Geologic Map of the Historic Ranch Headquarters and School House Areas

Tallgrass Prairie National Preserve
Chase County, Kansas

KGS OPEN-FILE
REPORT 2004-34
(Revised July 2008)

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Addendum

Kansas Geological Survey Open-file Report 2004-34 was revised in July 2008.

CHANGES:

Table 1. Geologic Control Points.

- Some of the geologic units in the 'Datum' column were revised; corresponding elevations in the 'Elevation' column were revised.

Page 3, <u>Base Map</u>

- The aerial photograph used for the base map changed.

Figure 1. Gamma Electric Log, Core No. 1 (KGS No. 1 NPS).

- The base and top of the Crouse Limestone were moved upward, which changed the thicknesses of the Blue Rapids Shale, Crouse Limestone, and Easly Creek Shale.

<u>Appendix A–Core No. 1</u>

- The descriptions of the Blue Rapids Shale, Crouse Limestone, and Easly Creek Shale were revised.

Map

- The aerial photograph used for the base map was updated.
- Alluvium and stream-terrace deposits were added.
- The Crouse Limestone correlation was revised.
- The Crouse Limestone contacts were redrawn (moved upward) based on the new correlation.
- The map colors were changed to match the geologic map of the preserve (Sawin, R. S., 2008, Surficial geology of the Tallgrass Prairie National Preserve, Chase County, Kansas: Kansas Geological Survey, M-119A, scale 1:12,000, 1 sheet).

Geologic Map of the Historic Ranch Headquarters and School House Areas

Tallgrass Prairie National Preserve
Chase County, Kansas

Robert S. Sawin and James R. McCauley
Kansas Geological Survey

Introduction

As planning, development, and renovation continue at the historic ranch headquarters and the school house at the Tallgrass Prairie National Preserve in Chase County, Kansas, basic geologic information about the near-surface bedrock geology at these sites is important. Geologic maps are usually the first source of informationóthe starting pointófor any geologically related investigation. They are useful in construction and engineering projects, for understanding groundwater characteristics, and in a variety of environmental assessments. Understanding the near-surface geology and incorporating geologic evaluations into the planning process can help prevent future construction, resource, and environmental problems.

Geologic maps graphically show the distribution, rock type, age, and horizontal distribution of bedrock near the earthís surface. They also show related geologic structures (e.g., faults and folds) that may be present, and thick surficial materials, such as alluvium. Interbedded layers of limestone and mudstone (Permian age) characterize the bedrock at the preserve.

Scope

Under a cooperative agreement (H6067A00009) between the Kansas Geological Survey (KGS) and the National Park Service (NPS), the KGS developed a geologic map of the historic ranch headquarters and school house areas at the Tallgrass Prairie National Preserve. In conjunction with the mapping, two stratigraphic cores were drilled, and geophysical electric logs of the core holes recorded. These data, along with outcrop, roadcut, construction excavation, and aerial photo information were used to construct a geologic bedrock map, stratigraphic rock column, and cross sections of the historic ranch headquarters and school house areas.

Methods

As part of the mapping process, two stratigraphic cores were drilled at the historic ranch headquarters site, and geophysical electric logs of the core holes were recorded. These cores and geophysical logs provided 1) stratigraphic control for geologic mapping, 2) a record of the lithologic characteristics and thicknesses of the rocks, and 3) a research and educational resource for the public. In addition to the cores and geophysical logs, rock outcrops, roadcuts, construction excavations, and aerial photos were incorporated into the study. These control points were located with a global positioning system (GPS) unit (Trimble GeoExplorer 3) and the elevations were tied to a USGS benchmark using a surveyorís level (accuracy 0.1 foot) (see Table 1).

Stratigraphic Cores. Two cores (2 inches in diameter) were drilled at the historic ranch headquarters area. Core No.1 was drilled on the ridge west of the ranch headquarters near the Southwind Nature Trail. Drilling began in the Threemile Limestone Member and finished in the Eskridge Shale, about 9.0 feet below the Cottonwood Limestone Member. Total depth was 159.0 feet. A brief description of Core No. 1 is included as Appendix A. Core No. 2 was drilled southeast of the corrals that are on the south side of the barn. This test began in the Easly Creek Shale and also ends in the Eskridge Shale, about 2.4 feet below the Cottonwood Limestone Member. Total depth of Core No. 2 was 63.8 feet. Appendix B contains a brief description of Core No. 2.

Table 1. Geologic Control Points.

No.	Datum	Elevation	Comments	Northing	Easting	Date
1	Core	1357.8	Surface Elev.	4256981.405	712793.202	8/21/03
2	Core	1260.6	Surface Elev.	4256649.894	713116.406	8/21/03
1	Base/Easly Ck ls	1269.0	Outcrop	4256671.395	712956.108	2/25/04
2	Base/Crouse	1284.0	Outcrop	4256709.963	712920.154	2/25/04
3	Top/Easly Ck ls	1272.0	Outcrop	4256729.615	713125.104	2/25/04
4	Base/Crouse	1283.7	Excavation	4256754.334	713090.757	2/6/04
5	Base/Easly Ck ls	1270.5	Excavation	4256754.944	713150.064	2/25/04
6	Base/Crouse	1283.5	Outcrop	4256762.832	713129.099	2/6/04
7	Base/Crouse	1283.9	Excavation	4256763.303	713114.199	2/25/04
8	Base/Crouse	1285.5	Excavation	4256818.610	713150.638	2/25/04
9	Base/Funston	1307.0	Excavation	4256832.718	713107.988	2/25/04
10	Funston		Outcrop	4256860.314	713083.601	2/6/04
11	Top/Eiss	1250.3	Roadcut	4256868.459	713223.636	2/25/04
12	Top/Morrill	1231.3	Outcrop	4257056.227	713212.625	2/25/04
13	Top/Cottonwood	1220.0	Outcrop	4257161.574	713191.059	2/6/04
14	Top/Morrill	1233.3	Outcrop	4257285.016	713201.663	2/25/04
15	Top/Eiss	1267.3	Outcrop	4257336.333	712777.984	2/25/04
16	Top/Morrill	1234.0	Outcrop	4257363.180	713095.240	2/25/04
17	Top/Eiss	1259.3	Roadcut	4257403.564	713209.858	2/6/04
18	Top/Morrill	1235.8	Outcrop	4257406.236	713023.439	2/25/04
19	Top/Morrill	1243.4	Outcrop	4257529.887	712757.920	2/25/04
20	Top/Eiss	1263.3	Outcrop	4257549.781	712989.994	2/25/04
21	Top/Middleburg	1270.2	Roadcut	4257564.574	713200.051	2/6/04
22	Base/Easly Ck ls	1285.0	Outcrop	4257587.499	713173.541	2/25/04
9-16	Spring			4256742.999	712969.165	2/25/04
9-15	Spring					
	USGS Benchmark	1228.07	Box Culvert	4257163.784	713217.471	2/25/04

Cores were drilled with a truck-mounted drilling rig. The cores were labeled, boxed, and preserved as a permanent record to be used jointly by NPS and KGS. The core holes were logged using geophysical electric logging equipment (Figures 1 and 2). The entire length of both core holes was plugged with bentonite according to standard practices set forth by the State of Kansas.

Geophysical Electric Logs. Geophysical electric logs (natural gamma ray) of the core holes provide accurate elevations and thicknesses of the rock units. These logs have been annotated with the geologic formation names and thicknesses (Figures 1 and 2).

Aerial Photography. Information from aerial photos was used to help construct some of the geologic contacts.

Rock Outcrops and Roadcuts. Locations where rocks are exposed at the surface were described and measured. These exposures provided control points that, along with other data, were used to construct the geologic map. Outcrop and roadcut data are listed in Table 1.

Construction Excavations. Water-supply improvements constructed during the fall and winter of 2003/2004 provided temporary subsurface exposures and additional control points that are normally not available. Excavations included large holes for tanks and trenches for water lines. Where identifiable rock units were exposed, GPS coordinates were recorded and elevations tied to the USGS benchmark. Construction excavation data appear in Table 1.

Base Map. Farm Service Agency National Agriculture Imagery Program (NAIP) color aerial imagery (1-m resolution) was used for the base. Contour lines are from the USGS Strong City, Kansas, 1:24,000 topographic quadrangle (contour interval = 10 feet). Water-supply improvements plans (contour interval = 1 foot) were used to help construct 5-feet contour lines around the ranch headquarters area. Beyond the headquarters area, the 5-feet contours were interpolated from the topographic quadrangle.

Summary

The number and quality of geologic control points, and the level of accuracy they provided, were sufficient to allow construction of a detailed geologic bedrock map in the historic ranch headquarters and school house areas. Mapping is of sufficient detail so that structural trends and stratigraphic thicknesses can be used for construction and engineering evaluations; however, site-specific projects may require additional investigations. This map should help evaluate ground-water conditions in the area and be useful in defining the extent of the rock units that provide water to the springs. The products of this studyóespecially the rock coresówill provide educational opportunities for the public. In addition, geologic knowledge gained from this study will be useful to other researchers throughout the Flint Hills region and beyond.

Date: Thursday, October 09, 2003 Time: 12:35 File: C:\Documents and Settngs\joe anderson\My Documents\logs\eagle log

COMPANY:	Kansas Geological Survey
Location:	SE SE SE Sec. 31, T. 18 S., R. 8 E.
Well	#1 NPS
Date	10-9-2003
BH Fluid	WATER
Casing	NONE
File Name	TPMP#1NPS_GAMUP1
Depth Driller	159'
Depth Logger	159'
Logged by:	ANDERSON
Witness:	SAWIN

OTHER SERVICES

Ground Elevation 1357.8'

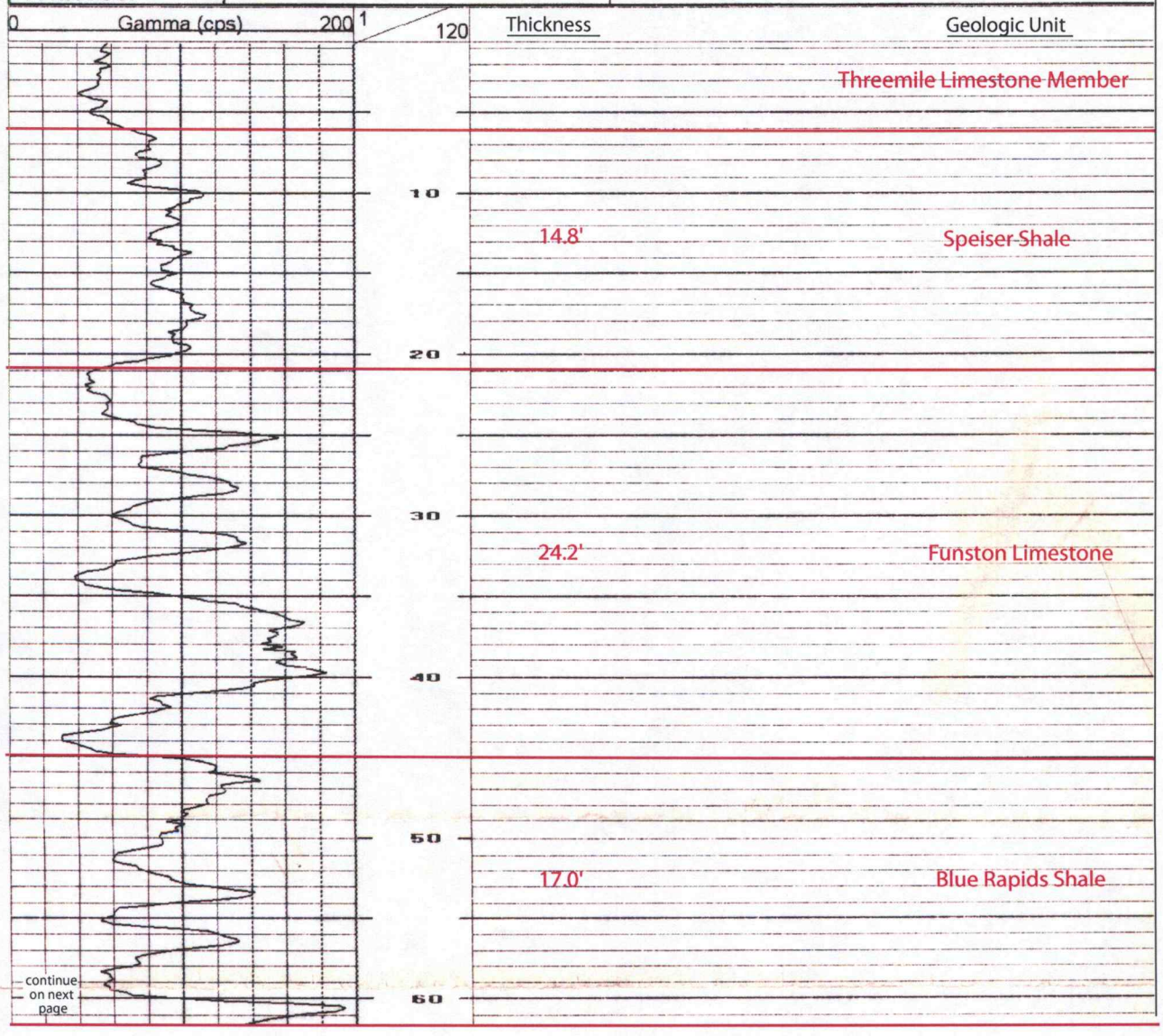

Figure 1. Gamma Electric Log, Core No. 1 (KGS No. 1, NPS).

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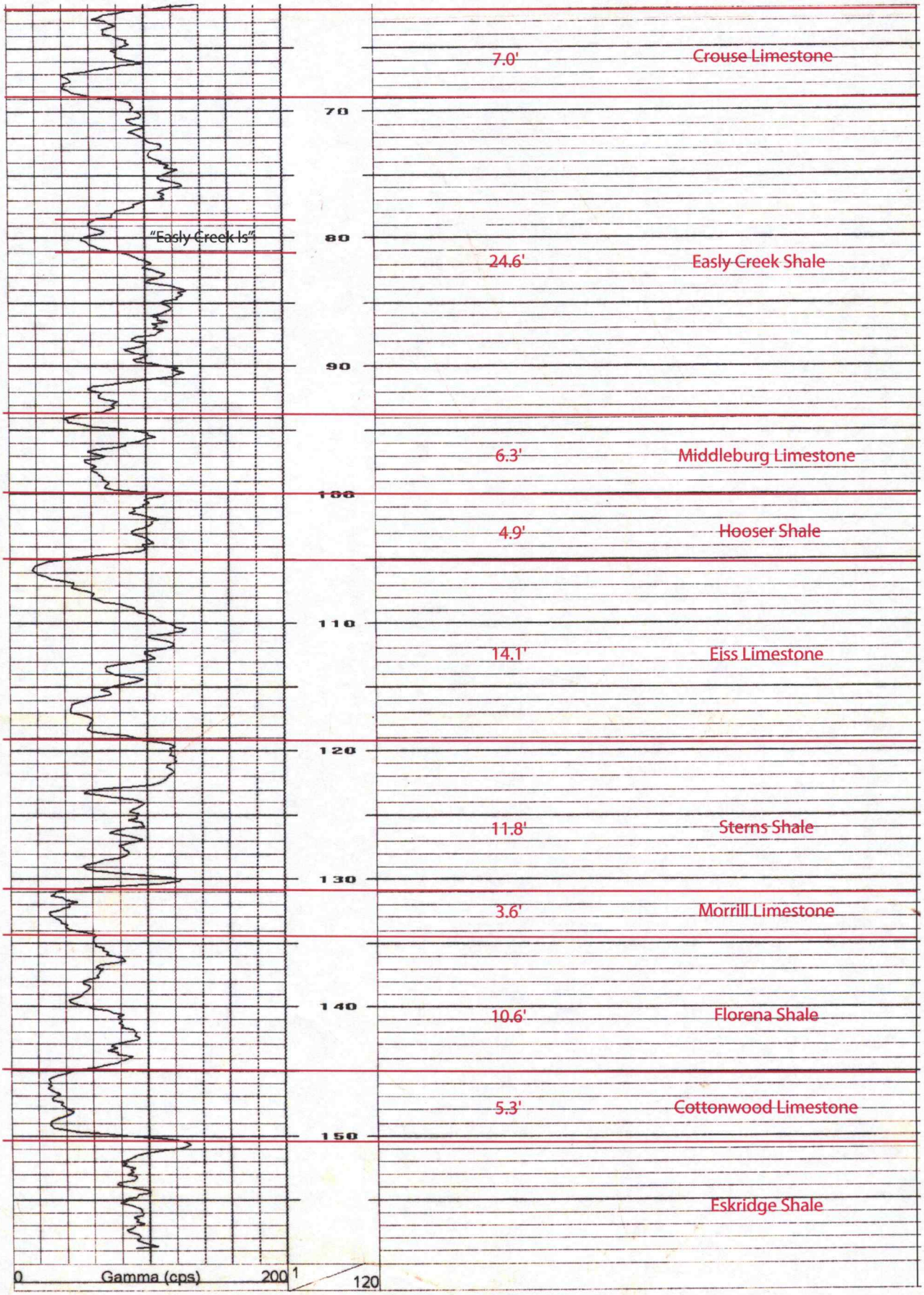

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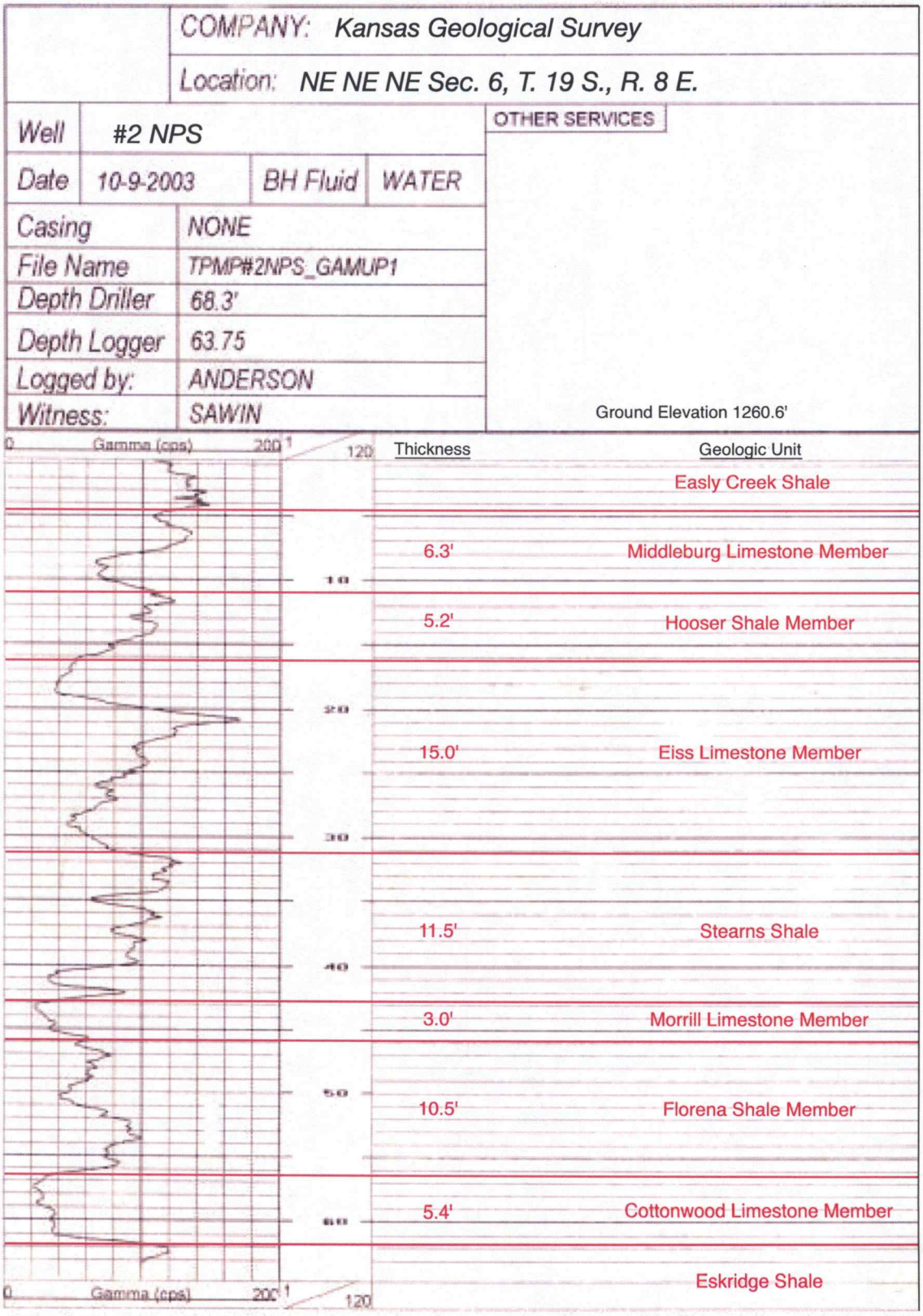

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Figure 2. Gamma Electric Log, Core No. 2 (KGS No. 2 NPS).

APPENDIX A — CORE NO. 1

Core Description
KGS #1 NPS
SE SE SE SEC 31, T18S R8E (ridge west of ranch hands house)
Chase County, Kansas
Surface Elevation = 1358'

Threemile Limestone Member (6') - Limestone, white to light gray, medium texture, irregular bedding, irregular fracture, fossiliferous. Chert. Contact below sharp.

Speiser Shale (14.8') - Mudstone, calcareous, varicolored (lower 5' maroon, upper 3' gray green, tan at top), very fine silt to silty texture, irregular bedding, irregular fracture, no fossils observed.

Funston Limestone (24.2') - Lower limestone (3.8'): Limestone, very light gray, medium grained grading to fine grained near top, massive bedded to thinly bedded at top, irregular fracture, fossiliferous (algal coated grains to 5 cm). Small iron stained (limonite) filled inclusions. Mudstone layer (0.9' thick) is 0.4' below top, calcareous, laminated, grades to limestone below. Contacts above and below sharp. Middle mudstone (6.3'): Mudstone, slightly calcareous in lower part to calcareous above, black (lower 1.5') grades to dark gray above, very fine silty to clay texture, lower 0.3' angular bedding with pale green mudstone clasts, indistinct bedding above, irregular fracture, no fossils observed. Very soft. Upper limestone (14.1'): Limestones and interbedded mudstones: limestone (2.6'), light gray, medium grained, irregular and angular bedding, irregular fracture, fossiliferous (coated grains, skeletal fragments), with interbedded thin mudstone layers, contacts above and below sharp; mudstone (1.7'), gray and interbedded gray/tan near base and top, silty texture, thinly bedded, bedded fracture, no fossils observed, middle portion soft; limestone (1.6'), argillaceous, very light gray to very light tan, medium bedded, medium texture, irregular fracture, fossiliferous, limonite filled vugs (1-2 mm) throughout, contact below sharp, above somewhat gradational; mudstone (1.6'), calcareous, tan and gray, fine silty texture, thin bedded, bedded fracture, no fossils observed; limestone (6.6'), lower 2' massive limestone, upper 4.6' interbedded limestone and mudstone (mudstone layers approximately 60%), limestone is light gray, medium to fine grained, massive below to thin bedded above, irregular fracture, chert nodules in lower 2' to 4 cm), mudstone layers dark gray in lower 0.7', light gray green and thinly bedded in upper limestone. Mudstone partings in upper part are numerous and sometimes thick (1cm). Contact below gradational, above sharp.

Blue Rapids Shale (17.0') - Mudstone, calcareous, varicolored (dark gray in lower part, gray green and light green in upper part), very fine silt texture, very thinly bedded, bedded fracture, no fossils observed. Upper 1' yellow gray color. Some zones are very soft, especially the upper 3'.

Crouse Limestone (7.0') - Lower limestone (2.4'): Limestone, argillaceous, very light gray, fine grained, irregular bedding and fracture, fossiliferous (brachipods). Iron stained mudstone clasts (or vug fills) and skeletal grains throughout. Large vugs (1-4 cm) filled with quartz crystals. Contacts below sharp, above gradational. Upper Limestone (4.6'): Limestone, very argillaceous, tan, thin bedded, no fossils.

Easly Creek Shale (24.6') - Lower mudstone (12.6'): Mudstone, calcareous, varicolored (gray green, maroon, pale green), clay to very fine silt texture, thinly bedded, bedded fracture, no fossils observed. Upper 1' with abundant (25%) siliceous nodules to 15mm. "Easly Creek limestone" (2.5'): Limestone, argillaceous, basal 1.5' very light gray (mottled gray), upper part gray to dark gray, fine grained with abundant skeletal fragments, irregular bedding, irregular fracture, fossiliferous (skeletal fragments to 30 mm). Iron stained mudstone or limonite clasts (rounded) in lower part, most abundant in basal 0.4'. Upper part very argillaceous, with coated skeletal grains; vertical fracture with weathered and iron stained face. Contacts below sharp, above somewhat gradational. Upper mudstone (9.5'): Mudstone, calcareous, dark gray, very fine silty texture,

thin bedded, bedding fracture, lower 1' very fossiliferous, no fossils observed above. Thin, whispy, white calcareous layers throughout. Upper 0.6' tan with mottled gray color.

Middleburg Limestone Member (6.3') - Lower limestone (3.4'): Limestone, argillaceous, gray, mottled light gray, very coarse grained (skeletal grains to 4cm) (wackestone), irregular bedding, bedding fracture, very fossiliferous (crinoids, brachipods, algal encrusted fragments). Contact below and above sharp. Middle shale (1.6'): Shale, black, fissile, bedding fracture, no fossils. Gray green mudstone at top (0.3' thick). Upper limestone (1.3'): Limestone, argillaceous, light gray, fine grained, thinly bedded, fractures (desiccation cracks?) filled with pale green mudstone increase upwards (appears pedagenic), also vertical fractures cut and distort bedding planes, no fossils observed. Contacts above and below sharp.

Hooser Shale Member (4.9') - Mudstone, calcareous, varicolored red (lower 1'), medium gray green (middle 3.4'), dark gray (upper 0.5'), thinly bedded, irregular fracture, no fossils observed.

Eiss Limestone Member (14.1') - Lower limestone (3.3'): limestone, argillaceous (shaly limestone), dark gray, course grained, thin bedded, bedding fractures, very fossiliferous (crinoids, fusulinids, brachiopods, gastropods, bivalves). Skeletal grains to 15 mm. Contact fairly sharp below, graditional above. Middle mudstone (7.4'): mudstone, calcareous, gray to dark gray, lower 1.3' looks like limestone below but with higher mudstone content, fossiliferous; argillaceous limestone (0.7') in middle, similar to lower limestone; upper 5.4' dark gray mudstone to light gray near upper contact, no fossils. Upper limestone (3.4'): limestone, very light gray, medium grained, massive bedding, irregular fracture, skeletal grains. Large vugs throughout filled with calcite in upper part, gypsum in the middle, and pale green mudstone in lower part. Lower part may be brecciated. Contact below fairly sharp (mudstone below grades into limestone), above very sharp.

Stearns Shale (11.8') - Mudstone, calcareous, varicolored maroon and pale green to medium gray green, very fine silt to clay texture above, very thin bedded, irregular fracture below to bedding fracture in upper part, no fossils observed. Boxwork limestone 0.8' thick (128.3' to 129.1' log depth) has chicken wire fractures filled with pale green mudstone, contacts gradational. Thin (0.3') boxwork limestone at 126.1' (log depth). Limestone 0.7' thick (122.9' to 123.6' log depth) is light gray and fine grained with fairly sharp contacts. Upper 3.2' is medium gray-green calcareous claystone, soft (wetting and drying has caused swelling and desiccation fractures).

Morrill Limestone Member (3.6') - Limestone, white to light gray, lower 1.9' fine grained, upper 1.5' medium grained, massive bedded above, lower 1.9' interbedded with very thin (< 1mm) mudstone lamina, irregular fracture, skeletal grains, small vugs in upper part. Contact below is sharp and erosional, above gradational. Mudstone layer 0.15' thick at 132.0' (log depth).

Florena Shale Member (10.6') - Mudstone, gray (lower 1' medium dark gray), lower 2.5 feet calcareous, silty to very fine silt texture grading upward, very thin bedded, irregular fracture, brachiopods (chonetids common) in lower 1'. Gypsum: thin whispy lenses in lower 1'; large (to 7 cm) anhydrite nodules and satin spar fracture fills (to 1 cm thick) that cut across bedding in middle 4' (138' to143' log depth).

Cottonwood Limestone Member (5.3') - Limestone, light gray with white skeletal grains (grainstone), texture grades upward from medium to course, massive bedded, irregular fracture, very fossiliferous (invertebrate skeletal fragments), large (to 5 mm in long direction) fusulinids abundant, especially in upper part. Vug 0.2' above basal contact is associated with vertical fracture that extends into mudstone below. Contact below gradational, above missing (incomplete core recovery).

Eskridge Shale (9.0') - Mudstone, calcareous, gray-green, silty texture, very thinly bedded, irregular fracture, fish debris, small brachiopods. Interbedded with very thin (less than 1mm) white calcareous layers. Anhydrite filled fractures (angular to near vertical) cross and distort bedding, anhydrite becomes nodular in places.

APPENDIX B — CORE NO. 2

Core Description
KGS #2 NPS
NE NE NE SEC 6, T19S R8E (south of barn)
Chase County, Kansas
Surface Elevation = 1261'

Soil and weathered mudstone (4.5')

Middleburg Limestone Member (6.3' from log).

Hooser Shale Member (5.2' from log).

Eiss Limestone Member (14.1') - Lower limestone (3.5'): limestone, argillaceous (shaly limestone), dark gray, course grained, thin bedded, bedding fractures, very fossiliferous (crinoids, fusulinids, brachiopods, gastropods, bivalves). Skeletal grains to 15 mm. Contact fairly sharp below, graditional above. Middle mudstone (7.8'): mudstone, calcareous, gray to dark gray, lower 1.7' looks like limestone below but with higher mudstone content, fossiliferous; argillaceous limestone (0.5') in middle, similar to lower limestone; upper 5.6' dark gray mudstone, no fossils. Upper contact is missing. Upper limestone (3.7' from log): core from here to surface is highly weathered and/or missing.

Stearns Shale (11.5') - Mudstone, calcareous, pale green to medium gray green, very fine silt to clay texture above, very thin bedded, irregular fracture below to bedding fracture in upper part, no fossils observed. Boxwork limestone 1.7' thick (40.0' to 41.7' log depth) has chicken wire fractures filled with pale green mudstone, contacts gradational. Thin (0.3') boxwork limestone at 36.1' (log depth). Limestone 0.7' thick (34.5' to 35.2' log depth) is light gray and fine grained with fairly sharp contacts; vertical fracture through entire thickness trails off into mudstone above and below. Upper 3.4' is medium gray-green calcareous claystone, soft (wetting and drying has caused swelling and desiccation fractures).

Morrill Limestone Member (3.0') - Limestone, white to light gray, lower 1.5' very fine grained, upper 1.5' medium grained, massive bedded above, lower 0.7' interbedded with very thin (< 1mm) mudstone lamina, irregular fracture, skeletal grains, small vuggy areas scattered throughout. Contact below is sharp and erosional, above gradational. Mudstone layer 0.15' thick at 44.3' (log depth).

Florena Shale Member (10.5') - Mudstone, gray (lower 2' medium dark gray), lower 4 feet calcareous, silty to very fine silt texture grading upward, very thin bedded, irregular fracture, brachiopods (chonetids common) in lower 1'. Gypsum: thin whispy lenses and some nodules in lower 2'; large (to 5 cm) anhydrite nodules and satin spar fracture fills (to 1 cm thick) that cut across bedding in middle 4' (48.8' to 52.9' log depth).

Cottonwood Limestone Member (5.4') - Limestone, light gray with white skeletal grains, grainstone, texture grades upward from medium to course, massive bedded, irregular fracture, very fossiliferous (invertebrate skeletal fragments), large (to 5 mm in long direction) fusulinids abundant, especially in upper 2 feet. Upper and lower contacts gradational.

Eskridge Shale (5.4') - Mudstone, calcareous, gray-green, silty texture, very thinly bedded, irregular fracture, fish debris, small brachiopods. Interbedded with very thin (less than 1mm) white calcareous layers.

Bedrock Associated with the Ranch House at the Tallgrass Prairie National Preserve, Chase County, Kansas

Robert S. Sawin
Kansas Geological Survey

Introduction

Trenches that were excavated in the Ranch House area for construction of the new water system have provided general information about the underlying bedrock and may offer explanations to ongoing problems, questions, and concerns about water infiltration and stability of the Ranch House structure. Examination of the bedrock by the Kansas Geological Survey during construction on November 25, 2003, was performed in conjunction with field work to develop a geologic map for the Ranch House and Fox Creek School areas. The information contained herein should be used for general purposes only, or as a guide for developing a plan for geotechnical testing if site-specific information is needed.

Elevations on the bedrock units, and their relative position to the Ranch House structure, are tied to a bench mark at the northwest corner of the Ice House (elevation 1313.32

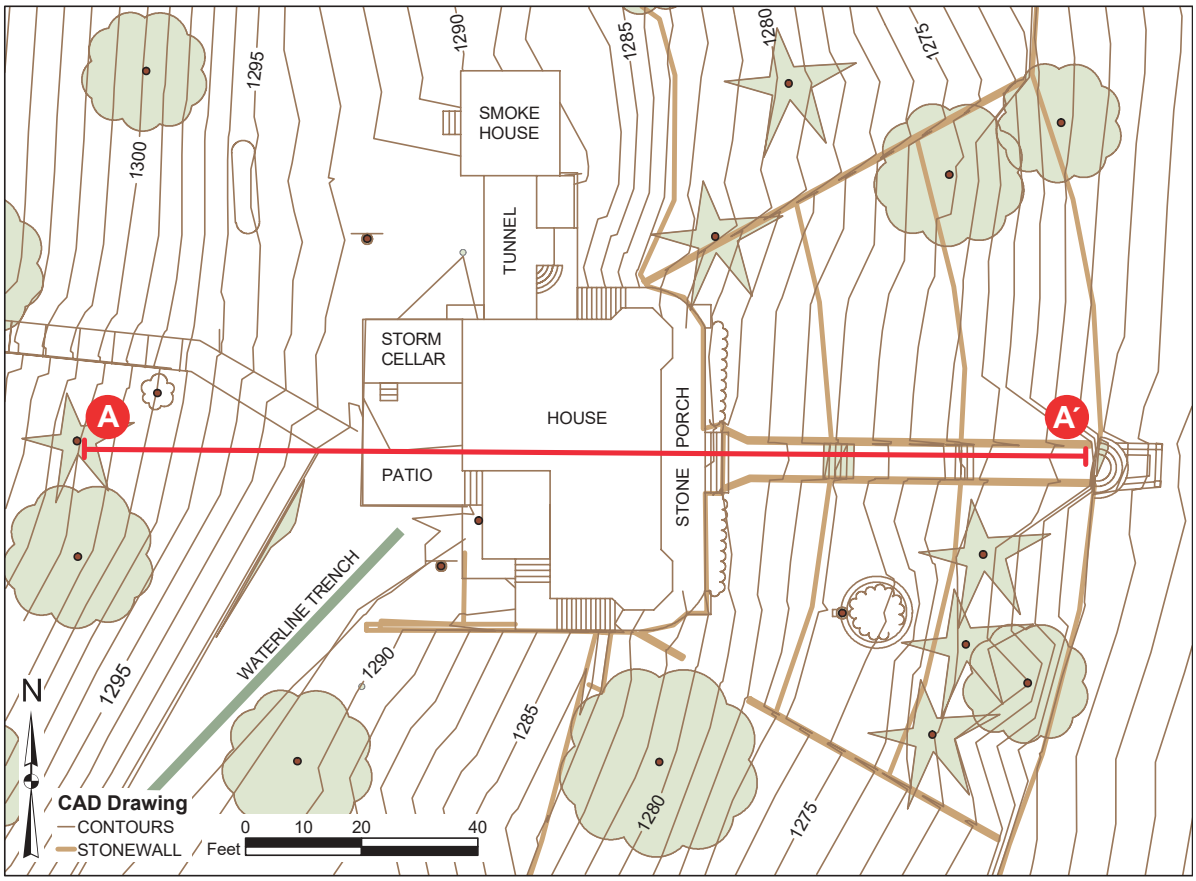


Figure 1. *Map of the Ranch House area from the Water Improvements plan showing the location of Cross Section A-A´.*

feet) that was established for construction purposes. These elevations also agree with the contours shown in the map (Figure 1) that was taken from the Water Improvements plan. Elevations on the bedrock, the ground floor of the house, the porch, and ties to the bench mark were determined with a hand level (accuracy about + or - 0.2 foot).

Cross Section A-A´

Figure 2 (Cross Section A-A´) depicts the west-east cross sectional view through the Ranch House and hillside. The upper limestone shown on the cross section (probably the lower unit of the Crouse Limestone) was observed in the waterline trench southwest of the Ranch House (Figure 3). The thickness of the limestone is about 2.4 feet in this trench. Regularly spaced vertical joints (fractures) have been widened by the flow of ground water and are easily seen in Figure 4. Figure 5 is a close-up of one of these enlarged joints. Water was observed dripping from this joint about four hours after the trench was excavated.

The lower limestone shown in Figure 2 (probably the Middleburg Limestone Member) was observed in the waterline trench that was dug in the driveway west of the main entrance to the top of the hill. The thickness of this limestone is about 1.4 feet at this location.

Observations

Alternating layers of shale and limestone that are characteristic of this area provide conditions for the subsurface movement of

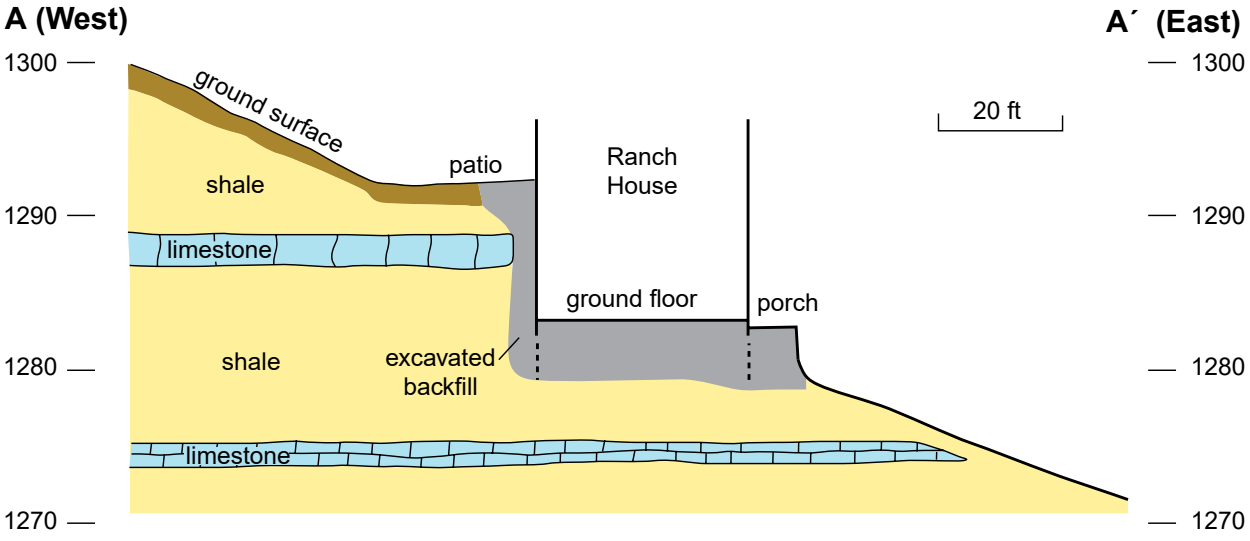


Figure 2. *Cross Section A-A´.*

water. The fractures (joints) in the limestones contain water at various times, depending on the season and precipitation. These fractures are widened through time by flowing water. The underlying shales are relatively impermeable and therefore stop the downward movement of water, and the limestones serve as conduits to move the water laterally. Where these water-bearing limestones intersect the hillside, they can form springs or seeps.

At the Ranch House, the upper limestone shown in Figure 2 is probably a water-bearing

Figure 3. *Limestone layer (2.4 feet thick) in waterline trench southwest of Ranch House. This is the upper limestone in Cross Section A-A´.*

unit during times of abundant precipitation. Where this limestone intersects the Ranch House foundation excavation, it probably transports water to the excavation's backfill material. This might explain reports of running water in the crawl space under the ground floor, and temporary seeps or springs that occur around the front porch.

Examination of the crawl space below the ground floor revealed no bedrock that was in

Figure 4. *View of the east side of trench. Note the regularly spaced vertical joints in the limestone.*

place. Slabs of limestone that are mortared together make up the foundation and floor supports. While the total depth of the foundation was not observed, it probably does not extend to the lower limestone shown in Figure 2. This suggests the Ranch House foundation probably rests on shale bedrock. Further investigation would be necessary to confirm this conclusion.

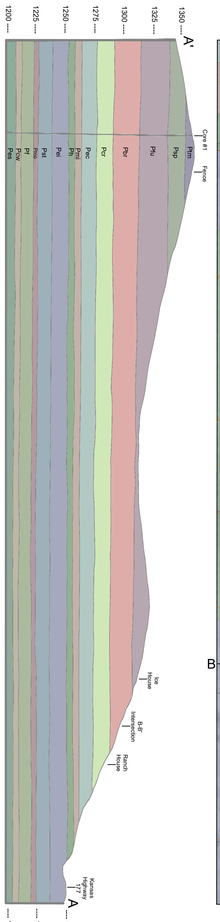
Figure 5. *Close-up of a vertical joint. This joint was dripping water about four hours after the trench was excavated.*

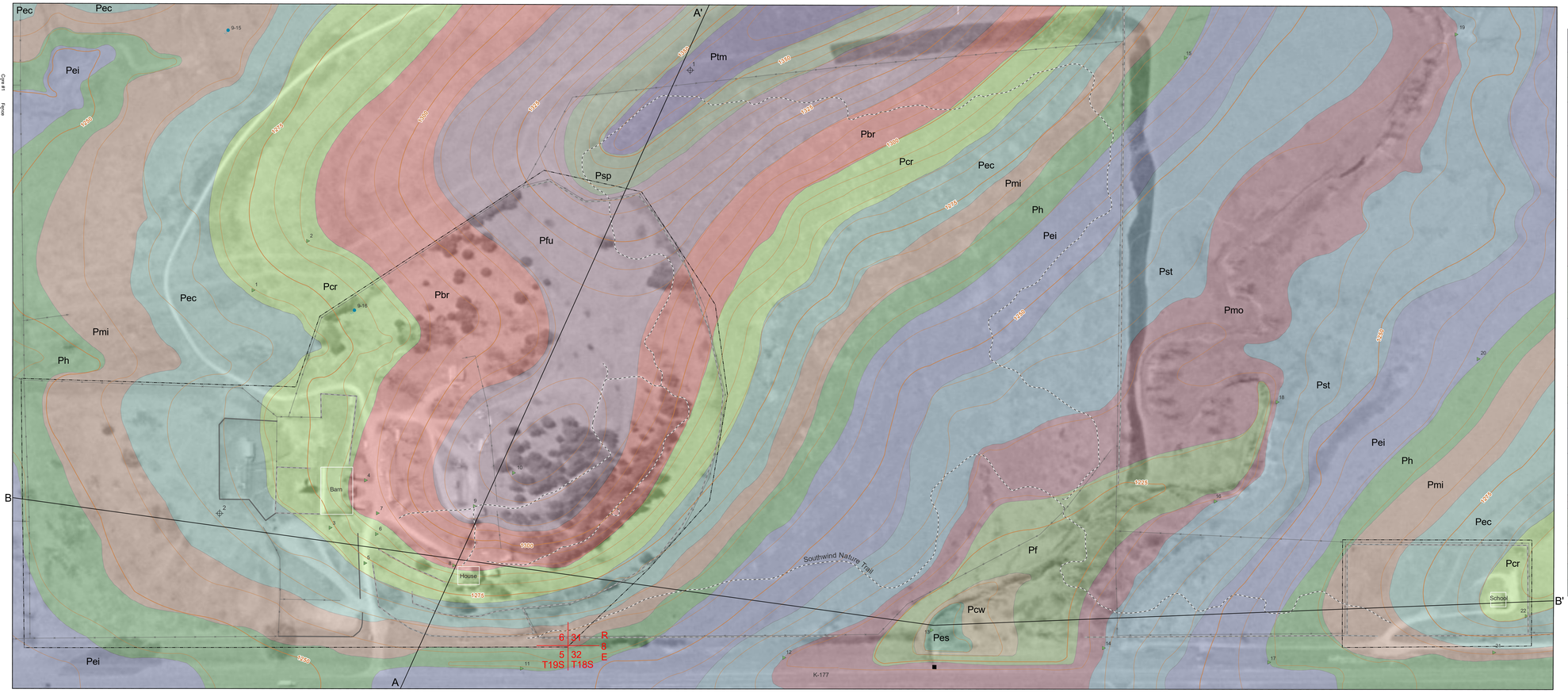
Geologic Map of the Historic Ranch Headquarters and School House Areas

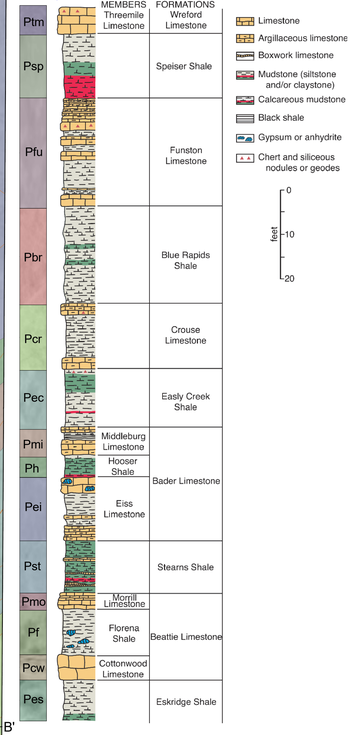
Tallgrass Prairie National Preserve

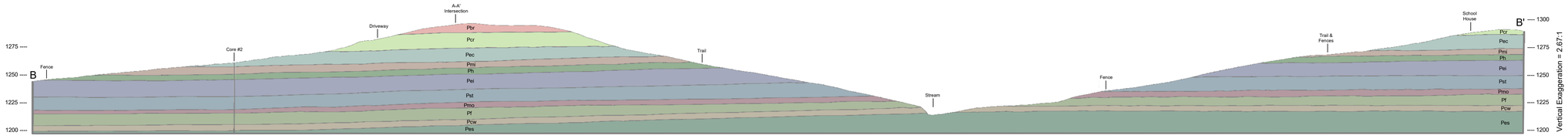
Robert S. Sawin and James R. McCauley

Kansas Geological Survey









Legend

- Barbed wire fence
- Stone fence
- Pipe fence
- Hiking trails
- Contours - interval 5 feet
- Index contours - interval 25 feet
- NPS property boundary
- A-3 Geologic data point
- USGS benchmark
- KGS stratigraphic core
- 9-15 Spring

Source of photo:
Sanborn, *Digital Orthophoto Quadrangle*. Kansas, 2002.

Digital cartography by
Elizabeth Crouse
Jennifer Sims

KGS Open-file Report 2004-34.

N

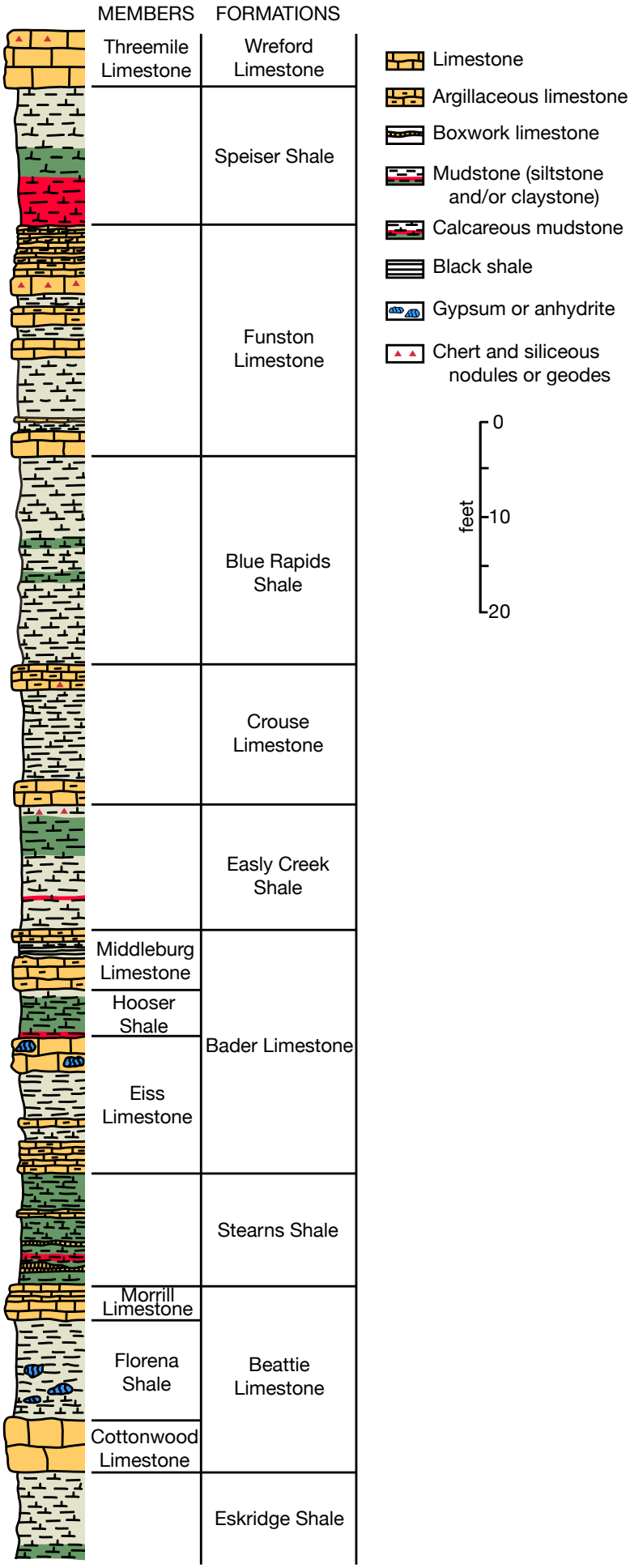
0 25 50 100
Meters

0 100 200 400
Feet

KEC

Kansas Energy Council

Rocks Exposed at the Tallgrass Prairie National Preserve



Kansas Geological Survey
www.kgs.ku.edu
October 2006