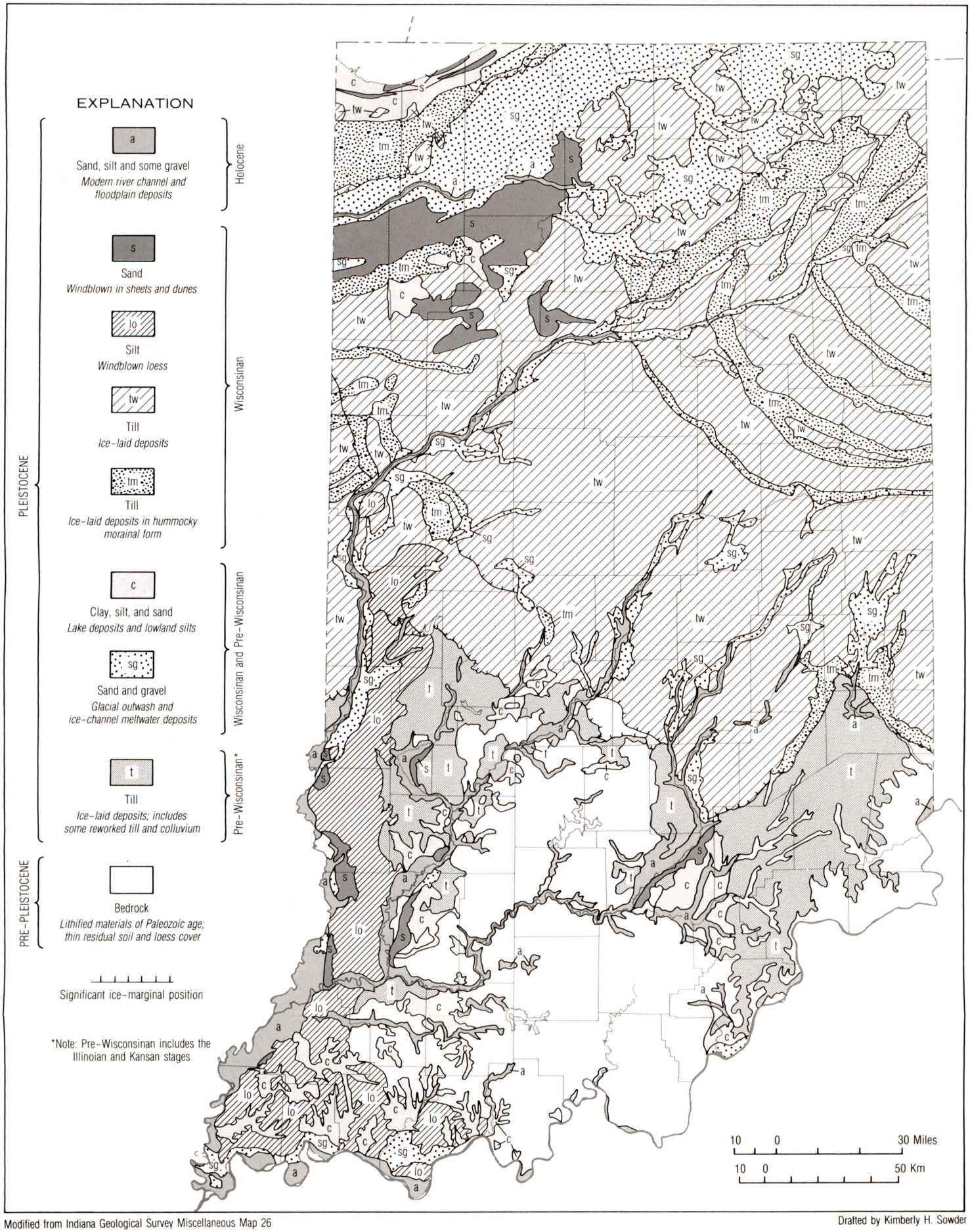
White, W. A., 1972, Deep erosion by continental ice sheets: Geological Society of America Bulletin, v. 83, p. 1,032–1,056.

THIS PAGE INTENTIONALLY LEFT BLANK

J. R. Hill Gold and Diamonds in Indiana: An Update Indiana Geological Survey Circular 12

OVERSIZED DOCUMENT

The following pages are oversized and need to be printed in correct format.



Modified from Indiana Geological Survey Miscellaneous Map 26

Drafted by Kimberly H. Sowder

MAP OF INDIANA SHOWING GLACIAL DEPOSITS