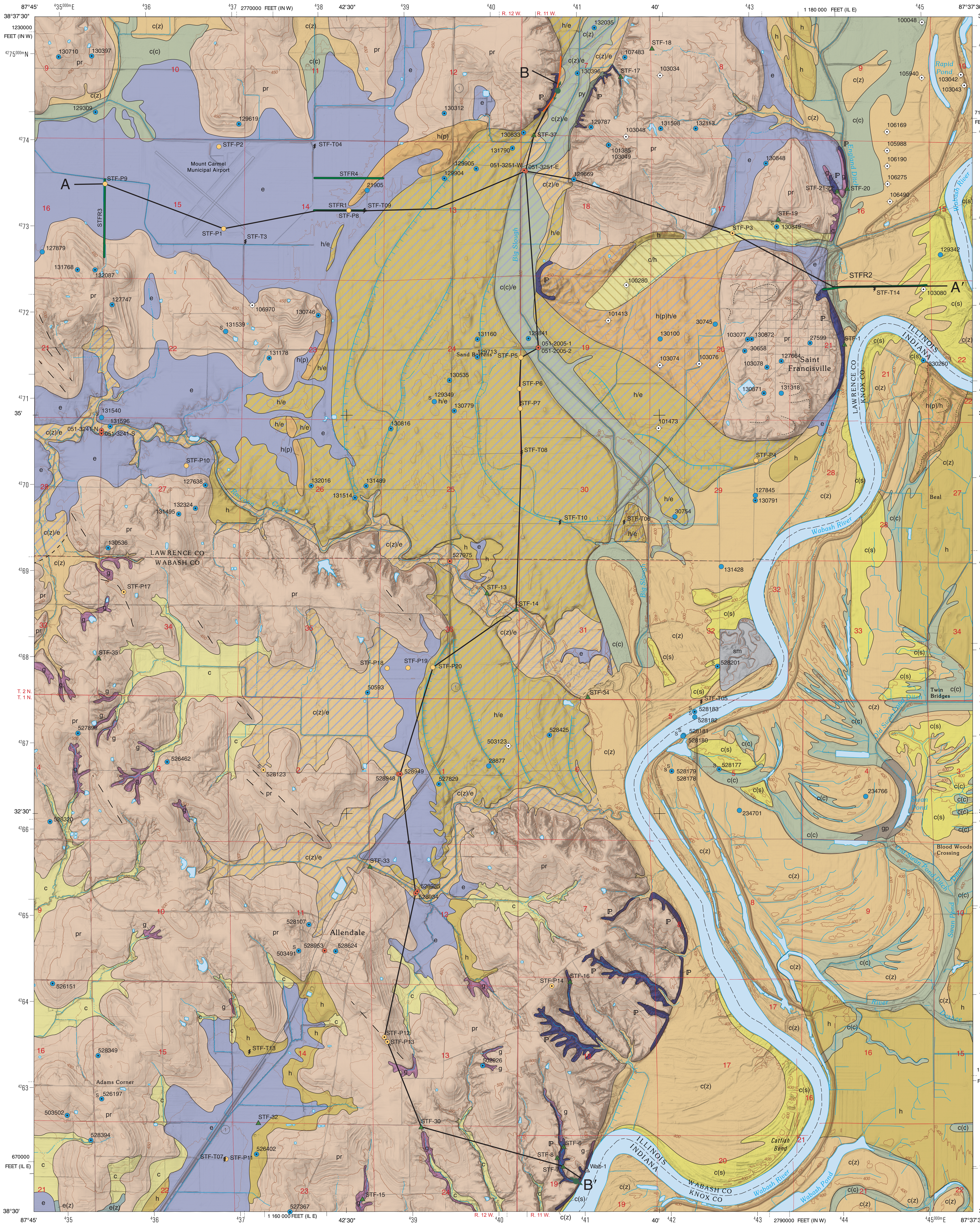
Prairie Research Institute
ILLINOIS STATE GEOLOGICAL SURVEY

SURFICIAL GEOLOGY OF SAINT FRANCISVILLE QUADRANGLE
LAWRENCE AND WABASH COUNTIES, ILLINOIS, AND KNOX COUNTY, INDIANA

STATEMAP Saint Francisville-SG

Andrew C. Phillips
2017



QUATERNARY DEPOSITS

HUDSON EPISODE (~13,000 years before present (B.P.) to today)

Description	Unit	Interpretation
Removed earth	Surface Mine (sm)	**Small aggregate pits** exploited channel and outwash gravels, now filled with water
Silt loam, organic; dark brown to gray brown to black; up to 5 feet thick	Grayslake Peat (gp)	**Alluvium;** single unit mapped in filling meander cutoff lake
Silt loam to loam, with local gravel; massive to weakly bedded; yellow brown; less than 10 ft thick	Peyton Formation (py)	**Colluvium;** mapped as fan complex along east wall of Big Slough; derived from loess and till-covered upland
Loam, silt loam, and silty clay loam; local basal sand or pebbly sand beds; fine portion typically massive, but locally laminated or thin bedded; graded upwards; brown to yellow-brown; typically leached; as much as 20 feet thick	Cahokia Formation (c)	**Alluvium;** Less than 10 feet thick in tributary stream valleys draining bedrock uplands; up to 20 feet thick where mapped as undifferentiated alluvium in Wabash Valley; where lithology of underlying unit is similar, contact is gradational and recognized by buried paleosol
Silty clay loam to silty clay, intercalated with minor loam; massive to weakly stratified; brown to olive brown to black; leached; less than 10 feet thick	Cahokia Formation (clayey facies) (c(c))	**Backswamp, flooplain lake, and overbank deposits**
Silt loam to loose silt over loamy sediment to sand; massive, may include loamy interbeds; olive brown to gray brown; leached near surface; as much as 10 feet thick	Cahokia Formation (silty facies) (c(z))	**Overbank and secondary channel deposits** in Wabash Valley; drapes over relict sandy scroll bar or outwash deposits; forms several low terrace flights
Sand, loamy sand, and sandy loam; very fine to coarse; laminated to thick bedded to massive; fine gravel lenses; yellow brown to brown; leached near surface; typically 5 but as much as 25 feet thick	Cahokia Formation (sandy facies) (c(s))	**Channel, point bar, crevasse splay, and levee deposits**; may be incised into older deposits or bedrock; forms terraces along valley walls; thickest in Wabash Valley

WISCONSIN EPISODE (~55,000–13,000 years B.P.)

Description	Unit	Interpretation
Silt loam to clay loam; upper unit massive with gradational contact, brown to yellow brown; lower unit sandier with granules, massive to crudely bedded, brown to reddish brown, typically leached; upper and lower units as much as 9 feet and 1 foot thick, respectively	Peoria and Roxana Silts (pr)	**Loess;** mapped over all upland surfaces, intercalates with some of the valley fill; locally eroded off some ridges to expose underlying till; lower Roxana Silt is loess intermixed with colluvium, locally includes eolian sand sheet
Sand to sandy loam; fine to coarse; thin bedded to massive, silty and fine gravel lenses; brown and light brown to gray; locally leached but typically calcareous; as much as 90 feet thick in Wabash Valley	Henry Formation (h); on map where buried	**Outwash;** comprises the surficial unit on terraces, or is buried below Cahokia Fm in Wabash Valley; as valley-filling deposit, originally formed sediment dams blocking tributary valleys, where prograding delta facies intercalated with slackwater lacustrine facies; largely incised by late-glacial flood flows, which deposited surficial units and constructed landforms; low terraces reworked by post-glacial overbank flows in Wabash Valley; deposited as alluvium and shoreface sediment in upper tributary valleys with slackwater fill
Fine sand to loamy fine sand and silt loam; thin-bedded to massive, yellow brown to brown; upper portion leached, as much as 15 feet thick	Henry Formation (Parkland facies) (h(p))	**Eolian dunes;** reworked from outwash deposits; occur on terraces and bedrock uplands near Wabash Valley; landforms include parabolic and complex dunes formed by westerly winds; older deposits intercalate with loess; shown as h(p)/h where undifferentiable at map scale
Silty clay loam to clay, few silty and sandy interbeds; laminated to massive, fossiliferous zones with gastropod, mussel and ostracode tests, peaty horizons, generally calcareous; gray to gray brown to olive brown; as much as 50 feet thick	Equality Formation (e); on map where buried	**Slackwater lake deposits from damming of tributary valleys by outwash;** crops out in terraces along Raccoon Creek and as surficial unit in tributary valleys; buried by Cahokia Fm or Henry Formation in lower valley fills and terraces; Inset into Teneriffe Formation in the subsurface; mixed with loess at surface; upper elevations as high as 440 ft in upper valley reaches, but mostly 425-428 ft asl
Silt loam; laminated to massive; yellow brown to gray; leached to dolomitic; as much as 5 feet thick	Equality Formation (silty facies) (cross sections only) (e(z))	**Nearshore lacustrine sediment and associated alluvium** deposited near Wabash Valley source. Found only in terrace east of Sand Barrens; not differentiated on map because extent is uncertain

ILLINOIS EPISODE (~190,000 to 130,000 years B.P.)

Description	Unit	Interpretation
Silt loam to clay; laminated to massive; includes fine sand lenses 1-5 feet thick; olive brown to gray; as much as 30 feet thick	Teneriffe Silt (cross sections only) (tr)	**Lacustrine sediment** in slackwater valley fills; found only in boreholes below surficial unit or below Equality Formation; recognized by remnants of eroded Sangamon Geosol developed in upper portion; upper elevations ~405 feet asl
Sand, gravelly sand, and sandy gravel, silty interbeds; medium to poorly sorted; thin bedded; light brown to gray; leached to calcareous; as much as 30 feet thick	Pearl Formation (cross sections only) (pl)	**Outwash;** found in core in tributary valley fills, upper portion may intercalate with Teneriffe Formation, lowermost portion lies above or intercalates with Glasford Formation or lies directly on bedock; may include remnants of eroded Sangamon Geosol in upper portion
Sandy loam to clay loam diamicton; brown to gray; leached to calcareous; generally less than 10 feet thick, but may be thicker where uneroded in bedrock valley bottoms	Glasford Formation (g)	**Till;** veneers bedrock hills below Peoria and Roxana Silt Formations, locally exposed in gullies and stream valley walls; mostly eroded from bedrock valleys and may intercalate with Pearl Formation where it was deposited as debris flow; truncated Sangamon Geosol may be developed in upper portion

PRE-QUATERNARY DEPOSITS

PENNSYLVANIAN SUBSYSTEM (323-299 million years B.P.)

Description	Unit	Interpretation
Sandstone, shale, limestone, coal	Pennsylvanian Bedrock (ℙ)	**Sandstone and shale** are most common outcrop and subcrop; Upper 5 ft are strongly weathered

Base map compiled by Illinois State Geological Survey from digital data (2015 US Topo) provided by the United States Geological Survey.

North American Datum of 1983 (NAD 83)
Projection: Transverse Mercator
10,000-foot ticks: Illinois Coordinate System of 1983, east zone (Transverse Mercator)
1,000-meter grid: Universal Transverse Mercator grid system, zone 16

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SCALE 1:24,000
1 1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER

BASE MAP CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1988

Geology based on field work by A. Phillips, 2016–2017.

Digital cartography by Deette M. Lund and Jennifer E. Carrell, Illinois State Geological Survey.

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This map has not undergone the formal Illinois Geologic Quadrangle map review process. Whether or when this map will be formally reviewed and published depends on the resources and priorities of the ISGS.

Point Data Type

- Stratigraphic boring
- Water well boring
- Engineering boring
- Coal boring
- Oil and gas boring
- Outcrop
- Outcrop in field notes (ISGS archives)
- Passive Seismic Sounding

Line Data Type

- Contact
- Inferred Contact
- Terrace scarp
- Dune
- Glacial lineament
- A—A′ Line of cross section
- Field note line

SG 126211 Labels indicate samples (s) or geophysical log (g).
Boring labels indicate the county number.
- First number indicates county: 1=Lawrence Co., 5= Wabash Co.
Outcrop labels indicate geologist's field number.
Dot indicates boring or outcrop is to bedrock.

Note: The county number is a portion of the 12-digit API number on file at the ISGS Geological Records Unit. Most well and boring records are available online from the ISGS Web site.

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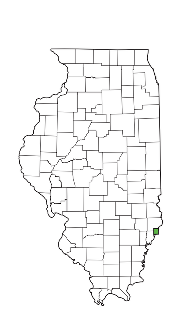
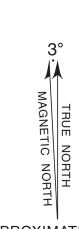


1	2	3
4		5
6	7	8

ADJOINING QUADRANGLES
1 Sumner
2 Lawrenceville
3 Vincennes
4 Lancaster
5 Decker
6 Mount Carmel
7 East Mount Carmel
8 Patoka



APPROXIMATE MEAN DECLINATION, 2017

ROAD CLASSIFICATION
State Route
Local road

Introduction

The Saint Francisville 7.5’ Quadrangle includes portions of the Wabash Valley and the surrounding uplands (Fig. 1). The quadrangle occurs about 60 river miles upstream of the confluence of the Wabash River with the Ohio River. The confluence of the Embarrass River, a major tributary that drains a large portion of eastern Illinois, with the Wabash River lies 1 mile north of the quadrangle boundary. Raccoon Creek, which flows west-east, is the largest of the streams draining the uplands. Big Slough, in the northern part of the quadrangle, functions as an overflow channel of the Wabash River. The towns of Allendale and Saint Francisville lie on uplands; the population is otherwise rural and distributed. The regional Mount Carmel Airport is in the northwest. The main economic activities are agriculture and petroleum production. This surficial geologic map is part of a long term surficial geologic mapping project (Phillips 2016; Phillips et al. 2014; Phillips et al. 2013; Phillips and Gemperline 2012; Bryk et al. 2012) in the lower Wabash River valley region that includes the Illinois-Indiana border. The Quaternary geology depicted here represents preliminary interpretation from this mapping effort. The map builds upon the existing geologic framework and supports studies of water and aggregate resources, seismic hazard, glacial processes, river processes, and geologic history.

Methods

The surficial geology was analyzed from compilations of boring records archived at the Illinois and Indiana State Geological Surveys (ISGS and IGS, respectively), the Illinois State Water Survey, and the Indiana Department of Natural Resources, unpublished geologic field notes from the ISGS, aerial imagery, and soil surveys (Soil Survey Staff 2015a, 2015b, 2015c). Thirty-two new geotechnical borings from the Illinois Department of Transportation were added to the database. Locations of water well (n = 91) shown on surficial map) and geotechnical boring records (n = 12 shown on surficial map) were confirmed with the best available data. Most of the geotechnical boring locations are likely within 50 ft of their true locations, whereas the accuracy of most water well locations ranges from 25 to 330 ft. Some of the petroleum wells (n = 23 on surficial map) have sample sets that include Quaternary sediments, and their locations were assumed reasonably accurate. New data were generated by study of 56 sample sets in the ISGS Samples Library, a coring program, geophysical surveys, bedrock sounding using passive seismicity, interpretation of recent high-resolution elevation data (FEMA 2012), and 22 outcrop descriptions. Coring with hydraulic push methods to depths of 14 to 88 feet at 20 sites, targeting tributary valley fills, terrace assemblages, and loess thickness. Coring was completed only in the Illinois portion of the map; several unexplored and important targets remain in Indiana. Data collected on core samples included volumetric magnetic susceptibility, size analyses of 27 samples by laser diffraction, elemental analysis of 10 samples by Energy Dispersive XRF, and 4 clay mineral analyses by XRD. Ages of 9 samples were obtained by AMS ^{14}C assays on plant material, and ages of two samples by luminescence methods (Table 1 and 2). Radiocarbon ages were calibrated to calendar years before 1950 using Calib 7.1 (Stuiver et al., 2017). Four earth electrical resistivity profiles (EER) totaling 2.2 miles in length were obtained. “Deep” and “shallow” arrays were deployed to image the upper 200 m and 20 m of the subsurface, respectively.

The bedrock topography map (Fig. 2) was constructed by machine contouring of point and contour observations with the Topo to Raster tool of ArcGIS. In addition to the 179 point data shown, and another 164 points within a mile-wide buffer surround the map area were included. Further, because of low data density relative to relief, overall thin sediment thickness, and common outcrop areas, additional synthetic contour data of the bedrock surface elevation were created according to inferred geologic interpretations. The bedrock topography map, in raster format, was created from a combination of the point data and interpretive contour lines. The unconsolidated sediment thickness map (Fig. 3) was constructed by subtracting a raster grid of the bedrock topography from the surface topography. Contours derived from the resulting raster were further generalized and smoothed to reflect the low density of the primary point data.

Setting

The Wabash Valley may have existed in the Mesozoic and was certainly an active river valley throughout the Quaternary Period. It lies within the Wabash Valley Seismic Zone. Faulting and downwarping associated with the seismicity (Bristol and Treworgy 1979; Woolery 2005; Hermann et al. 2008) were likely conducive to valley formation. The epicenter of the M5.4 April 2008 Mount Carmel Earthquake, the largest ever recorded in Illinois, was ~8 miles southwest of the quadrangle boundary (Hermann et al. 2008). The area was covered by ice during the Illinois Episode glaciation, ~160-130 ka (Grimley et al., in press). In this area, the ice flowed southeastward, and the terminal moraine of the Illinois Episode occurs on the highlands ~15 mi to the SE (Gray 1988). During deglaciation, the Wabash Valley was a major meltwater outlet of the ice sheet and was likely filled with outwash, damming tributary valleys to form slackwater lakes. Erosion during the ensuing Sangamon Episode interglacial, ~130-60 ka, removed much of the sediment from the uplands and incised portions of the valley, to expose bedrock on some of the ridges, especially in the southwest. During the Wisconsin Episode, ice of the Huron-Erie lobe first entered the drainage basin ~50 ka. It reached its maximum extent about 40 miles N of Saint Francisville at ~22 ka, and finally retreated from the drainage basin ~13 ka (Dyke, 2004; Curry, 2011). During the deglaciation, outwash again filled the valley and dammed tributaries to form slackwater lakes that reached nearly the same surface elevation as during the Illinois Episode. Dry and windy climate towards the end of the Wisconsin Episode was conducive to the generation of loess and dunes from extensive unvegetated outwash plains; the thickest deposits accumulated on the eastern side of the Wabash Valley, but isolated dunes and thin loess deposits occur on terraces and uplands in the eastern portion of the quadrangle. Huge floods cascaded episodically down the Wabash Valley during the glacial-interglacial transition when proglacial lakes burst their dams (Fraser 1993; Curry et al., 2014). The floods eroded much of the fill in the main valley. They also carved through the upper slackwater lake deposits in the northeast quadrant and deposited a veneer of fluvial sand on top. The Wabash River developed as a meandering system during the Hudson Episode postglacial, ~13 ka – present. Episodes of reworking and downcutting of valley fill deposits as well as episodes of aggradation resulting overlapping deposits that can be difficult to differentiate (Autin 1996).

Key Findings

Landscape-sediment Assemblages

Landscape-sediment assemblages related the origin and composition of the landforms. Four main landscape-sediment assemblages were differentiated within the quadrangle (Fig. 1). (1) Bedrock-controlled uplands dominate the west half of the quadrangle. The uplands are covered by a loess over a patchy veneer of till. The bedrock was exposed by erosion in steeper gullies and along much of the Wabash Valley wall. Incised river valleys separate bedrock knobs from the main landform at Saint Francisville and north. (2) Broad, flat plains between bedrock uplands are slackwater lacustrine sediment deposits, especially Raccoon Creek and the conjoining Mount Carmel Airport plain. Lacustrine deposits south of Allendale are connected to the Crawfish Valley (see Phillips 2016). The upper reaches include alluvial and nearshore sediment. (3) Arcuate outwash terraces dominate the central portion of the quadrangle. Meltwater flows eroded outwash and slackwater sediments, creating eastward-facing scarps. Sandy ridges topping slackwater terrace edges are interpreted as levee deposits that spilled into the shallow lakes that still occupied the slackwater basins. The sandy deposits are partly reworked into eolian dunes, which also occur on the Saint Francisville upland. Their age is not certain, but they may be correlated to periods of dune formation at ~22 ka and ~15 ka that were differentiated in previous mapping (Phillips and Gemperline, 2012; Phillips et al., 2013; Phillips, 2016). Two terrace levels at about 419-430 ft and 412-415 ft elevation can be differentiated. The older, higher terrace is distinct with fluvial and eolian dunes, partly reworked by later flood flows, on its surface. (4) Active floodplain and channels of lower Raccoon Creek, Big Slough, and the Wabash River include several small terraces and meander cutoffs. The Wabash Valley fill is mostly incised to bedrock within the quadrangle, with the deepest portion of its bedrock valley to the East. However, remnants of braided outwash deposits occur in Indiana. Some of the crevasse splay and scroll bar morphology is subdued by a veneer of fine overbank sediment in swales. Several minor valleys were cut through the uplands north of Saint Francisville by ancestral Embarrass or Wabash River flows. Two sluiceways were abandoned in the late Wisconsin Episode based on cross-cutting relationships. They are filled with a mixture of lacustrine and fluvial sediment. Big Slough functions today as an overflow channel of the Wabash River, and includes sandy to silty deposits. Fine-textured alluvium in smaller tributaries is reworked from older deposits with varied texture. Meander cutoff lakes mapped during the first land survey in 1851 are now mostly filled with overbank sediment. The prominent fluvial terraces are surficial features and incised into Wisconsin and Illinois Episode lacustrine sediment. These lacustrine sediments extend to the Wabash Valley, and possibly underlie outwash terraces in Indiana. This raises a possible scenario of slackwater conditions in the Wabash Valley itself, with a sediment dam of uncertain origin and location

Bedrock Uplands and Buried Valleys

Bedrock, mostly Pennsylvanian sandstone, supports the ridged uplands (Fig. 2). Bedrock valleys underlie the Raccoon Creek terrace and Wabash Valley, but are not coincident with modern stream valleys channels. The ancestral Raccoon Creek(?), was likely incised before the Illinois Episode as a minor tributary to the Wabash Bedrock Valley. The lowest part of the valley, 300-325 ft elevation, was mapped with passive seismic soundings which may overestimate the depth to bedrock by as much as 10-20 feet. The path of the present-day Wabash River is contrary to the bedrock topography. It flows largely over a bedrock shelf and across the Raccoon Bedrock Valley, with the deepest part of the Wabash Bedrock Valley lying east of the Quadrangle. This thalweg is evident in Fig. 2 by the low area in the southeast corner, but the circular pattern shown there is likely the model result of very sparse point data. The thalweg of the Raccoon Bedrock Valley might connect with the thalweg of the Wabash Bedrock valley, but there are no data in that area.

Bedrock uplands are covered by an 8-10 foot thick blanket of loess, mainly Wisconsin Episode Peoria Silt, over a thin veneer of till of the Illinois Episode Glasford Formation. The till was evidently eroded off the hilltops during the Sangamon Episode, but thin beds were encountered in more sheltered settings. Bedrock, mostly sandstone, is exposed along steep slopes across the quadrangle, and is deeply weathered where buried.

There is regionally strong lineation of ridges trending SSE (Fig. 1; also see Grimley and Phillips, in press). The lineation includes overall upland valley orientations, narrow ridges on bedrock-supported uplands, and also landforms of unlithified sediment. The SSE orientation parallels the flowpath of the Illinois Episode glaciation, and extends across the Wabash Valley towards the Illinois Episode terminal moraine in Indiana. Although previous researchers had mapped alignment of some ridges (D. McKay, unpublished GIS data), the extent of the lineation could not have been appreciated before the availability of lidar elevation data in 2011. The generally weak, uniform shale, sandstone, and coal bedrock with shallow dip provides little obvious structural control. Coring through two of the lineaments (STF-P12, STF-P13, STF-P17; cross section B-B′) encountered only a blanket of eolian sediment over weathered sandstone. The coring demonstrates that the ridges in southern Saint Francisville Quadrangle are bedrock supported, but the features are likely caused by subglacial erosion. Imaging of lineaments by EER in a previous project showed similar sculpting of bedrock in one ridge, but of unlithified sediment in another (Phillips 2016).

Illinois Episode Units

Till of the Glasford Formation has a patchier distribution across the quadrangle compared to areas to the south (Phillips and Gemperline, 2012; Phillips 2016). The till on the upland was partly removed by erosion, especially in the southern half of the quadrangle (cross section B-B′). However, the original till deposit was possibly thin. The borehole STF-P1 (cross section A-A′) penetrated only thin, coarse diamicton interbedded with sand, interpreted as debris flow. The relatively thick deposit of Glasford Formation depicted in the Raccoon Bedrock Valley (see STF-T08, cross section A-A′) is interpretive, based on the expected thickness of the overlying sediment. Outwash of the Pearl Formation in STF-P1 (cross section A-A′) was differentiated mainly by correlation of elevation with Teneriffe Silt, which includes clear Sangamon Geosol. The Teneriffe Silt is more extensive than has been found elsewhere, and is the near-surface below alluvial terraces where Equality Formation was eroded. Several old and possibly “dead” ^{14}C dates (Table 1) on plant matter from just above the unit confirm its differentiation from the Equality Formation.

Slackwater Terraces

The Wabash Valley was a meltwater outlet for several glacial episodes. During each episode, outwash filled the main valley and dammed tributary valleys to form slackwater or proglacial lakes, which in turn filled with lacustrine sediment (Heinrich, 1982; Fraser, 1993). Horizons with weak soil development and concentrations of plant matter are evidence of episodic drainage. Sediment was also sourced in the small upland basins and was deposited as alluvium prograding from the heads of the valleys. The Raccoon Bedrock Valley was largely filled with slackwater sediment (Teneriffe Formation) during the Illinois Episode, which was then partly incised before deposition of the Equality Formation (cross section B-B′). A similar sequence was found in the neighboring Crawfish Valley to the south (Phillips 2106).

The Raccoon Creek valley fill was explored by coring and EER profiling (cross Section A-A′). Two episodes of slackwater lake sedimentation were encountered. Ice covered the valley during part of the Illinois Episode. Upon retreat of that glacier, outwash (Pearl Formation) was deposited. Intercalated beds of diamicton (Glasford Formation), possibly debris flow, indicate ice contact. A ^{14}C date on needles from near the base of the section obtained in STF-P1 (cross section A-A′) was finite, but very old and thus probably in error. Outwash filling the Wabash Valley during deglaciation likely dammed the tributary. Ostracod species preserved in the sediment indicate that the lakes were shallow, possibly reflecting lacustrine deposition that kept pace with outwash accumulation in the main valley. The lake bed reached a maximum elevation of 405 feet asl. Strong weathering horizons up to 10 ft thick at the top of the sequence, including strong mottling, carbonate leaching, and clay and iron-manganese accumulations, are evidence of the Sangamon Geosol, was found in most core that penetrated them. A second phase of slackwater deposition occurred during the Wisconsin Episode. Wood fragments from lacustrine clays yielded dates of 27-19 ka (calibrated radiocarbon years). EER profiles on the slackwater terrace imaged three clearly defined, horizontal resistivity layers 50-60 ft thick. These confirm the preceding scenario and can be interpreted as a lowermost sandy deposit buried by silt- to clay-rich deposits. The maximum level of outwash accumulation in the Wabash Valley was 440 feet asl. The sand ridge at the east edge of the slackwater terrace is associated with the highest flood flows in the Wabash Valley during deglaciation (the Maumee event was ~14 ka). It may have been deposited at the edge of the shallow lake, and may signal a downcutting event that ultimately drained the lake.

Wabash Valley

Under the Wabash Valley floodplain southeast of Mount Carmel, a bedrock shelf is buried by 30-50 feet of glacifluvial and meandering stream sediment (cross section B-B′). Although pervasive sand and gravel of the Henry Formation in the Wabash Valley is a potential aquifer, it is suitable only for small sources because it is relatively thin and shallowly-buried. Existing municipal wells are located along the bank of the Wabash River at the very edge of the main bedrock valley, which reaches a local maximum depth of 120 feet deep (290 feet above sea level (asl)) at the east of cross section B-B’ (see also Gray 1982).

Economic and Groundwater Resources

Several small, abandoned gravel borrow pits occur on the floodplain south of Saint Francisville. However, extensive near-surface gravel deposits were not found. Buried deposits have at least 20 ft of fine sediment overburden. Municipal wells of Saint Francisville exploit these same relatively thin and sensitive sand and gravels. They appear to provide sufficient supply nonetheless. Further west, the only significant potential aquifer materials are at the bottom of the Raccoon Bedrock Valley. Thicker aquifer materials occur in the Wabash Valley east of the quadrangle.

Acknowledgements

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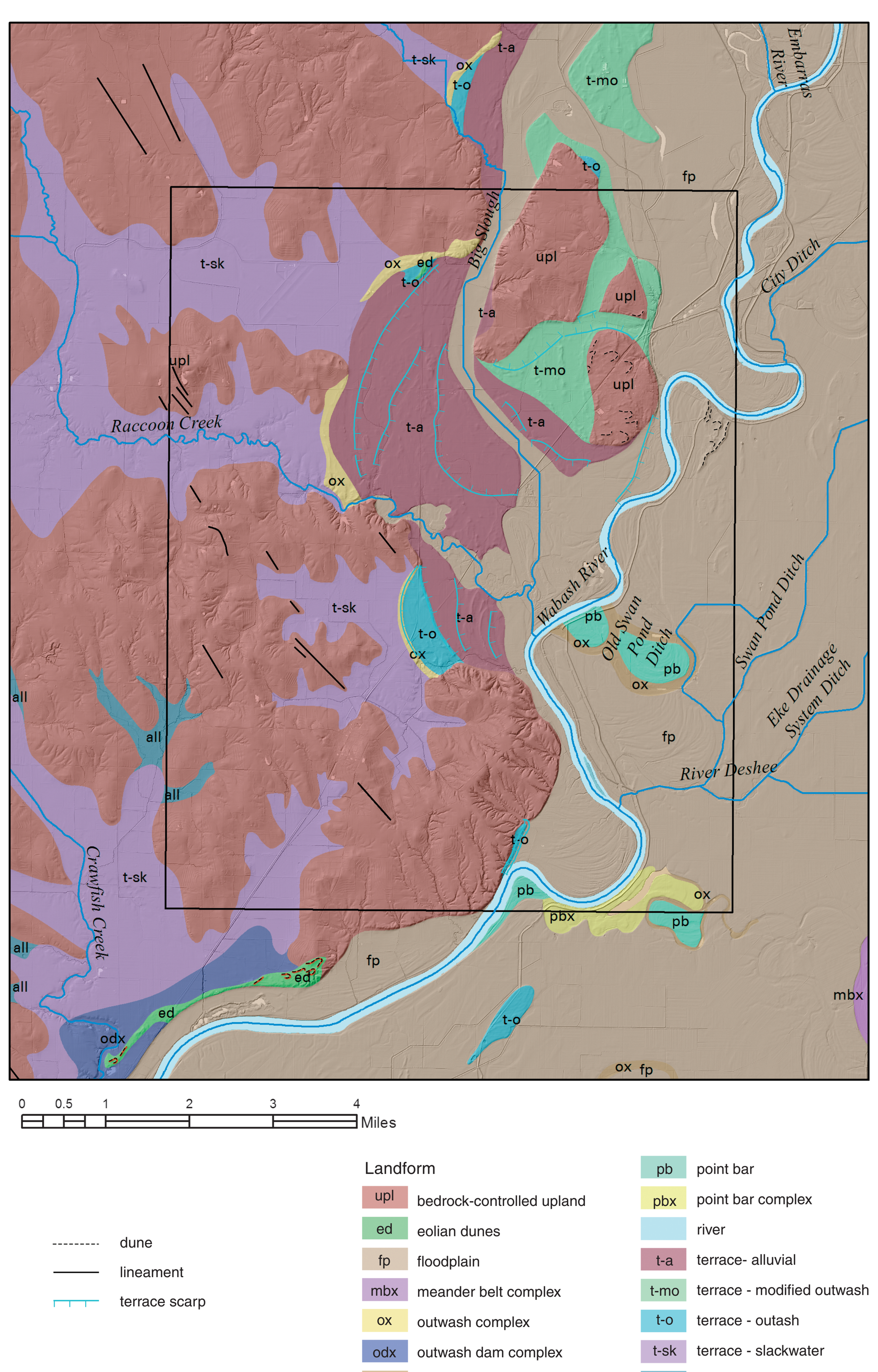

Figure 1 Geomorphic map of Saint Francisville Quadrangle area. Outline of quadrangle is in black. Map scale is 1:100,000.

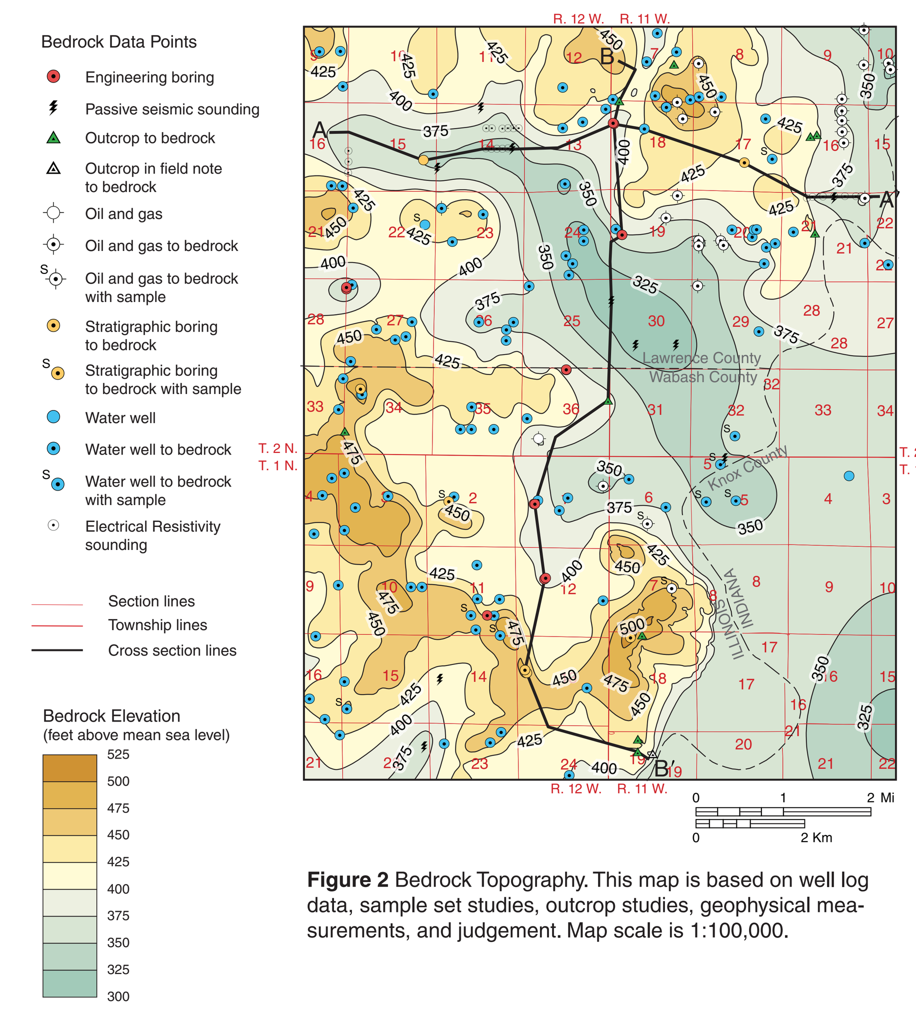

Figure 2 Bedrock Topography. This map is based on well log data, sample set studies, outcrop studies, geophysical measurements, and judgement. Map scale is 1:100,000.

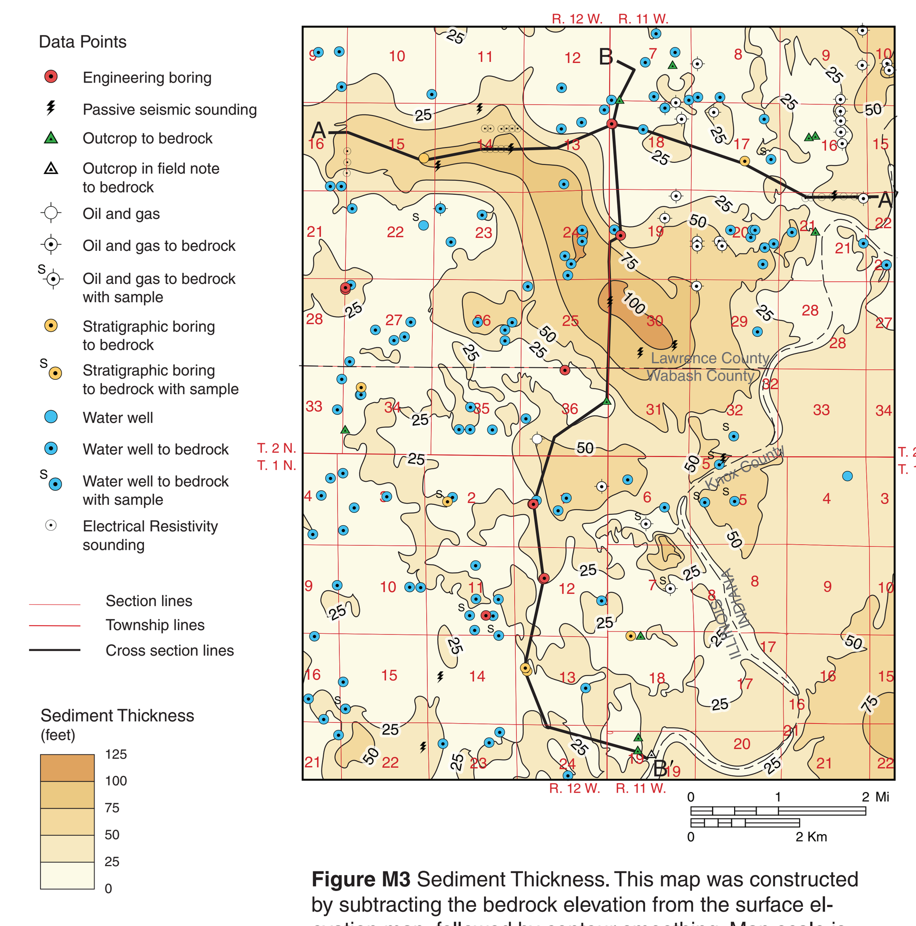

Figure M3 Sediment Thickness. This map was constructed by subtracting the bedrock elevation from the surface elevation map, followed by contour smoothing. Map scale is 1:100,000.

Table 1. Radiocarbon Ages

ISGS Code	Sample Code	Depth (ft)	Material	d13C	Fraction of MC	±	$D^{14}C$	±	^{14}C yr BP	±	Calendar Years BP*	± (2σ)
A4291	STF-P1-16.8	16.8	plants	-26.6	0.0698	0.0011	-930.2	1.1	21,390	130	25,718	526
A4290	STF-P1-2.2	2.2	plants	---	0.9689	0.0017	-31.1	1.7	255	15	299	24
A4226	STF-P1-30.3	30.3	plants	---	0.0586	0.001	-941.4	1	22,790	140	27,149	746
A4224	STF-P1-80.7	80.7	plants	---	0.0059	0.0009	-994.1	0.9	41,200	1300	44,684	4443
A4284	STF-P2-15.9	15.9	plants	---	0.1271	0.0011	-872.9	1.1	16,570	70	19,993	475
A4225	STF-P2-22.9	22.9	plants	-25.6	0.0832	0.0007	-916.8	0.7	19,980	80	24,040	492
A4285	STF-P2-23.5	23.5	plants	-26.8	0.079	0.0011	-921	1.1	20,390	110	24,504	773
A4288	STF-P4-7.4	7.4	plants	-27	0.0031	0.0011	-996.9	1.1	46,400	2800	47,990	
A4289	STF-P4-16.2	16.2	plants	-27.8	-0.0014	-0.0011	-1001.4	-1.1	>49,200			

*Radiocarbon ages calibrated to calendar years before 1950 (Intcal13; Reimer et al., 2013) using CALIB v. 7.1.0 (Stuiver et al., 2017)

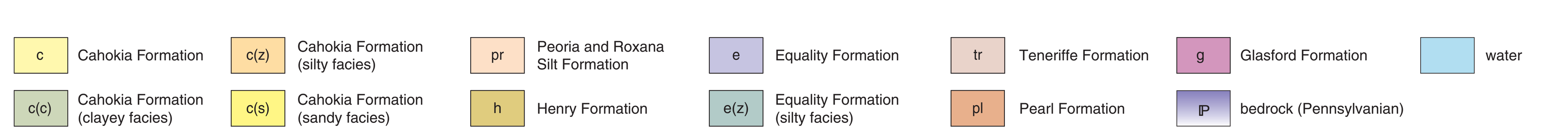

Table 2. Optically Stimulated Luminescence Ages

ISGS Code	Sample Code	Depth (ft)	Deposit	Mineral	Equivalent dose (Gy)	Dose rate (Gy/ka)	Age (ka)	N (accepted/total)
557	Beste-1-56	56	Stream	K-feldspar	115 ± 9	2.82 ± 0.08	41.0 ± 3.0	10/10
496	MTC-38-6'	6	Dune	Quartz	38 ± 2	1.81 ± 0.06	21.1 ± 1.4	19/93
497	MTC-38-8'	8	Dune	Quartz	40 ± 3	1.75 ± 0.06	22.7 ± 1.9	23/54