Kentucky Geological Survey

DESCRIPTION OF MAPPED UNITS ALLUVIUM—Silt, sand, gravel, and clay: complexly interbedded and intermixed, in part SALEM AND WARSAW FORMATIONS—Limestone, siltstone, shale, and sandstone, crudely crossbedded. Locally contains poorly sorted lenses of sand and gravel. Gravel Limestone, argillaceous, arenaceous, mostly detrital, fine- to very coarse-grained, the bedded to massive, locally thinly crosslaminated or faintly to strongly crossbed ılders, with some siltstone, limestone, dolomite, and shale fragments. Locally round composed largely of fragments of brachiopods, bryozoans, crinoids, and blastoids and z pebbles are abundant where derived from the slumped conglomerate of small horn corals in a very fine-grained, calcareous, silty, clastic matrix; locally finely nnsylvanian age. Unit typically mapped only in larger stream valleys. o coarsely crystalline; locally contains abundant glauconite; commonly interbedde interfingered with calcareous, thin- to thick-bedded siltstone; in places contain LANDSLIDE DEPOSITS—Hillside slumping and collapse of overlying units due to ringers and nodules of chert. Siltstone, locally calcareous or dolomitic, thin-bed instability and plastic flow of shale beds. massive; in part thinly laminated, interbedded with thin lenses of fine to mediur ystalline limestone and fine-grained limy quartzose sandstone. Shale, calcareous .OESS—Intensely weathered, windblown, quartzose silt, with calcite, dolomite, an arenaceous, predominantly silt shale with lenses of clay shale, fissile to irregular, think other mineral constituents that form a well-drained and fertile, silty, loamy soil as mu aminated, with lenses of brown calcareous sandstone: locally very fossiliferous as 3 m (10 ft) thick. Soil is underlain by about 15 to 30 cm (6–12 in.) of dark gray, poor erbedded with and gradational into limestone and siltstone. Chert is abundant a aminated hardpan. The loess is tentatively correlated with the Peoria Loess of the lowe n irregular lenses at and near base of formation. Small and large geodes are comn io Valley (Leverett, 1929). Unit is mapped in the Bradfordsville and Spurlington in shale and siltstone; generally hollow, composed of quartz and calcite. Fragment itally Vectorized Geologic Quadrangles (DVGQ's), and is present, at a reduce and complete specimens of horn coral Hapsiphyllum are widespread in the limeston ickness, in the Hibernia and Saloma 7.5-minute quadrangles, but was not mapped beds of unit. Includes a unit mapped as the Salem and Harrodsburg Limestones in the Bradfordsville NE 7.5-minute quadrangle. TERRACE DEPOSITS—Gravel. along lower slopes of Green River Valley, consists of HARRODSBURG LIMESTONE—Limestone, calcarenite, coarse- to very coarse granules, pebbles, cobbles, and a few boulders of chert, silicified limestone, silicified grained, medium- to thick-bedded, in part crossbedded; consists of well-sorted angul iasper, sandstone, and quartz in a matrix of quartz sand and silt with min to subangular crinoid and bryozoan fragments and lesser amounts of brachiopo coral, and echinoderm fragments in a microcrystalline calcite matrix; locally cherty an ft) is locally cemented in lenses by hydrous iron oxide. Occurs sandy in lower part. Lower contact is sharp except locally, where uppermost beds of on erosional surface developed on Ste. Genevieve Limestone. underlying Muldraugh Member of the Borden Formation are bioclastic limestone. TERRACE GRAVEL—Gravel, about 30 to 40 percent well-rounded spherical and BORDEN FORMATION—Siltstone, limestone, sandstone, and shale. Units as described ellipsoidal quartz pebbles and granules ranging from 2 to 25 mm (0.08–1 in.) in diamete or amounts of clay: poorly to moderately sorted, poorly consolidated to unconsol

dely to strongly crossbedded: contains widely scattered boulders and cobbl

erruginous quartz conglomerate and minor amounts of orthoguartzite pebbles. Basa

).3 to 1.5 m (1–5 ft) of unit is locally cemented into lavers and lenses by hydrous iro

oxide. Gravel is extremely porous, resistant to erosion. Deposits cap hills and are derive

rocks of Pennsylvanian age. They are remnants of an ancient stream channel

ge. Potter and Siever (1956, p. 240–241) indicated a Pennsylvanian age for this stream

dium-grained, in part crossbedded. Shale, light to medium gray. Conglomerate, wel

led quartz pebbles and granules in a fine-grained, angular to subangular sandst

rix. Material derived from rocks of Late Mississippian and Early Pennsylvanian

iring Tertiary time, and was facilitated by extensive solution of the Mississippi

stone units along and below the unconformable contact at the base of the Casev

nation and possibly the Hardinsburg Sandstone. Locally contains many well-round

at have slumped into solution cavities in underlying units. Slumping probably occur

ormation. At places clay weathered from shale has been squeezed out of beds to

vhite quartz pebbles, derived from deposits in a poorly defined channel of Pennsylvani

andstone, shale blocks, and conglomerate, as well as sand, gravel, and clay;

aylor County lines and mapped as stippled, color-fill pattern.

conglomerate and sandstone occur in lower part of a channel.

as a result of solution of underlying limestone.

n Sulphur Well 7.5-minute quadrangle. Dated as post-Mississippian.

e. In the northwestern corner of this quadrangle, large areas are blanketed by slum

apped as open hatchured pattern. In north-central part of quadrangle (Hibernia 7

ninute quadrangle), same unit is present along ridge tops at Larue-Green and Larue-

MPED SANDSTONE—Jumbled blocks of sandstone composed of fine to media

grains; fractures recemented, some appearing to be slickensided; source o

stone thought to be the Big Clifty Sandstone Member of the Golconda Format

ch, in some previous geomorphic cycle, formed the roof of a cave that collapse

opping the sandstone about 84 m (275 ft) below its true stratigraphic position. Occurs

DEWATER AND CASEYVILLE FORMATIONS—Conglomerate, sandstone, siltstone

part of the Canmer 7.5-minute quadrangle, approximately 30 m (100 ft) of coarse

and shale: same as the Caseyville Formation, which follows, except: (1) Conglomera

CASEYVILLE FORMATION—Conglomerate, sandstone, siltstone, and shale

onglomerate, poorly sorted, in part crossbedded; consists of well-rounded spheric

artz; pebbles are as much as 3 cm (1.2 in.) across. Sandstone, fine- to coarse-graine

ally conglomeratic, thin- to very thick-bedded, consists of angular to subround

bedded, locally highly stained by iron oxides. Siltstone and shale are light g

to medium-bedded, interbedded with fossil-fragmental limestone, coarse- grain

middle part), light greenish gray, interbedded with medium gray calcareous shak

imestone (lower part), fossil-fragmental, coarse-grained, thick-bedded, in part.

quartz grains cemented by silica and minor amounts of limonite; weathers slabb

ocally, the upper 1.5 to 3 m (5–10 ft) of unit is medium gray siltstone. Locally, basal

alcareous siltstone. Base of unit locally may have been lowered as much as 6 m (20

nterbedded with clastic, cherty, oolitic limestone. Lower 3 to 4.6 m (10–15 ft) of un

i fossil-fragmental limestone. Forms cliffs in places, but near tops of hills and ridges

nay occur as scattered float or within reddish-brown, clayey soil, which also contains

tone, and shale. Sandstone is fine grained, well sorted, thin to very thick bedde

monly thickly crossbedded in lower part; consists of subangular to well-round

wn and brown; forms cliffs and steep slopes. Siltstone and shale very dark gra

lartz grains cemented by silica and minor amounts of limonite; weathers yellowis

preen, and light brown, occur locally in the top, central, and basal sections of the ur Occurs in beds as much as 3 m (10 ft) thick; also occurs in seams, partings, and lense

■ BEECH CREEK LIMESTONE MEMBER OF GOLCONDA FORMATION—Limestone

and shale. Limestone, fine- to coarse-grained, crystalline. Shale, greenish gray to gray

ely exposed, becomes more limy eastward and probably becomes mostly limestor

GIRKIN FORMATION—Limestone, shale, and siltstone. Several types of limestone

nt olive-gray to medium gray and yellowish brown to light reddish brown, very fine

sbedded, in part oolitic, fossil-fragmental, cemented by microcrystalline calci

y argillaceous, mostly coarse bioclastic material with a few dense beds, ii

weathers light yellowish gray and gray. Limestone (calcarenite), medium gray to very

ark gray, very fine- to coarse-grained, thin- to thick-bedded, locally crossbedded

ocrystalline calcite; weathers gray to very dark gray; becomes very friable w

noval of cementing material. Limestone (calcilutite), very light gray, gray, light tan

ellowish tan and buff, very fine to finely crystalline, thin-bedded to massive; locally s

nicrocrystalline calcite cement and inclusions; weathers brownish gray, gray, and dar

ite to very light gray and gray, fine- to medium-grained, thin- to thick-bedded, loc

ssbedded; weathers mottled gray and white. Shale, gray to greenish gray, gra

of Malott (1919). Shale and siltstone, light to medium gray; siltstone is yellowish t

ownish gray. Occurs 15 to 21 m (50–70 ft) below top of formation. Probably equivalent

rmation. Locally, the lowermost bed is a dense limestone breccia. Sandy limestone

etrital, light to medium olive gray, thin- to thick-bedded and crossbedded; also occurs

"horizon of Sample Sandstone" of McFarlan and others (1955). Simple and compoun

sters of small quartz crystals as well as beds and lenses of bluish gray, dark g

BEAVER BEND AND PAOLI LIMESTONES—Limestone, very fine- to coarse-grained

ined, rounded fossil fragments, in beds generally less than 1.5 m (5 ft) thick, is nmon at base and about 10 m (30 ft) above base; quartz rosettes also occur near

GENEVIEVE LIMESTONE—Limestone, dolomite, and chert. Several types of

ne occur in this formation. Limestone, oolitic, white, very light gray, and gra

crossbedded, thin- to very thick-bedded, locally very fossiliferous. Limes

carenite), buff, light gray, and medium gray; composed of very fine to coa

ibrounded and rounded limestone and dolomitic limestone grains, granules, a

bebbles, in a matrix of sparry and microcrystalline calcite; very thin- to thick-bedded

ently to strongly crossbedded locally, in places fossiliferous. Limestone (calcilutite

nally nonfossiliferous. Irregular and discontinuous beds and nodules of fossilifer

cur locally in middle and lower part of unit. Beds of dolomitic limestone in upper part of unit.

nit are light yellowish brown to medium brown, very fine-grained to dense, thi

dium-bedded; contain widely scattered nodules of dark bluish black chert. In place

icrocrystalline limestone locally overlain by a 0.6- to 1-m- (2- to 3-ft-) thick bed of

nestone conglomerate consisting of light medium gray, well-rounded limestone granule

se. Argillaceous limestone, light gray to light olive-gray, thin-bedded, and ool

nd thin beds and seams of gray and greenish gray shale occur locally. Upper conta

the crinoid *Platycrinites*. Basal contact conformable.

Limestone in the remainder of this quadrangle.

enerally placed above highest beds of oolitic limestone containing diagnostic columnals

rt of Elrod (1899), occurs some 6 to 12 m (20-40 ft) above the base of the Ste

evieve Limestone (Moore, 1972a–b, 1975). A persistent zone of silicified fossilifero

estone 15 cm (6 in.) to 3 m (10 ft) thick containing irregular beds 5 cm (2 in.) to abou

0.3 m (1 ft) thick, and occurring 3 to 6 m (10–20 ft) above the base of this unit, is probably equivalent to this chert. It contains abundant fenestellid bryozoans, born corals, an

everal species of brachiopods. On fresh surface, chert is very light gray to light yellowis

, weathers to light reddish gray. Mapped as a bed in the Hammonville, Magno

nd Upton 7.5-minute quadrangles; contact is inferred near the base of the Ste. Genevieve

DUIS LIMESTONE—Unit is described from top to bottom. Limestone, light to

, dolomitic limestone and dolomite; contains abundant balls, nodules,

noebiform masses of light to dark gray chert. Lithostrotionoid corals occur through

out are most abundant in upper beds of this unit. Limestone, siltstone, and shale

imestone, silty, yellowish gray to light and moderate olive-gray, mostly dense and vei.

ine-grained with a few fine-grained beds, thin- to thick-bedded; some beds contai

oundant chert that weathers to a vuggy yellowish to reddish gray, earthy mass

gged chert stringers. Intercalated dolomitic and calcareous siltstone partings wit

w beds of light yellowish gray, oolitic limestone. Siltstone is yellowish gray to light oliv

ray, thinly laminated to thin-bedded. Shale, calcareous, light yellowish gray, as parting

and beds up to 1 m (3 ft) thick. Limestone, siltstone, and shale. Limestone, cherty, ligi

lium- to thick-bedded; consists of angular to subangular fossil fragments mostl

0.5 mm (0.2 in.) across in a calcareous silty matrix. A few beds of limestone co

enses of medium to dark gray chert. Siltstone, medium gray as partings and layers a

nuch as 2 m (6 ft) thick. Shale and silty shaly limestone, medium gray to light greeni

ray, as much as 2.4 m (8 ft) thick, occurs locally at base of unit. A dark gray, fir

SALEM LIMESTONE—Limestone, siltstone, and shale. Limestone, fine- to coarse-

ned, thin- to medium-bedded, in part faintly to strongly crossbedded. Upper 3

niddle limestone is silty and shaly; lower limestone consists of angular fragment

crinoid columnals, bryozoan fronds, brachiopods, and horn corals in a silty and fine- to

minated; occurs as partings and beds as much as 3 m (10 ft) thick in middle par

e, calcareous, silty, fissile, locally contains lenses and thin beds of limest

chiopods in a silty and shaly dolomitic limestone matrix. Calcareous shale grades

to a faintly laminated, dolomitic siltstone. The horn coral Hapsiphyllum sp. occurs

throughout unit. Basal part of unit interbedded with underlying member.

nedium-grained sandy bioclastic matrix. Siltstone, dolomitic and calcareous, fain

s and quartz in a calcite matrix, thick-bedded and strongly crossbedded;

urs locally at base of unit and grades into light yellowish brown, silty, argillaceou

herty limestone. Lower contact is gradational and locally intertongues with underlying

15 ft) of unit is shalv limestone containing disseminated quartz sand and

ned sandy and argillaceous limestone consisting of angular fragments of ca

medium olive-gray and medium gray to medium dark gray, fine- to medium-grai

m gray, mostly fine-grained, locally medium- to coarse-grained and dense to

ystalline, thin- to very thick-bedded; few interbeds of light yellowish

ipper 0.6 to 3 m (2–10 ft) of unit is made up of brecciated, medium dark gra

thert occur at all levels in the unit. These beds, ranging up to 1.5 m (5 ft) in thickne

onsist of a dense light bluish grav silicified limestone containing brachiopods, bryozoar and solitary corals. Beds of light brown, fine-grained dolomite less than 1.5 m (5 ft) thick

light gray, gray, light tan to yellowish tan, and buff, very fine to finely crystallir

o massive; locally silty; microcrystalline calcite cement and inclu

in part, locally cherty. Crossbedded, sandy limestone composed largely of r

d reddish gray chert as much as 20 cm (8 in.) thick are characteristic of lower

moderate slopes with blocky outcrops. Lower contact is gradational.

pase. Fossils are moderately abundant, most abundant at top of unit.

an: almost everywhere occurs immediately aboye lower contact. Limestone. ool

nto laminated light to medium gray siltstone. Probably equivalent to Elwren Sandst

ts of limestone and dolomitic limestone grains cemented by sparry calcite a

ım-grained, thin- to thick-bedded to massive with a few thin laminated

ivalent of Elwren Sandstone of Malott (1919). Both units contain productid brachiopog

vever, beds rich in these fossils, which are typically distinctive of this formation, are

5 to 2 m (5-7 ft) grades from very fine-grained sandstone through siltstone into

derate yellowish brown, commonly contain lenses and interbeds of light to

ırav. fine- to verv fine-grained sandstone. Locally a 1.5- to 3-m- thick (5- to 10-ft- t

artz grains moderately well cemented by silica and minor amounts of limonite, local

e of asphaltic conglomerate occurs near base. Unit rests unconformably on rocks

· to thick-bedded, crossbedded; medium gray calcareous shale partings. Sha

article sizes go up to cobbles with major diameters to 8 cm (3 in.) and (2) In north

cks of Mississippian and Pennsylvanian age and on slumped rock of Pennsylva

MULDRAUGH MEMBER—Siltstone, limestone, and sandstone. Siltstone, dolomitic and calcareous, in part silicified, faintly to moderately laminated; medium- to thickedded, interbedded with a few thin beds of dolomitic limestone and a few biostroma ayers of light gray to light yellowish gray, cherty, crinoidal, dolomitic limestone. Loca ontains numerous geodes and a few fine-grained sandstone layers or lenses Limestone, dolomitic, coarse- to very coarse-grained, crudely crossbedded, contain abundant chert nodules. Also occurs as limestone banks, medium- to very thick-bedded angly crossbedded: consists mostly of coarse to very coarse crinoid stem fragme bryozoan, brachiopod, and other fossil fragments; interstices filled with microcrysta lcite matrix. Sandstone, occurs in the Hibernia, Mannsville, and Saloma 7.5-mi adrangles, fine- to very fine-grained, in part crossbedded; consists of quartz grai mented by carbonate and minor amounts of silica and hydrous iron oxide, as mu-: 43 m (140 ft) thick, considered to be equivalent to the Knifley Sandstone Member he Fort Payne Formation. Basal 1.5 to 3 m (5–10 ft) of unit is a glauconitic zon auconite is dark greenish gray, concentrated in seams 5 to 15 cm (2locally disseminated in grains, granules, and pellets above and below seams. Glauconitic zone is the Floyds Knob Formation of Stockdale (1939). The Muldraugh Member is equivalent to the upper and middle parts of the Fort Payne Formation.

HALLS GAP MEMBER (not mapped separately)—Siltstone, shale, and limestone. Siltstone, dolomitic, calcareous, medium- to coarse-grained, massive to shaly, conta pyrite nodules as large as 1 cm (0.5 in.) across and quartz geodes as large as 10 c n.) in diameter, intercalated with a few lenses of limestone and light to medium g ilty shale partings. Limestone, calcarenite, dolomitic, occurs as lenses, partly silicified edium- to coarse-grained, cherty and fossiliferous, contains crinoid columnals. Sear nd disseminated granules of glauconite occur in upper 3 m (10 ft) of shale and siltstone. Basal contact gradational. NANCY MEMBER (not mapped separately)—Shale, silty, poorly fissile to nonfissile, contains scattered to abundant partially oxidized pyrite nodules and scattered quartz

geodes. Member grades downward through a zone 1.5 to 4.6 m (5–15 ft) thick from silty shale into more fissile shale of underlying member. IEW PROVIDENCE SHALE MEMBER (not mapped separately)—Shale, clayey to silty, locally highly fissile, locally contains discoidal reddish-brown iron carbona

ncretions as much as 0.3 m (1 ft) in diameter. Clay shale, plastic when wet, loca ossiliferous. Silty shale, light olive-gray, contains a few quartz geodes and chert lenses. Locally includes a zone 6 to 9 m (20–30 ft) above base containing numerous ferruginou concretions 15 to 38 cm (6–15 in.) in diameter interconnected by ferruginous veinlets. 3 m (5-10 ft) is a medium to dark greenish gray clay shale contain odules, lenses, and thin beds of sideritic limestone and a few scattered phosphati nodules. Basal contact is sharp. FORT PAYNE FORMATION (excluding reef limestones and Knifley Sandstone Member)—Siltstone, shale, claystone, and chert. Siltstone and shale, light olive-gray

ocally silicified; thin-bedded to massive, locally crossbedded; calcareous and fossilifero oximate to limestone, contains disseminated quartz geodes 1 cm (0.5 in.) to 0 1 ft) in diameter with minor amounts of calcite, barite, and gypsum; particularly commo along bedding planes. Chert beds 0.3 to 0.6 m (1–2 ft) thick occur locally in uppermost art of formation. Irregularly shaped masses of fossiliferous chert are widespread. In he Russell Springs 7.5-minute quadrangle, near north-trending faults, most of the upper 30 m (100 ft) is composed of chert. Chert is reddish brown to reddish gray, thinthick-bedded, evenly to irregularly bedded, in part contorted, dense, unfossiliferou probably of secondary origin. Claystone occurs at base of formation, light green to reenish gray, with few small lenses of calcareous shale, limestone, and sandstone. achiopods and trilobites, glauconite, and thin limestone beds. Lower part genera assive and structureless, with conchoidal fracture, slakes on contact with air, pla when wet. Basal 15 cm (6 in.) to 0.6 m (2 ft) characterized by numerous phospha nodules, some with an organic nucleus

F LIMESTONES (Fort Payne Formation)—Limestone (Includes the main body of ine Valley Limestone Member and other limestones that may occur in formation as the Muldraugh Member of the Borden Formation or undifferentiated Borden mation), medium- to very coarse-grained, mostly detrital, siliceous, cherty, glaucon fossiliferous; composed mostly of fragments of small crinoids, brachiopods, at bryozoans; medium- to thick-bedded, locally crossbedded, massive, locally shall irgillaceous, and cherty. Microfossils locally abundant near top. Formed in large gular crinoidal reefs, occurring as biostromes trending slightly north of we bedded with dolomitic siltstone and silty, dolomitic shale. Lies mainly west of parallel to the Knifley Sandstone Member, descends stratigraphically to the west, whe it pinches out or grades into adjacent dolomitic siltstone (Sedimentation Seminar, 197 Kepferle and Lewis, 1974). Ranges in thickness from 0 to 43 m (140 ft).

KNIFLEY SANDSTONE MEMBER—Sandstone, quartzose, very fine- to mediumgrained, generally poorly sorted, commonly calcareous and clayey, grades into sand iltstone and siltstone; contains thin lenses of red or variegated claystone, siltstone and calcareous sandstone. The unit is a northwest-trending prism, irregular in outline n and in the dolomitic siltstones and shales of the Fort Payne Formation. It is abo 0 km (25 mi) long and 10 km (6 mi) wide, and attains a thickness of 76 m (250 ft he sandstone is high in the formation in the east and descends stratigraphically to the west, where it finally pinches out or grades into the adjacent dolosiltstones and mestones (Sedimentation Seminar, 1972; Kepferle and Lewis, 1974).

NEW ALBANY/CHATTANOOGA SHALE—Shale, dark brownish black to black, rbonaceous and petroliferous, slightly uraniferous (Conant and Swanson, 1961) laminated to thick-bedded, well-jointed. Contains many seams, veinlets, an rite. Contains an assemblage of small fossils, including brachiopods, fi ales and teeth, and conodonts. Weathers to a light gray to gray-brown fissile r labby to papery, surfaces commonly stained with iron oxide; locally coated with su or other mineral blooms along joints and cracks. Basal contact is unconformable an sharp in most places. Originally mapped as New Albany Shale in the northeastern corner and Chattanooga Shale in southern and eastern parts of the quadrangle.

mestone, calcarenite, light gray to light yellowish gray, coarse- to very coarse-graine edium- to thick-bedded; contains fragments and whole specimens of horn corals brachiopods, and winged crinoid columnals. Dolomite, limy, fine- to medium-grained thick-bedded. Limestone and dolomite contain sparse chert nodules and beds as muc is 10 cm (4 in.) thick, and rounded masses of coarsely crystalline calcite. Locally uppe to 1.8 m (1–6 ft) is a dolomite conglomerate composed of rounded dolomite cobble ind pebbles, angular to rounded chart fragments as much as 10 cm (4 in.) acro ınd a few widely scattered, rounded, coarsely crystalline masses of calcite in a fin o medium-grained crystalline dolomite matrix. Basal contact is sharp and unconformable Southern extent: limestone and sandstone. Upper limestone, yellowish brown to ligh luish gray. Locally interbedded with overlying black shale. Contains winged crin nnals, 8 to 13 cm (3–5 in.) long. Middle limestone, bluish white to dark blue-g lense, finely to coarsely crystalline, contains sporadic to abundant large chert nodule containing fossil fragments. Sandstone, lower 0.3 to 0.6 m (1-2 ft), fine-grained, wellsorted, generally with siliceous cement, but locally calcareous, very hard and dense; weathers to dark brown, resistant ledges. Unit occurs as a convex-downward lens,

DRAKES FORMATION—Limestone, siltstone, minor shale. Limestone, laminated and thin-bedded, dolomitic; uneven beds 2.5 to 8 cm (1–3 in.) thick, locally contain abundar fossils, including cylindrical bryozoans, gastropods, horn corals, and clusters of colonial corals as much as 0.6 m (2 ft) in diameter. Siltstone, lower 4.6 to 6 m (15-20 f dolomitic laminated contains interbeds and partings of shale up to 0.6 m (2 ft) thick apped area includes rocks labeled as limestone and dolomite of Late Ordovician age he Dunnville 7.5-minute quadrangle. Upper dolomitic limestone unit mapped Saluda Dolomite Member is underlain by fossiliferous limestone of Bardstown Membe and lower silty unit of Rowland Member. Separate members are mapped on individual DVGQ's in northeastern part of map area.

indicating deposition in small isolated basins.

GRANT LAKE LIMESTONE—Limestone and shale. Limestone, silty and argillaceous in nodular and uneven beds 5 to 13 cm (2-5 in.) thick; contains abundant foss including brachiopods, bryozoans, gastropods, pelecypods, and crinoid columnals. Shale, calcareous, in partings and thin beds up to 0.3 m (1 ft) thick. ASHLOCK FORMATION—Limestone, siltstone, and shale. Limestone, silty and argillaceous, occurs in nodular and uneven beds 5 to 13 cm (2–5 in.) thick: contains oundant fossils, including brachiopods, bryozoans, gastropods, pelecypods, and

ew crinoid columnals. Siltstone, dolomitic, laminated and thin-bedded; glaucon granules sparsely disseminated throughout. Shale, calcareous, in partings and th ds up to 0.3 m (1 ft) thick. Upper limestone unit mapped as the Gilbert Member an lower dolomitic siltstone unit mapped as Tate Member on individual DVGQ's in

silty, argillaceous limestone and greenish gray shale. Base not exposed.

Sikeston Murray Hopkins- Bowling Tompkins- Corbin Middles Bristol

Locations of the 30 x 60 minute quadrangles covering Kentucky. The location of the Campbellsville

⁹⁰ 89° 88° 87° 86° 85° 84° 83°

quadrangle is highlighted in blue.

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GEOLOGIC MAP OF THE CAMPBELLSVILLE 30 x 60 MINUTE QUADRANGLE, **SOUTH-CENTRAL KENTUCKY**

Mark F. Thompson and Carl Petersen Interstate highway or parkway U.S. highway — State highway √400 Structure contour, feet 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 KILOMETERS —-—- County boundary Datum horizon boundary 1 0 1 2 3 4 5 6 7 8 9 10 MILES ····· City boundary Active stone quarry or mine ········· Railroad Abandoned stone quarry or mine 1000 0 5000 10 000 15 000 METERS Normal fault (U, upthrown side; Active pit; gravel D, downthrown side) 5000 0 10 000 20 000 30 000 40 000 50 000 FEET X Abandoned pit; gravel or asphalt Concealed fault SCALE 1:100 000 Contact niversal transverse Mercator projection, zone 16: 1927 North American datum

ure 2. Location of structure contours in the Campbellsville 30 x 60 minute quadrangle. Index gives nes of each mapped datum horizon. The horizon boundaries are shown on the geologic map as thir ed dashed lines or faults. Contour interval is 40 ft with index contours at every 200 ft. TOPOGRAPHIC CONTOUR INTERVAL 20 METERS NOTE: cross section is diagrammatic vertical exaggeration 8x Salem and Warsaw Formations Calloway Creek Formation Ashlock Grant Lake Drakes Formation Formation Boyle Limestone Formation Grant Lake Limestone Middle Ordovician and older rocks Middle Ordovician and older rocks

Middle Ordovician and older rocks

The geology of the Campbellsville 30 x 60 minute quadrangle was digitally compiled mostly from U.S. Geological Survey 7.5-minute geologic quadrangl maps (GQ's), as cited in the references. The original GQ's were products of a cooperative mapping project between the U.S. Geological Survey and the Kentucky Geological Survey from 1960 to 1978. The conversion into digital format has been another USGS-KGS cooperative program funded through he State Geologic Mapping component of the National Cooperative Geologi Mapping Program (NCGMP STATEMAP). Regional geologic studies on mapping and stratigraphy (Lewis and Potter, 1978; Sable and Dever, 1990) have resulte n changes in the stratigraphic nomenclature and correlation. These changes are shown on this map, and were necessary for compilation of regional map and for stratigraphic continuity between 7.5-minute quadrangles. The 7 minute quadrangles that make up the Campbellsville 30 x 60 minute quadrangle are shown in the index map (Fig. 1).

The data files resulting from the digitization of the GQ's are part of a comprehensive relational and spatial data set, being released as Digitally (Anderson and others, 1999). These DVGQ's are available on CD-ROM, an and are available on an Internet map service on the KGS Web site. Users of he DVGQ's can prepare custom geologic maps by overlaying data using their which extends from the central part of Green County northeast into the central own GIS or CAD software. KGS has also developed an Internet map server part of Taylor County. The KGS oil and gas database shows that over 600 where users can prepare similar maps via an interactive Geologic Map productive wells were drilled in this pool. The data for Green and Taylor Information Service without purchasing DVGQ's (kgs.uky.edu/kgsmap/ Counties combined make up most of the Greensburg production. The successfu kgsgeology) (Weisenfluh and others, 2005).

The 7.5-minute quadrangle maps were digitally compiled using a semiautomated data capture technique to convert hard-copy geologic maps into bbl/yr. Most of the production from this pool has come from the Laurel Dolomite digital format. Compiling 7.5-minute maps into a 30 x 60 minute map required and the Corniferous, with some recent production in the Knox. the resolution of significant problems, such as (1) correlating geologic formations across quadrangle boundaries, (2) resolving nonuniform structure-contour datums or intervals, and (3) resolving discrepancies in Quaternary alluvium boundaries and inferred contacts. The metadata portion of the digital file provides detailed information about the conversion process. Formation codes were assigned using the American Association of Petroleum Geologists' standard stratigraphic code (Cohee, 1967), which was modified by the Kentucky Geological Survey for state-specific use. Formations and formation boundaries were not mapped the same way on each of the 7.5-minute maps, since they were compiled by various authors between 1960 and 1978. Resolution of the INDUSTRIAL MINERALS differences between quadrangles was necessary for efficient topological

analysis in a GIS environment. In addition, numerous lithologic members mapped on individual 7.5-minute quadrangle maps are too small to be displayed on a 30 x 60 minute guadrangle map, but are included in the Digitally Vectorized **Limestone**

GEOLOGIC SETTING AND STRUCTURAL GEOLOGY The Campbellsville 30 x 60 minute quadrangle is located in the Mississippian Plateau physiographic region (Fig. 2), which forms an arcuate belt around the Western Kentucky Coal Field in the southern part of the Illinois Basin. The region is subdivided into two major plateaus, which are separated by the southcing Dripping Springs Escarpment. The Mammoth Cave Plateau lies north the escarpment, and the Pennyroval Plateau to the south of the escarpment. This quadrangle is nearly equally divided between the Eastern and Western Pennyroyal subregions. The northeastern parts of the quadrangle, closely corresponding to the area in Marion County, is located in the Knobs physiographic region, a narrow arcuate belt of conical hills around the periphery of the Bluegrass Region of central Kentucky. The Knobs are Lower Mississippian shale and siltstone erosional remnants standing along the front of the Muldraugh Hills across west-central and south-central Kentucky. The Muldraugh Hills are a limestone-capped, east-facing escarpment forming the eastern border of he Mississippian Plateau Region (Sable and Dever, 1990). The Illinois Basin is a major structural downwarp in the eastern Midcontinent, occupying large parts of Illinois, Indiana, and Kentucky. This basin developed

through several phases of subsidence over a failed rift in the crust (an aulacogen) called the Reelfoot Rift that originated during the Precambrian or guadrangle have a general dip to the northwest into the basin. The Rough Reelfoot Rift called the Rough Creek Graben (Greb and others, 1992). This standards of 2 lb and 0.6 lb, respectively (Barron and others, 1991). graben underlies a large part of the basin. The Rough Creek Fault System enters Kentucky at Shawneetown on the Ohio River and extends east for about 100 mi into eastern Grayson County (immediately west of this quadrangle) where it dissipates into a series of bifurcating faults that arc to the southeast corner of this quadrangle. Several normal faults in the northwestern corner of

The Cincinnati Arch is described by Dever (1999) as a broad anticlinal structure that extends through the quadrangle northeastward from central nnessee through central Kentucky toward Cincinnati, Ohio. It was a positive structural feature as early as Silurian time. The arch influenced sedimentation fterrigenous-detrital sediment and forming a barrier to open marine circulation Freeman, 1951; Currie, 1981). Progressive onlap of the arch by units of the quadrangles. uring Pennsylvanian time is indicated by the westward thinning of Pennsylvanian fine and might be used for plaster aggregate or foundry sand. features on the arch are the Jessamine Dome (or Lexington Dome) of central some locations the deposits are composed almost entirely of fragments of Kentucky, the Cumberland Saddle of southern Kentucky, and the Nashville angular to subrounded chert derived from the weathering of limestone and Dome of central Tennessee. This quadrangle lies along the western flank of deposited along the present stream channels. Though the deposits are small,

and the Jessamine Dome. This saddle is part of the north-trending Cincinnati The Borden Formation is a sequence of sedimentary rocks that were a Mississippian delta front (Borden front) that extends northwest across the in this quadrangle are discussed in Hall and Palmquist (1960), Brown and quadrangle (Sable and Dever, 1990). The Borden front was a southwest- Lambert (1962), Lambert and Brown (1963), and Carey and Stickney (2001, prograding fluvial delta, rich in clastic sediments, which deposited many shales 2002, 2004a,b, 2005a-g). The elevation of the fresh-saline water interface is and siltstones in the northeastern part of the quadrangle. As the Borden front in Hopkins (1966). Groundwater basins in this quadrangle have been mapped migrated westward, the Borden clastic delta sediments intertongued with the by Ray and Currens (1998). The locations of water wells and springs in this marine limestones being deposited by the Fort Payne Formation. A series of quadrangle have been presented in map form by Davidson (2002). reef limestones, bioherms, and sandstone bodies were deposited by the For Payne Formation southwest of and parallel to the delta front (Sedimentation Seminar, 1972). Distinct lateral facies changes between Borden clastics and Landslides and Slumping Soils Fort Payne carbonate sediments are evident in adjoining geologic quadrangles in the northeastern part of the quadrangle. The Devonian shales consist of three nomenclatural units—the New Albany, Chattanooga, and Ohio Shales—all laterally continuous with one another. In

he Cumberland Saddle there is a very thin section of this shale, typical of Arch coincides with the 40-ft contour of this shale, thus demonstrating that it was a weak positive feature in Devonian time. The base of these Devonian drainage and the creation of steep slopes should be avoided. These units are of Silurian and Late Ordovician age are absent near the Cincinnati Arch.

or general construction purposes, and shale and clay shale, some of which below springs and seeps are especially susceptible to sliding. was suitable for use in the refractory industry.

Eleven counties are wholly or partially within the Campbellsville 30 x 60 minute quadrangle. Data for these counties were tabulated from the KGS oil and gas database, the Severance Tax Division of the Kentucky Revenue Cabinet, and the Oil and Gas Division of the Kentucky Department of Environ- KARS1 mental Protection and Natural Resources (KGS, 2009). Since Hardin, Larue, and Marion Counties contained fewer than 10 productive wells in the mapped area, their county production records were not included in the table below. extent the Mammoth Cave Plateau, is readily soluble in groundwater and **Table 1.** Total cumulative oil production and most recently available annual I production for counties in the Campbellsville area, with comparison to state's yearly production (2006).

The KGS oil and gas database contains records for 10,530 wells in the

were known and permitted beginning in 1960, of which 3,377 were classified successful. There were 2,935 oil completions, 434 gas completions, and eight combined oil-and-gas completions. Total oil production through 2006 from hese counties exceeded 40 million barrels, and that amount accounted for less than 3 percent of the state's oil production. There is no significant natural gas production from these counties. The majority of the strata that have produced oil or natural gas are limestone away by the conduit draining the sinkhole. The collapse occurs when the soil primary producing zones are described in ascending order. • The Knox Group (Middle Ordovician): Approximately 800 suc-

cessful wells were associated with this unit, the vast majority striking oil. They occurred primarily in the southeastern and southcentral sections of this quadrangle. Many producing wells were on paleokarst highs, but some production was fracture-related. The High Bridge Group (Middle Ordovician): Of the approximately 100 successful wells reported for this unit, approximately 70 percent were oil and 30 percent were gas. They were located in the southeastern half of this quadrangle, with the oil pays concentrated in the central part and the gas pays primarily in the northeastern and southwestern areas. • The Lexington Limestone (Middle Ordovician): Fewer than 100 successful wells were reported for this unit, with nearly equal numbers of oil and gas wells. Their distribution was similar to • The Leipers Limestone (Upper Ordovician): This unit was reported

that of the High Bridge Group. as the producing zone for approximately 200 successful wells, of which approximately 85 percent were oil and 15 percent gas They occurred primarily in the southwestern quadrant of this quadrangle. The producing zones were relatively thin, often lenticular, porous bioclastics associated with beach strandlines, offshore bars, and tidal deposits. Laurel Dolomite (Middle Silurian): Approximately 400 successful wells were reported in these rocks, primarily in the Greensburg Oil Field; approximately 85 percent were oil and 15 percent were

Cumberland Saddle

gas. This producing zone occurred in the central and western parts of this quadrangle. The "Corniferous" (Middle Silurian to Middle Devonian): Approximately 500 successful wells were reported from these rocks, of hich nearly 75 percent were oil and 25 percent were gas. Corniferous" is a drillers' term referring to miscellaneous producin intervals between the base of the Devonian black shales and the

Dolomite. Traps in the Corniferous were typically erosional remnants associated with an angular unconformity capped by the Chattanooga Shale. This producing zone covers the same area as the Laurel Dolomite. The Fort Payne Formation (Lower Mississippian): Wells in this unit occurred primarily in the southwestern quadrant of the quadrangle. Approximately 500 successful wells were reported, of which nearly 20 percent were gas and 80 percent were oil. oducing areas were distributed throughout the quadrangle and corresponded to isolated, crinoid-rich, and often highly compartentalized carbonate bioherms. The bioherm at the base of the Fort Payne is locally known as the "Beaver Sand."

top of the Lower Silurian Brassfield Dolomite, including the Laurel

• The Warsaw Formation (Middle Pennsylvanian): Fewer than 50 wells were reported in this unit. The vast majority were gas wells, nost located in the southwestern corner of the quadrangle in

wells yielded a cumulative production of over 20 million barrels (bbl). Recorded roduction began in the early 1950's at slightly more than 1,000 bbl/y duction rapidly increased and peaked in 1959 at over 10 million bbl/yr. Three gas storage fields are located in the Campbellsville quadrangle. Of the more than 400 miscellaneous wells in the KGS oil and gas database, most are gas storage wells. The Magnolia gas storage field is in northern Green ounty and westward, along the boundary between Hart and Laurel Counties. The Canmer gas storage field is located in east-central Hart County. Canmer was abandoned as a gas storage field in 1987. The Center gas storage field is in northern Metcalfe County. These fields were developed in the Silurian

Much of the information in this section was obtained from a review of the economic geology sections of the individual 7.5-minute quadrangle maps.

geologic, cartographic, and GIS standards appropriate for the scale of the the late 1980's the value of quarried limestone, on a statewide basis, has exceeded that of both oil and natural gas (Anderson and Dever, 2001). This map is a compilation of existing maps, and no additional field work

The eastern half of the quadrangle contains limestones in the Salem and took place. When there were problems in stratigraphic correlation between Warsaw Formations and Fort Payne Formation. The western half contains the quadrangles, the best current data available were used to resolve these Ste. Genevieve Limestone, the St. Louis Limestone, and limestones of the economic value. Large quantities of limestone are easily accessible, of sufficient and road metal, however. Brovles and Malone, 2009). Total production from these quarries is estimated e less than 3 million short tons per year (oral commun., W. Anderson, KGS. 2003). The guarry in the Upton 7.5-minute guadrangle was in the upper te. Genevieve Limestone and Paoli and Beaver Bend Limestones. The quarry in the Saloma 7.5-minute guadrangle was in the St. Louis and Salem Limestones The Ste. Genevieve Limestone was the source material for quarries in the Glasgow North, Hiseville, Horse Cave, and Sulphur Well 7.5-minute quadrangles.

in the Fort Payne Formation. Although the quality of the limestones of the Salem and Warsaw Limestones is highly variable, containing shale and chert, in some areas it is a relatively pure carbonate. Chemical analysis of the Salem and Warsaw Limestones Cambrian. Because of the subsidence of the Illinois Basin, the strata in this demonstrated that it is suitable for use in power plants that utilize atmospheric fluidized-bed combustion to reduce their SO₂ and NO₂ emissions. Pilot plan Creek and Pennyrile Fault Systems are located along the approximate northern tests using this limestone resulted in SO₂ emissions of approximately 1 lb/million and southern margins, respectively, of an east-trending arm or branch of the Btu and NO₂ emissions of 0.2 lb/million Btu. Both values are below the emission

luring Middle and Late Silurian time, gradually limiting westward movement erate. In 2009 an active open pit mine was operating in the Magnolia quadrangle

he Cumberland Saddle, a broad structural low between the Nashville Dome they supply adequate material in some areas for farm and county roads.

ENGINEERING GEOLOGY E, Campbellsville, Mannsville, and Spurlington 7.5-minute quadrangles), the ilty and clayey shales of the Nancy and New Providence Shale Members of the Borden Formation are unstable. Widespread benches are present along valley slopes where slumps and landslides were caused by liquefaction of areas where deposition was limited. The approximate outline of the Cincinnati water-saturated shale. Both members provide a poor foundation for roads and buildings. Structures on these members should be provided with adequate shales is marked by a major regional unconformity, such that all of the rocks relatively impervious and consequently provide an excellent base for farm

The shale member of the Fort Payne Formation in the Knifley 7.5-minute When the equilibrium of hillslopes is disturbed, the shale tends to creep or slide. Roadcuts or other excavations in the shale generally result in landslides adequate drains are rough or have been repeatedly repaired where they cross

Surface and near-surface limestones have the potential for karst hazards. he thick-bedded limestone underlying the Pennyroyal Plateau, and to a lesser of the valleys separating the ridges are largely underlain by silty dolomites hat are only slightly soluble (Currens, 2001a). The Western Pennyroyal has nany of the karst conditions necessary for the development of the long cave otected from erosion at the surface by overlying insoluble rocks, and higher-The large number of sinkholes, caves, underground streams, and springs dded limestone has developed an intricate subsurface drainage system by hese rivers, by solution and abrasion of the underlying limestone, have incised neir valleys from less than 100 ft to more than 300 ft below the uplands

cave becomes too thin to support the weight of the bedrock and soil above The cave roof then collapses, forming a collapse sinkhole. Bedrock collapse s rare and the least likely way a sinkhole can form. The second, and most common, way sinkholes form is for the bedrock under a sinkhole to dissolve and be carried away underground, and for the soil to gradually slump or erode nto the sinkhole. Cover-collapse sinkholes are special sinkholes that occur n the soil or other loose material overlying bedrock. When the overlying soi cover becomes too thin to support its own weight. The collapse occurs on in the overlying soil cover, not in the limestone bedrock (Currens, 2002). Sinkhole flooding occurs when there is more precipitation than the conduits (and caves) can handle. There are two types of sinkhole flooding. In the first type, the throat of the sinkhole may be constricted and thus unable to carry way water as fast as it flows in. Frequently, the throat of the sinkhole is logged by trash and junk, soil eroded from fields and construction sites, and

ometimes by natural rock fall within the conduit. The second type of sinkhole ooding is caused when the sinkhole's discharge capacity is limited farther downstream. This can be caused by caves blocked with trash or rock fall, imited conduit size, or backflooding from other sinkholes. Some sinkholes, hich drain normally during modest storms, may actually become springs and discharge water from their throats during intense storms (Currens, 2002). Solution-enlarged openings of the conduit system serve as the primary aquifer in this region and the primary pathway for groundwater contamination Water enters the karst aguifers either directly, through swallow holes (points long streams and sinkholes where surface flow is lost to underground conduits indirectly, through the pores in the soil overlying the limestone bedrock. Once the underlying conduits become large enough, insoluble soil and rock particles are more easily carried away. All of the dissolved limestone and soil particles pass through the sinkhole's throat. The throat of a sinkhole is sometimes visible, but is commonly covered by soil and broken rock, and can be partly or completely filled with this material. This opening can vary from a few inches n diameter to many feet. Contaminants associated with agriculture and urban evelopment can be transported by overland flow into these swallow holes,

n both urban and rural areas can also percolate through the overlying soil in the sinkhole and then quickly enter the conduit. Any building, construction, or highway over sinkholes would be prone to collapse or subsidence. Groundwater contamination from pesticides, herbicides, or raw sewage could degrade the water supply. Adequate foundation testing

Anderson, W.H., and Dever, G.R. Jr., 2001, Mineral and Moore, F.B., 1972a, Geologic map of the Hammonville

The most productive area in this quadrangle was the Greensburg Poo

Louisville Limestone, Lego Limestone, or Laurel Dolomite.

Geologic Quadrangles. These problems were resolved by adhering to the

The limestone and dolomite deposits in this quadrangle are extensive. Since In many places these limestones are too thin, or contain a considerable amount of chert and silicified fossils, or may be too silty or sandy to be of ourity, and thick enough to be quarried for aggregate, agricultural limestone, In 2009 there were eight operating limestone quarries in this quadrangle

> Although the top part of the guarry in the Gresham 7.5-minute guadrangle is ı the Salem and Warsaw Limestones, the main operation is in the Fort Payne ormation. The quarries in the Columbia 7.5-minute quadrangle, likewise, are

Gravel deposits of Tertiary(?) and Quaternary age cap hills in parts of the Hibernia, Munfordville, and Saloma 7.5-minute quadrangles. They consist of (Greb and others, 1992). These bifurcated faults are located in the northwestern approximately equal amounts of quartz pebbles, sand, and silt. These gravels have been mined from open pits and used locally for fill and road metal. They his quadrangle trend southeast and appear to splay off the Rough Creek Fault are a potential source of aggregate sand and quartz pebbles suitable for Slumped sandstone and conglomerate, mostly of Pennsylvanian age, is part of a large alluvial fan and occurs in parts of the Hammonville, Hibernia,

Hudgins, Magnolia, and Munfordville 7.5-minute quadrangles. Deposits of sand and gravel are derived from weathering of this sandstone and conglom-(Broyles and Malone, 2009). There were also small abandoned pits in these Devonian black shale sequences, and their thinning toward the axis, indicate

A large amount of sand is available from the Knifley Sandstone Member of that the arch was a positive, but submerged, feature during the Late Devonian the Fort Payne Formation, which is exposed in the southeastern part of this Ettensohn and others, 1988). During Mississippian time, the arch was alternately quadrangle (the Cane Valley, Campbellsville, Dunnville, Knifley, Mannsville, submergent and emergent (Sable and Dever, 1990). Influence of the arch Montpelier, and Russell Springs 7.5-minute quadrangles). The sand is very strata in the Appalachian Basin of eastern Kentucky (Chesnut, 1991). Principal Deposits of sand and gravel are available in the larger stream valleys. In

The quantity and quality of groundwater available in the counties included

In the northeastern part of this quadrangle (the Bradfordsville, Bradfordsville

ponds and other water-retention needs. quadrangle is soft but relatively impermeable, so water percolating through Oil and natural gas are the principal economic resources of this quadrangle. siltstone above the shale forms seeps or small springs at the top of the shale. Other mineral resources include limestone, sand, and gravel, which are used Many farm ponds have been excavated in the shale below the springs. Areas

when the shale near the surface is saturated with water. Most roads without

develops into a karst terrane. In the Eastern Pennyroyal, most ground-water basins, and subsequently caves, occur along the flanks of ridges. The floors systems for which this region is famous. These include a thick block of limestone, levation areas draining toward a major stream (Currens, 2001b). nd the lack of surface streams show that the dominant drainage of this plateau subsurface. Percolating groundwater in the underlying relatively pure, thicksolution along joint systems, fractures, and bedding planes and resulted in arge cave systems. The discharge of groundwater from this subsurface system s as springs and seeps along the valleys of the major rivers and their tributaries.

There are three common karst-related hazards (Currens, 2002); sinkhole collapse, sinkhole flooding, and groundwater contamination. There are two Hall, F.R., and Palmquist, W.N., Jr., 1960, Availability of methods for sinkhole collapse to occur. In the first way, the bedrock roof of a Campbellsville quadrangle through December 2008, based on the wells that

where they quickly enter the conduit aquifer system (Currens, 2002). Contamnants associated with trash deposited in sinkholes as well as overland flow

should be done prior to construction in karst areas, and water testing should

be done to ensure safe drinking water.

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