SELECTED INDUSTRIAL MINERAL PRODUCERS ALONG INTERSTATE 70

AND MISSOURI HIGHWAY 94, ST. CHARLES COUNTY, MISSOURI

48th Association of Missouri Geologists Annual Meeting and Field Trip

September 28 and 29, 2001

Prepared by

David C. Smith, R. P. G.
Missouri Department of Natural Resources
Division of Geology and Land Survey
P. O. Box 250
Rolla, MO 65401
573-368-2183
nrsmitd@mail.dnr.state.mo.us

and

Robert C. Beste, R. P. G.
Lafarge Corporation
Construction Materials, Missouri Division
2115 South River Road
St. Charles, MO 63303
636-940-0073
Mobile 314-910-9999
Bob.Beste@lafargecorp.com

September 18, 2001

For

The Association of Missouri Geologists
George A. Kastler, Treasurer
704 Broadway
Jefferson City, MO 65101
573-634-3487 home
573-751-5384 work
e-mail nrkastg@mail.dnr.state.mo.us

Table of Contents

SELECTED INDUSTRIAL MINERAL PRODUCERS ALONG INTERSTATE 70

AND MISSOURI HIGHWAY 94, ST. CHARLES COUNTY, MISSOURI

48th Association of Missouri Geologists Annual Meeting and Field Trip

September 28 and 29, 2001

David C. Smith, R. P. G.
Missouri Department of Natural Resources
Division of Geology and Land Survey
P. O. Box 250
Rolla, MO 65401
573-368-2183
nrsmitd@mail.dnr.state.mo.us

Robert C. Beste, R. P. G.
Lafarge Corporation
Construction Materials, Missouri Division
2115 South River Road
St. Charles, MO 63303
636-940-0073
Mobile 314-910-9999
Bob.Beste@lafargecorp.com

Association of Missouri Geologists Annual Meeting and Field Trip Itinerary

Hard hats, safety glasses, and steel toed boots are required for both Friday and Saturday Association of Missouri Geologists (AMG) field trips.

AMG Field Trip, 1:00 p.m. to 5:30 p.m. Friday, September 28, 2001
Selected industrial mineral producers along Interstate 70, central St. Charles County, MO.

AMG Banquet and Annual Meeting, 7:00 p.m. to 9:30 p.m. Friday, September 28, 2001
Featuring keynote speaker John Stull, Vice President and General Manager, Construction Materials, Missouri Division, Lafarge Corporation

AMG Field Trip, 7:30 a.m. to 1:30 p.m. Saturday, September 29, 2001
Selected industrial mineral producers along Highway 94, southern St. Charles County, MO.

Acknowledgements

The authors are grateful for access provided by Kurt Lucas, Quarry Manager, Construction Materials, Missouri Division; Lafarge Corporation to St. Charles Sand, St. Charles Quarry, and Defiance Quarry. The City of St. Peters kindly provided access to the old north pit at St Charles Quarry. We thank Doug Weible, President, and Daryl Fehr, Plant Superintendent, Materials Division, Fred Weber, Incorporated for access to O'Fallon Quarry. Douglas G. Kassabaum, Kassabaum Development; and Andrew Degginger, St. Charles County Parks and Recreation Department, graciously permitted access to the Berg and Klondike Quarries, respectively. We dedicate this guidebook, and each of our efforts, to strengthening America, one nation under God.

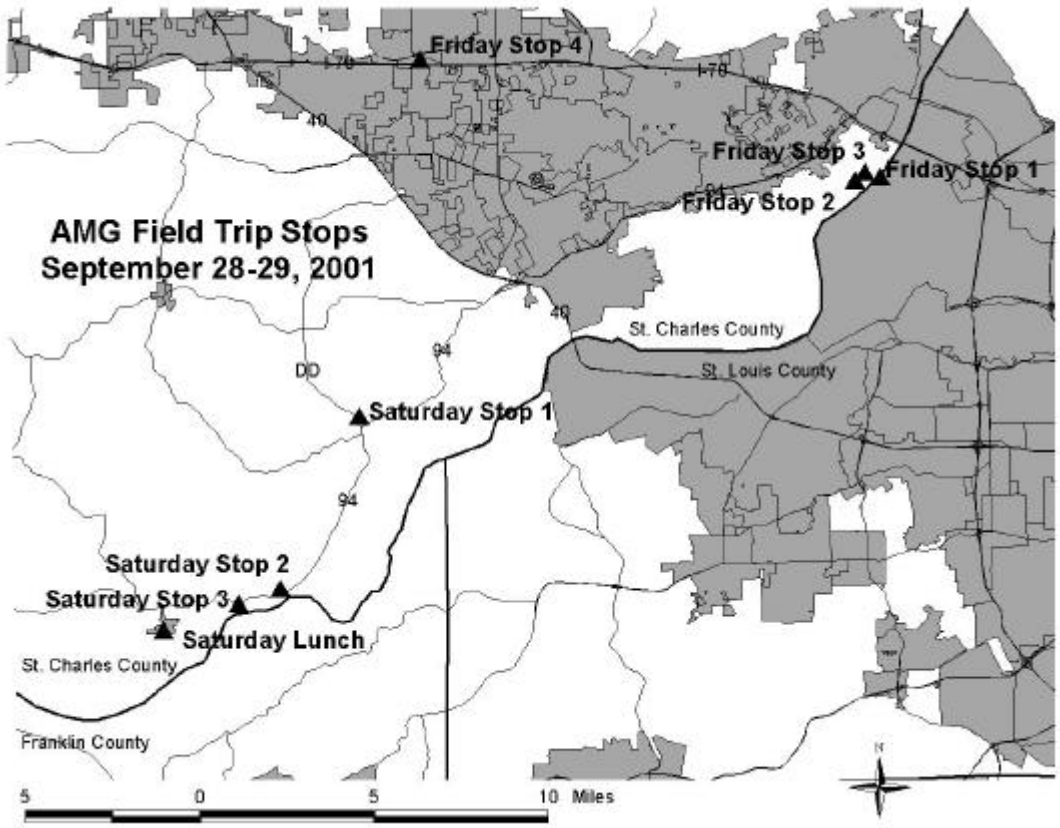
Association of Missouri Geologists Field Trip Itinerary, September 28 and 29, 2001

Friday, September 28, 2001

1:00 P.M.		Assemble equipped for the field trip on the north parking lot, Holiday Inn Southwest, 10709 Watson Road, St. Louis, MO for Part 46 Safety Briefing
1:30 – 2:00 P.M.		Bus via I-70 to St. Charles
2:00 – 3:00 P.M.	**Stop 1**	Lafarge Corporation - St. Charles Sand Dredge
	Stop2	Lafarge Corporation – St. Charles Quarry
	Stop 3	City of St. Peters – Old North Pit, St. Charles Quarry
3:00 – 3:45 P.M.		Bus via I-70 to Weber Materials, Incorporated - O'Fallon Quarry
	Stop 4	Weber Materials, Incorporated - O'Fallon Quarry
4:30 – 5:20 P.M.		Return to Holiday Inn Southwest, St. Louis, MO

Saturday, September 29, 2001

7:30 A.M.		Depart north parking lot, Holiday Inn Southwest, St. Louis, MO
7:30 – 8:30 A.M.		Bus via Hwy. 40 to 94 to Defiance
	Stop 1	Lafarge Corporation – Defiance Quarry
9:15 – 9:30 A.M.		Bus to Augusta Shores
	Stop 2	Kassabaum Development – Berg Quarry
10:15 – 10:30 A.M.		Bus to Klondike
	Stop 3	St. Charles Parks and Recreation Department - Klondike Quarry
11:00 – 11:30 A.M.		Bus to Augusta Winery
11:30 – 12:30 P. M.		Lunch at Augusta Winery, Jackson and High Streets, Augusta, MO
12:30 – 1:30 P.M.		Return to Holiday Inn Southwest, St. Louis, MO



The 2001 Association of Missouri Geologists field trip will examine extraction and use of Quaternary Missouri River sediment and Mississippian- and Ordovician-age rocks exposed at several St. Charles County quarries. The Friday field trip will begin with Quaternary sediments and from there examine the St. Louis, Salem, Warsaw, Burlington-Keokuk, Fern Glen, and Chouteau. Saturday's trip reviews the Fern Glen and Chouteau and examines the Bushburg, Kimmswick, Decorah, Plattin, Joachim, and St. Peter.

Genralized Stratigraphic Column - St. Charles County

System	Formation	Thick
Pennsylvanian	undifferentiated	0-365
Mississippian	Ste. Genevieve Formation	0-160
	St. Louis Limestone	0-180
	Salem Formation	0-180
	Warsaw Formation	0-110
	Burlington-Keokuk Limestone	0-240
	Fern Glenn Formation	0-105
	undifferentiated	0-122
Devonian	Bushberg Sandstone	0-60
	Glen Park Limestone	0-60
	Grassy Creek Shale	0-50
Silurian	undifferentiated	0-200
Ordovician	Maquoketa Shale	0-163
	Kimmswick Formation	0-145
	Decorah Formation	0-50
	Plattin Formation	0-240
	Rock Levee Formation	0-93
	Joachim Dolomite	0-135
	St. Peter Sandstone	0-160
	Everton Formation	0-130
	Powell Dolomite	0-150
	Cotter Dolomite	0-320
	Jefferson City Dolomite	0-225
	Roubidoux Formation	0-177
	Gasconade Dolomite	0-280
Cambrian	Eminence Dolomite	0-172
	Potosi Dolomite	0-325
	Derby-Doerun Dolomite	0-165
	Davis Formation	0-150
	Bonneterre Formation	245-385
	Lamotte Sandstone	0-235
Precambrian		

Adapted from "the resources of St. Charles County, Missouri Land, Water, and Minerals" - 1975

Friday, September 28, 2001, Stop 1: Lafarge Corporation - St. Charles Sand Dredge

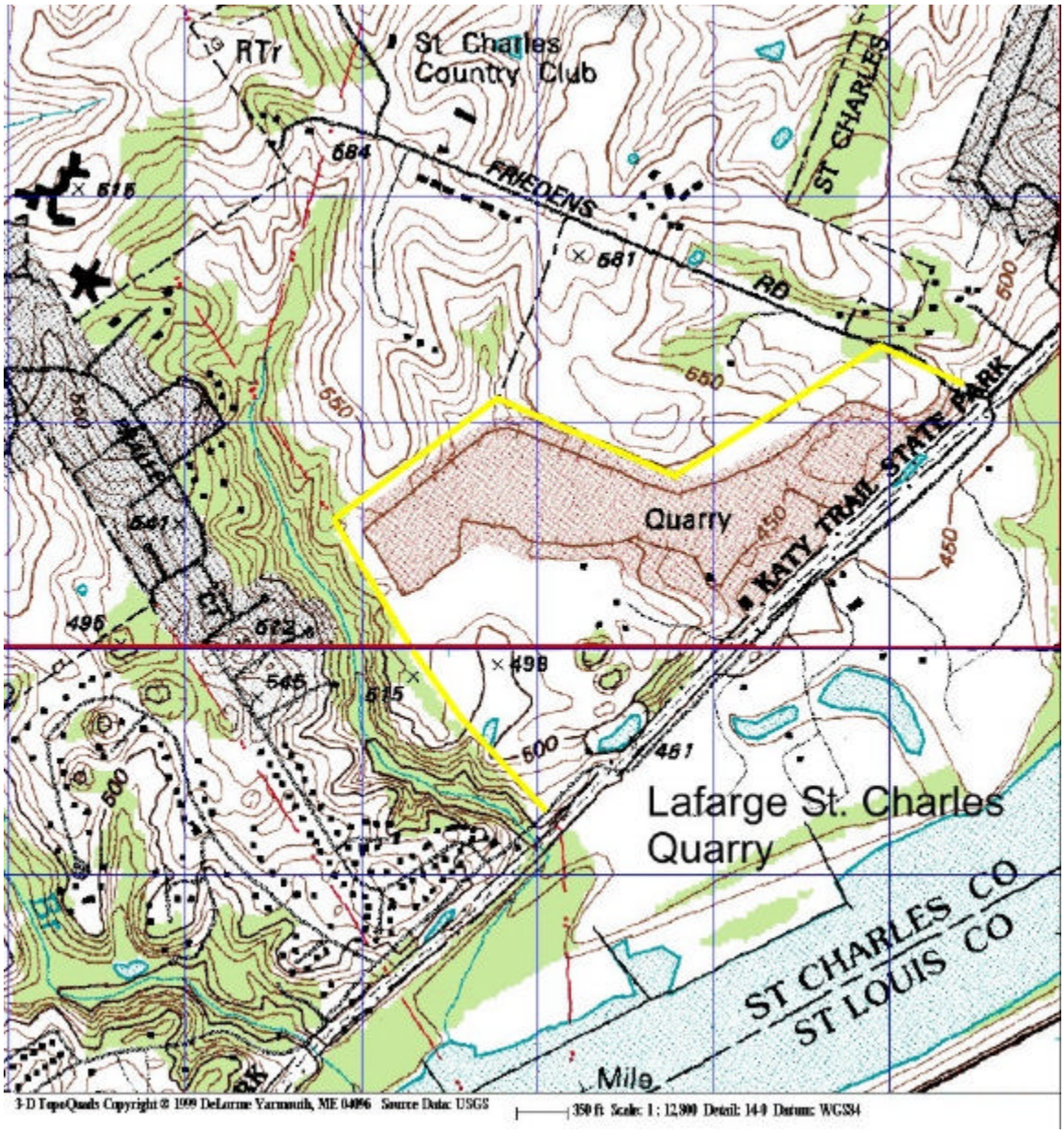
St. Charles County, Kampville 7.5 Minute Quadrangle
Land Grant Surveys 2982 and 3280
Approximately Latitude 38^{o} 45' north Longitude 90^{o} 30' west, T. 46 N., R. 5 E.
Lafarge Corporation Sand Dredge in Missouri River Alluvium

formerly
St. Charles Sand
Dredge No. 2
Highway 40/61 & MO River
Chesterfield, MO 63017
314-532-3120
Paul Viehman

Lafarge Corporation
Construction Materials, Missouri Division
St. Charles Quarry
P. O. Box 40
St. Charles, MO 63302
636-946-0004
Kurt Lucas, Manager

Friday, September 28, 2001, Stop 2: Lafarge Corporation – St. Charles Quarry

St. Charles County, Chesterfield and Kampville 7.5 Minute Quadrangles
Land Grant Surveys 2982 and 3280
Approximately Latitude 38° 45' north Longitude 90° 30' west, T. 46 N., R. 5 E.



Owner:
Lafarge Corporation
Construction Materials, Missouri Division
St. Charles Quarry
P. O. Box 40
St. Charles, MO 63302
636-946-0004
Kurt Lucas, Manager

The following description of rocks and their correlation for the south pit of Lafarge Corporation's St. Charles Quarry is adapted from Beste and Woody (1992, p. 6-9).

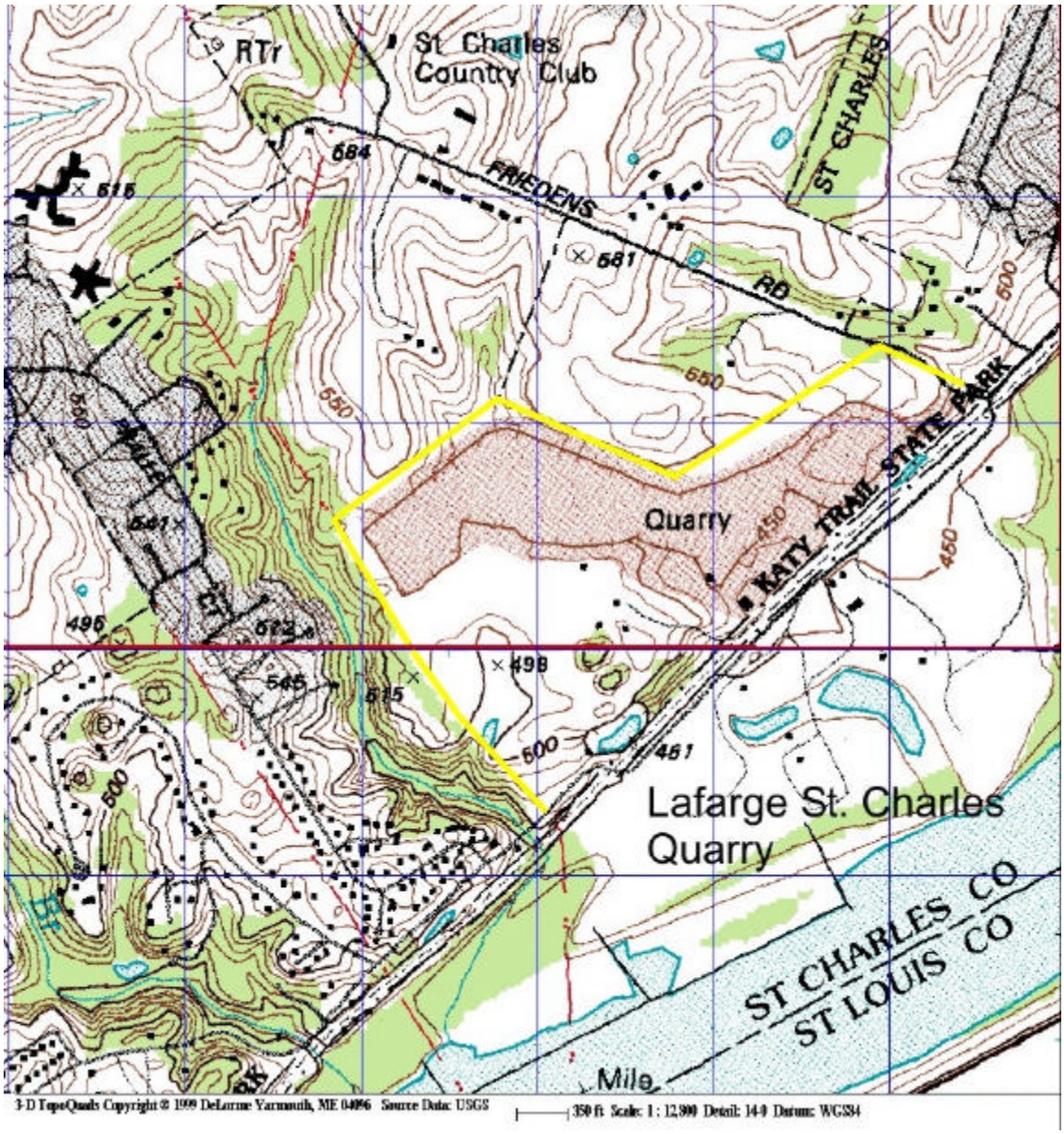
	Elevation	Thickness
Ledge 1		
MISSISSIPPIAN SYSTEM-MERAMECIAN SERIES		
St. Louis Limestone (82 ft 11 in)	493 ft 11 in	
22. Dolomitic limestone, tan, fine-grained, medium-bedded		15 ft
Ledge 2	478 ft 11 in	
21. Limestone, gray, very fine-grained, medium-bedded, top is irregular		7 ft
	471 ft 11 in	
20. Shale, brown, weathered		1 ft
Ledge 3	470 ft 11 in	
Limestone, light gray, medium-bedded, contains weathered brown shale seam		12 ft
Ledge 4	458 ft 11 in	
19. Limestone, dark gray to brownish-gray, very fine-grained, medium-bedded, top foot is highly absorptive, 6 feet to 6 feet 5 inches thick		6 ft 4 in
	452 ft 7 in	
18. Shale		1 in
Ledge 5	452 ft 6 in	
17. Limestone, light gray, fine-grained, medium-bedded, contains 4 to 6 inch shale beds 1 foot and 5 feet below top, 7 feet to 7 feet 6 inches thick		7 ft
Ledge 6	445 ft 6 in	
16. Limestone, dark gray, fine- to medium-grained, medium-bedded to massive, contains a 6 inch green shale bed in middle of interval, 4 feet 6 inches to 6 feet thick		6 ft
Ledge 7	439 ft 6 in	
15. Dolomitic limestone, tan, medium-grained, massive		5 ft
Ledge 8	434 ft 6 in	
14. Limestone, light gray, gradational lower contact		2 ft
	432 ft 6 in	
13. limestone, dark gray, coarse-grained, 4 to 4 feet 6 inches		4 ft
	428 ft 6 in	
12. Shale, black, estimated thickness		2 in
Ledge 9	428 ft 4 in	
11. Limestone, gray, thin-bedded		2 ft
	426 ft 4 in	
10. Limestone, contains a 3 foot thick zone of chert nodules with green shale at base, 2 feet to 5 feet thick		5 ft
	421 ft 4 in	
9. Limestone, medium-bedded grading downward into dolomite, dark gray, thin-bedded		3 ft
Ledge 10	418 ft 4 in	
8. Shale, dark green		6 in
	417 ft 10 in	
7. Limestone, dark gray, fine-grained, cherty, with large chert nodules, chert free in parts of the quarry, thickness varies from 4 feet 6 inches to 6 feet 10 inches		6 ft 10 in
Ledge 11		
Salem Formation (44 ft 2 in)	411 ft (estimated)	
6. Dolomitic limestone, light gray, medium- to coarse-grained, massive, contains dark chert nodules		3 ft 6 in
	407 ft 6 in	
5. Limestone, contains very large chert nodules		3 ft 6 in
	404 ft	
4. Shale, black, estimated thickness		2 in
Ledge 12	403 ft 10 in	
3. Dolomite, light gray grading downward to brownish-gray, medium-grained, cross-bedded, contains abundant chert, 6 feet to 9 feet thick		6 ft
Ledge 13	397 ft 10 in	
2. Dolomitic limestone, dark gray, coarse-grained, massive, contains considerable nodular chert		16 ft
Ledge 14	381 ft 10 in	
1. Dolomitic limestone, brownish gray, coarse-grained, thick-bedded to massive, contains chert		15 ft
	366 ft 10	
Total Thickness		127 ft 1 in

Lafarge Corporation quarries the Salem Formation and St. Louis Limestone (Mississippian System, Meramecian Series) at the south pit of St. Charles Quarry. The Salem Formation is a buff weathering, fine- to coarse-crystalline, commonly cross-bedded, fossiliferous limestone and dolomitic limestone, with interbedded shale and siltstone in the lower third of the formation. Chert nodules occur throughout, but are common near the top (Missouri Geological Survey, 1977, p. 103). The Salem's lower contact with the Warsaw is obscure due to similar lithologies shared by the two formations (Thompson, 1986, p. 110). Its upper contact with the St. Louis is placed at a thin shale bed above a distinctive "cannonball" or "bulls-eye" chert zone. The chert is present as concentrically banded, spherical nodules, 4 inches to 6 inches in diameter. When the shale bed is absent, the upper Salem contact is placed at the top of the chert zone (Thompson, 1986, p. 110). The St. Louis Limestone is a white to light gray, lithographic to finely-crystalline, medium-bedded to massive limestone. Limestone breccia in shale matrix commonly occurs in the lower part and may occur elsewhere in the formation. Thin, bluish-gray shale beds occur throughout the formation. Small, brown, angular chert fragments are occasionally found near the base of the St. Louis (Missouri Geological Survey, 1977, p. 103; Thompson, 1986, p. 115).

The Salem is separated into Ledges 11 through 14 at the south pit of St. Charles Quarry and is considered suitable for graded base rock (Beste and Woody, 1992, p. 8-10). The overlying St. Louis Limestone is a high-quality stone resource (Missouri Geological Survey, 1977, p. 95). The St. Louis is divided into Ledges 1 through 10. Ledges 2, 3, 4, 6, 8, 9, and 10 are suitable for aggregate used in portland cement concrete paving applications. Ledges 1, 5, and 7 of the St. Louis are used for graded base rock (Beste and Woody, 1992, p. 6-8).

Friday, September 28, 2001, Stop 3: City of St. Peters - Old North Pit, St. Charles Quarry

St. Charles County, Kampville 7.5 Minute Quadrangle
Land Grant Surveys 2982 and 3280
Approximately Latitude 38° 45' north Longitude 90° 30' west, T. 46 N., R. 5 E.
Friedens Road and South River Road



Owner:
Tom Brown, Mayor
City of St. Peters
City Hall
One St. Peters Centre Blvd.
St. Peters, MO 63376
636-477-6600
Bill Malach 636-477-6600 Ex. 301

The City of St. Peters purchased the old north pit of the St. Charles Quarry for a landfill site prior to 1990. Attempts to permit this site for a landfill have been inactive for about 10 years. The Salem and St. Louis were also quarried at this location. The old north pit is deeper than the south pit and exposes Ledges 17 through 20 of the Salem. Ledges 17, 19, and 20 are suitable for asphalt paving aggregate and Ledge 18 is suitable for graded base rock (Beste and Woody, 1992, p. 9-10).

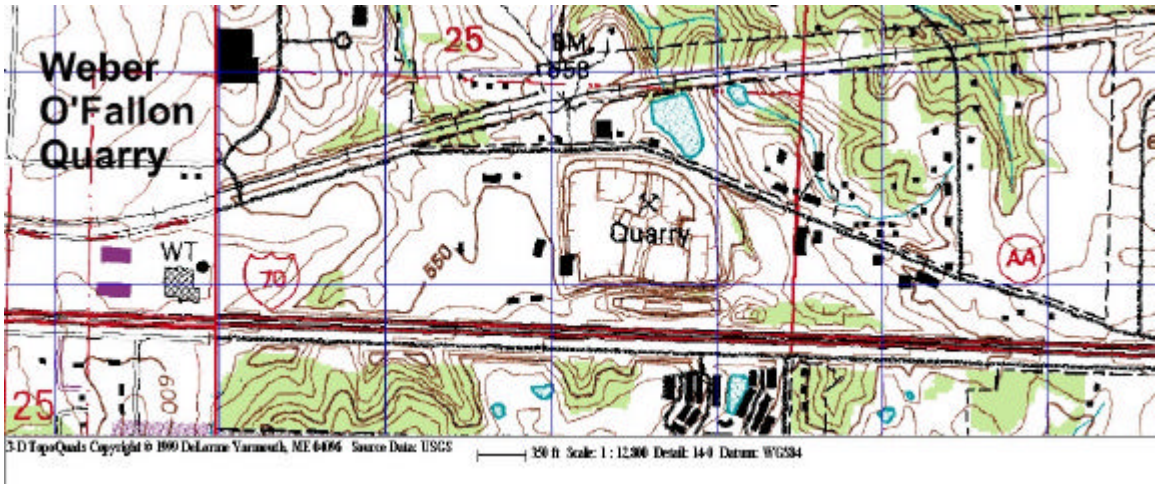
The following description and correlation of rocks exposed in the north pit of St. Charles Quarry is adapted from Beste and Woody (1992, p. 6-10).

Ledge 1		
MISSISSIPPIAN SYSTEM-MERAMECIAN SERIES	Elevation	Thickness
St. Louis Limestone (82 ft 11 in)	495 ft 5 in	
32. Dolomitic limestone, tan, fine-grained, medium-bedded		15 ft
Ledge 2	480 ft 5 in	
31. Limestone, gray, very fine-grained, medium-bedded, top is irregular		7 ft
	473 ft 5 in	
30. Shale, brown, weathered		1 ft
Ledge 3	472 ft 5 in	
29. Limestone, light gray, medium-bedded, contains a brown weathered shale seam		12 ft
Ledge 4	460 ft 5 in	
28. Limestone, dark gray to brownish-gray, very fine-grained, medium-bedded, upper foot is highly absorptive, 6 feet to 6 feet 5 inches thick		6 ft 4 in
	454 ft 1 in	
27. Shale		1 in
Ledge 5	454 ft	
26. Limestone, light gray, fine-grained, medium-bedded, contains 4 to 6 inch shale beds 1 foot and 5 feet below top, 7 to 7 ft 6 in thick		7 ft
Ledge 6	447 ft	
25. Limestone, dark gray, fine- to medium-grained, medium-bedded to massive, contains a 6 inch green shale bed near center of interval, 4 feet 6 inches to 6 feet thick		6 ft
Ledge 7	441 ft	
24. Dolomitic limestone, tan, medium-grained, massive		5 ft
Ledge 8	436 ft	
23. Limestone, light gray, gradational lower contact		2 ft
	434 ft	
22. Limestone, dark gray, coarse-grained, 4 feet to 4 feet 6 inches		4 ft
	430 ft	
21. Shale, black, estimated thickness		3 in
Ledge 9	429 ft 9 in	
20. Limestone, gray, thin-bedded		2 ft
	427 ft 9 in	
19. Limestone, contains chert nodules with green shale at base		3 ft
	424 ft 9 in	
18. Limestone, medium-bedded grading downward into dark gray, thin-bedded, dolomite		5 ft
Ledge 10	419 ft 9 in	
17. Shale, dark green		6 in
	419 ft 3 in	
16. Limestone, dark gray, fine-grained, cherty, with large chert nodules, can be chert free, thickness varies from 4 feet 6 inches to 6 feet 10 inches		6 ft 10 in
Ledge 11		
Salem Formation (88 ft 2 in)	412 ft 5 in	
15. Dolomitic limestone, light gray, medium- to coarse-grained, massive, contains dark chert nodules		3 ft 6 in
	408 ft 11 in	
14. Limestone, contains very large chert nodules		3 ft 6 in
	405 ft 5 in	
13. Shale, black, estimated thickness		2 in
Ledge 12	405 ft 3 in	
12. Dolomite, light gray grading downward to brownish-gray, medium-grained, cross-bedded with abundant chert, 6 feet to 9 feet thick		6 ft
Ledge 13	399 ft 3 in	
11. Dolomitic limestone, dark gray, coarse-grained, massive, contains considerable nodular chert		16 ft
	383 ft 3in	

Ledge 16	383 ft 3in	
10. Limestone, dull buff to light gray, fine-grained, interval contains several undulating bedding planes, thin black shale beds, and intermittent chert bands and nodules, bottom contact is distinct, 13 feet 6 inches to 15 feet thick		15 ft
Ledge 17	368 ft 3 in	
9. Limestone, dark gray, fine- to medium-grained, irregular fracture, contains several chert nodules, 2 inches to 2 feet thick		2 ft
	366 ft 3 in	
8. Limestone, dull gray, fine-grained, laminated		2 ft
	364 ft 3 in	
7. Limestone, dark gray, sublithographic, laminated		1 ft
	363 ft 3 in	
6. Limestone, dull gray, fine-grained to sublithographic, laminated, contains intermittent band of calcite crystals 3 feet 6 inches above the base, 4 feet to 6 feet thick		6 ft
Bench, Ledge 18	357 ft 3 in	
5. Limestone, light gray, medium-grained to sublithographic, laminated, irregular fracture		5 ft 6 in
	351 ft 9 in	
4. Shale, black, 6 inches to 1 foot thick		6 in
Ledge 19	351 ft 3 in	
3. Limestone, light gray, laminated in upper 4 to 5 feet grading downward into dark gray, coarsely-crystalline, limestone, contains intermittent white chert band 3 feet to 5 feet below top		8 ft
Ledge 20	343 ft 3 in	
2. Dolomitic limestone, dark gray, medium-bedded to massive, cross-bedded, irregular top		8 ft 3 in
Quarry floor	335 ft (estimated)	
1. Shale, estimated thickness		3 in
Total Thickness		160 ft 8 in

Friday, September 28, 2001, Stop 4: Fred Weber, Incorporated - O'Fallon Quarry

St. Charles County, O'Fallon 7.5 Minute Quadrangle
NE ¼, Sec.25, T. 47 N., R. 2 E.
Fred Weber, Incorporated, O'Fallon Quarry
2 miles west of I-70 exit M and K on Highway AA (north outer road)



Owner:
Fred Weber, Incorporated
Materials Division,
O'Fallon Quarry
1440 Terra Lane West
O'Fallon, MO 63366
Daryl Fehr, Plant Superintendent 636-272-6271
Douglas K. Weible, President, 314-344-0070, 314-344-0980

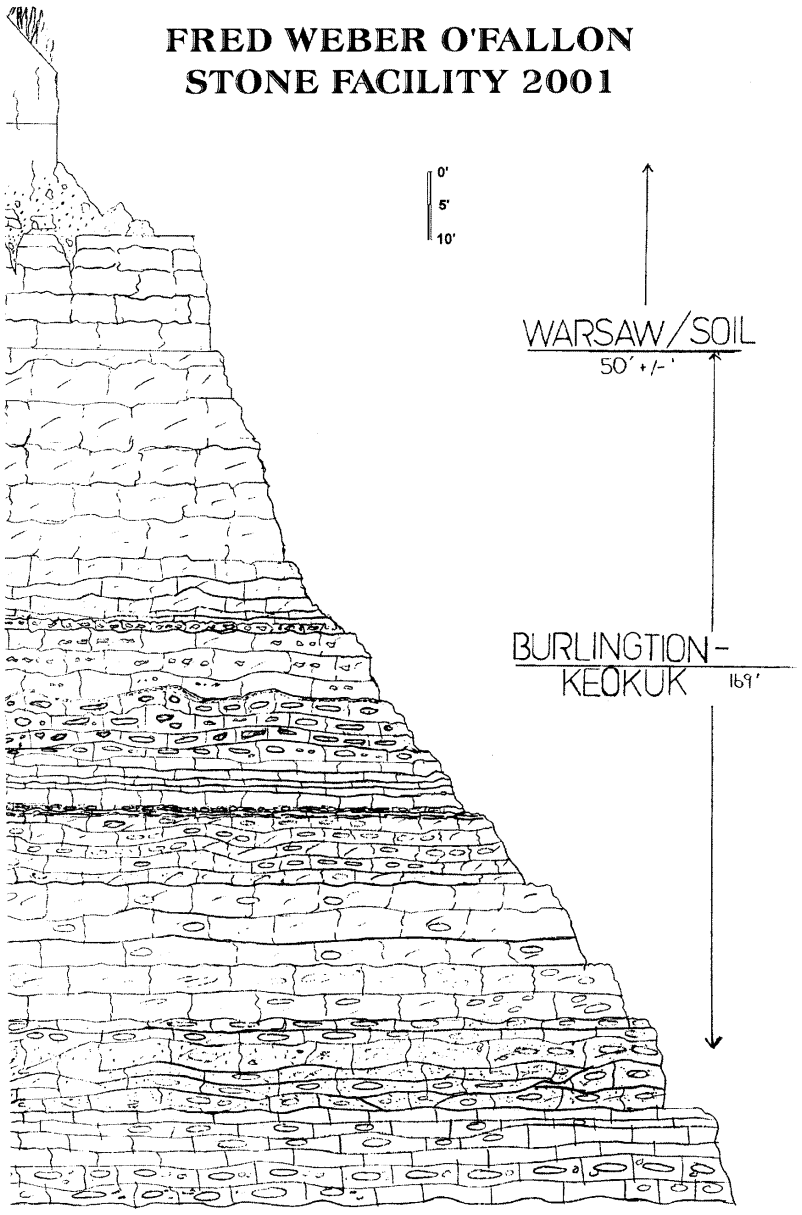
Operations at the O'Fallon Quarry have exposed the Mississippian-aged Chouteau Group, Fern Glen Formation, Burlington-Keokuk Limestone, and the lower part of the Warsaw Formation. The Chouteau Group (Kinderhookian Series) exposed in St. Charles County is typically a gray to yellowish-brown, fine-grained, thin- to medium-bedded with occasional wavy-bedded or nodular appearance, fossiliferous dolomitic limestone, dolomite, or limestone that contains abundant thin black shale partings and commonly contains calcite-filled geodes (Missouri Geological Survey, 1977, p. 99; Thompson, 1986, p. 62). The Chouteau is used for riprap in construction aggregates (Missouri Geological Survey, 1977, p. 99). The lower part of the Fern Glen Formation (Osagean Series) is a yellowish brown, fine-grained, thin- to medium-bedded, very fossiliferous, crinoidal limestone. The upper part is yellowish-brown, fine-grained, medium-bedded to massive, cherty, crinoidal limestone or occasionally a dolomitic limestone (Missouri Geological Survey, 1977, p. 99). The Fern Glen is also used for riprap (Missouri Geological Survey, 1977, p. 99, 102). The Burlington-Keokuk Limestones (Osagean Series) are usually white to bluish-gray, medium- to coarsely-crystalline, thickly-bedded limestone. Typically, the basal 25 to 30 feet contains 5 to 15% chert, the middle 100 feet averages 30%, and the upper 75 feet varies from 30 to 70%. These limestones produce a high-quality stone used for asphaltic concrete, bituminous surfacing, graded base and surface stone when chert content is low (Missouri Geological Survey, 1977, p. 102). The lower part of the Warsaw Formation (Meramecian Series) is a fine- to medium-grained, shaly, somewhat cherty limestone or occasionally dolomitic limestone (Missouri Geological Survey, 1977, p. 102-103). The lower Warsaw is used for asphaltic concrete, bituminous surfacing, base and surface stone, riprap, and aglime. Occasionally a Warsaw ledge may meet specifications for aggregate for use in portland concrete construction paving (Missouri Geological Survey, 1977, p. 103).

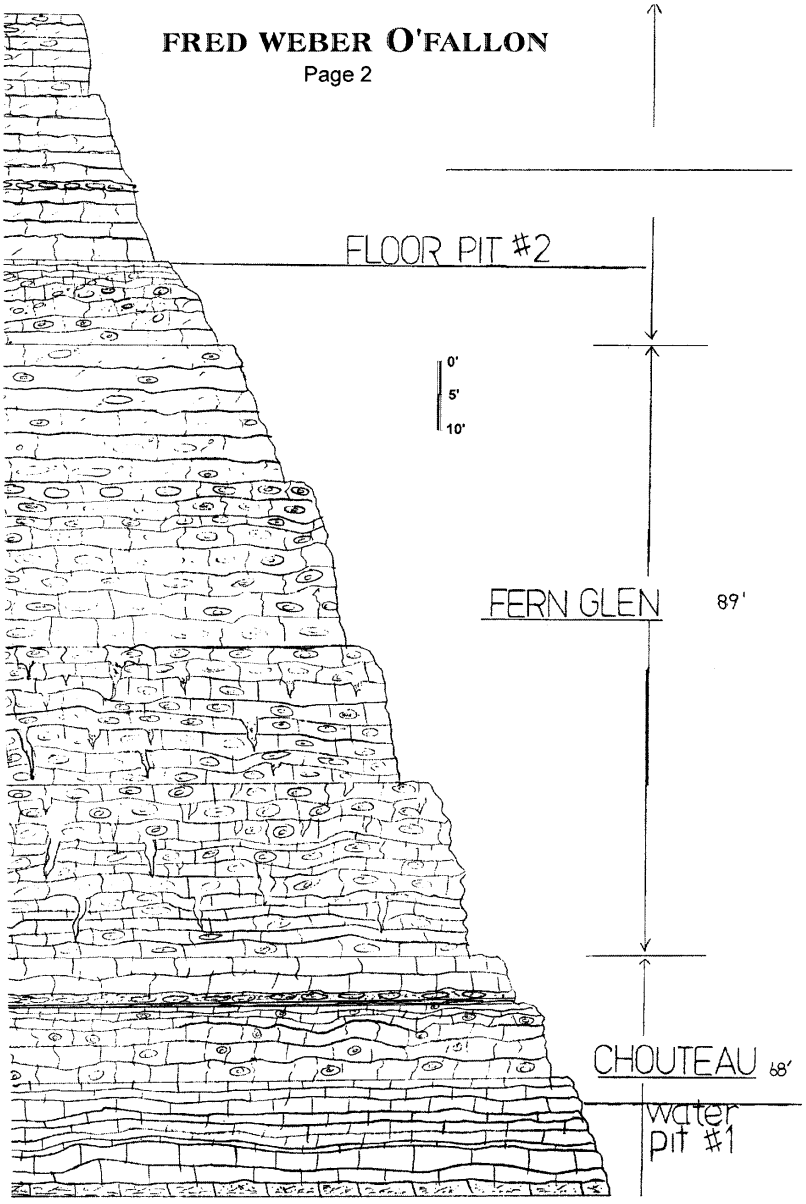
The following stratigraphic section of rocks exposed at the O'Fallon Quarry is adapted from Martin and Wells (1966, p. 23) and Rueff and Hayes, (1991, p. 19-21, 91-97).

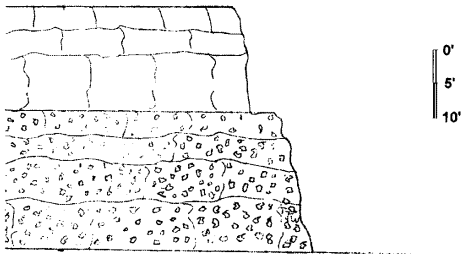
	Elevation	Thickness
QUATERNARY SYSTEM-PLEISTOCENE SERIES		
Wisconsin Loess	590 ft (estimated)	
32. Silt, yellowish-brown to reddish-brown		10 ft
Sangamon(?) Soil	580 ft	
31. Clay, red, blocky, partly developed on shale, 1foot to 4 feet thick		2 ft
MISSISSIPPIAN SYSTEM, MERAMECIAN SERIES		
Warsaw Formation (17 ft)	578 ft	
30. Limestone, gray, slightly dolomitic in part, medium-grained calcarenite, thin- to medium-bedded, contains calcareous shale partings and laminae, fossiliferous, primarily bryozoa and crinoids, contains blue and gray fossiliferous chert nodules and lenses which include abundant bryozoa		17 ft
OSAGEAN SERIES		
Burlington-Keokuk Limestone (169 ft)	561 ft	
29. Limestone, light gray, medium- to fine-grained calcarenite, crinoidal becoming coarsely crinoidal in upper 2 feet, massive, chert nodules speckled blue and white with dark gray and brown mottles		3 ft
	558 ft	
28. Limestone, brown, fine-grained, thin- to medium-bedded, contains up to 65% chert nodules, white to gray, porous to nonporous		8 ft
	550 ft	
27. Limestone, brown, fine-grained, thin-bedded, very cherty, chert is light gray with distinct brownish cast, porous and nonporous		5 ft
	545 ft	
26. Limestone, brown, becoming gray at base, fine- to medium-grained, abundant calcite vugs occur at base, very cherty, massive bed of gray, nonporous chert occurs from 3 feet 6 inches to 5 feet above base, porous chert bed occurs from 5 feet to 8 feet above base, chert content estimated to be 45%		10 ft
	535 ft	
25. Limestone, very cherty		5 ft
	530 ft	
24. Limestone, dark gray to medium gray with brown tint, fine-grained, thin- to medium-bedded, highly fractured, massive chert beds occur near top of interval, chert is light gray, with grayish-brown specks and represents 30% of interval		7 ft
	523 ft	
23. Limestone, gray, medium-grained, thin- to medium-bedded, chert comprises 15 to 20% of interval, a 2 inch thick stylolite zone occurs 8 feet above base		11 ft 6 in
	511 ft 6 in	
22. Limestone, gray with brownish tint, fine-grained, medium- to thick-bedded, well-jointed, stylolite zones occur 4 inches, 8 feet, and 8 feet 6 inches above base, a gray, porous, chert-rich zone occurs from 7 feet to 10 feet above the base, chert content of interval varies from 1 to 25%		11 ft 6 in
	500 ft	
21. Limestone, medium gray with brown tint, fine-grained, thick-bedded to massive, interval contains about 10% chert		5 ft
	495 ft	
20. No record		9 ft 7 in
Top of core hole no 1	485 ft 5 in	
19. Limestone, light gray, finely-crystalline, sucrosic, very cherty, chert mostly "dead" to bleached white, stylolitic, interval has porous, leached appearance		10 ft
	475 ft 5 in	
18. Limestone, light gray, finely-crystalline, sucrosic, very cherty, chert mostly "dead" to bleached white, stylolitic, interval has porous, leached appearance		11 ft
	464 ft 5 in	
17. Limestone, light bluish gray, fine- to medium-crystalline, large calcite-replaced crinoid fragments and calcite crystals common, stylolitic, chert mostly bleached white		12 ft 7 in
	451 ft 10 in	
16. Limestone, light bluish-gray, fine- to medium-crystalline, large calcite-replaced crinoid fragments and calcite crystals common, stylolitic, chert mostly bleached white		13 ft 2 in
	438 ft 8 in	

	438 ft 8 in	
15. Limestone, light gray, fine- to medium-crystalline, cherty, most chert tripolitic, interval has porous, leached appearance		10 ft 6 in
	428 ft 2 in	
14. Limestone, light gray, fine- to medium-crystalline, interval contains minor chert, interval has porous, leached appearance		9 ft 2 in
	419 ft	
13. Limestone, light gray, fine- to medium-crystalline, interval contains minor chert, interval has porous, leached appearance		9 ft 6 in
	409 ft 6 in	
12. Limestone, light gray, fine- to medium-crystalline, interval contains minor chert, interval has porous, leached appearance		6 ft 6 in
Floor of Pit No. 2	403 ft	
11. Limestone, light gray, fine- to medium-crystalline, interval contains minor chert, interval has porous, leached appearance		3 ft
	400 ft	
10. Limestone, light gray, fine- to medium-crystalline, interval contains minor chert, interval has porous, leached appearance		8 ft
Fern Glen Formation (89 ft)	392 ft	
9. Limestone, light greenish-gray, finely crystalline, interval contains some calcite-filled vugs, interval is very cherty, with chert mostly bleached white and tripolitic, contains small amplitude stylolites filled with green clay, estimated thickness		24 ft 10 in
	367 ft 2 in	
8. Limestone, light greenish-brown, finely-crystalline, large calcite crystals and fossil fragments are common, interval contains some gray, mottled chert, but much less than above unit, estimated thickness		20 ft 4 in
	346 ft 10 in	
7. Limestone, light brown, fine-grained, interval contains some gray chert, estimated thickness		7 ft 10 in
	339 ft	
6. Limestone, light gray, fine-grained, interval contains numerous large calcite crystals and fossil fragments, stylolites are present, estimated thickness		25 ft 6 in
	313 ft 6 in	
5. Limestone, light gray, fine-grained, interval contains occasional calcite-filled vug, especially near middle of unit, fossil fragments and stylolites are present, estimated thickness		10 ft 6 in
KINDERHOOKIAN SERIES		
Chouteau Group (68 ft)	303 ft	
4. Dolomite, medium gray, fine-grained, calcareous, calcite-filled vugs common, contains very thin shale partings, several small stylolites, and some chert nodules, estimated thickness		10 ft 10 in
	292 ft 2 in	
3. Dolomite, medium gray, fine-grained, large calcite-filled vug near top, contains some “graphic” mottling, thicker shale partings than above, several small stylolites, and some chert nodules		11 ft 6 in
Approximate top of water in Pit No. 1	280 ft 8 in	
2. Dolomite, medium gray, fine-grained, large calcite-filled vug near top, contains some “graphic” mottling, thicker shale partings than above, several small stylolites, and some chert nodules		21 ft 6 in
	259 ft 2 in	
1. Dolomite, medium gray, rock has speckled “dominicker” appearance, fine-grained, calcareous with large floating calcite crystals and calcite-filled fossil fragments common, shale partings become more numerous than above, occurring every few inches		24 ft 2 in
Approximate base of Pit No. 1	235 ft	
Total Thickness		355 ft

The following illustration of rock units at the O'Fallon Quarry was provided by Douglas K. Weible.

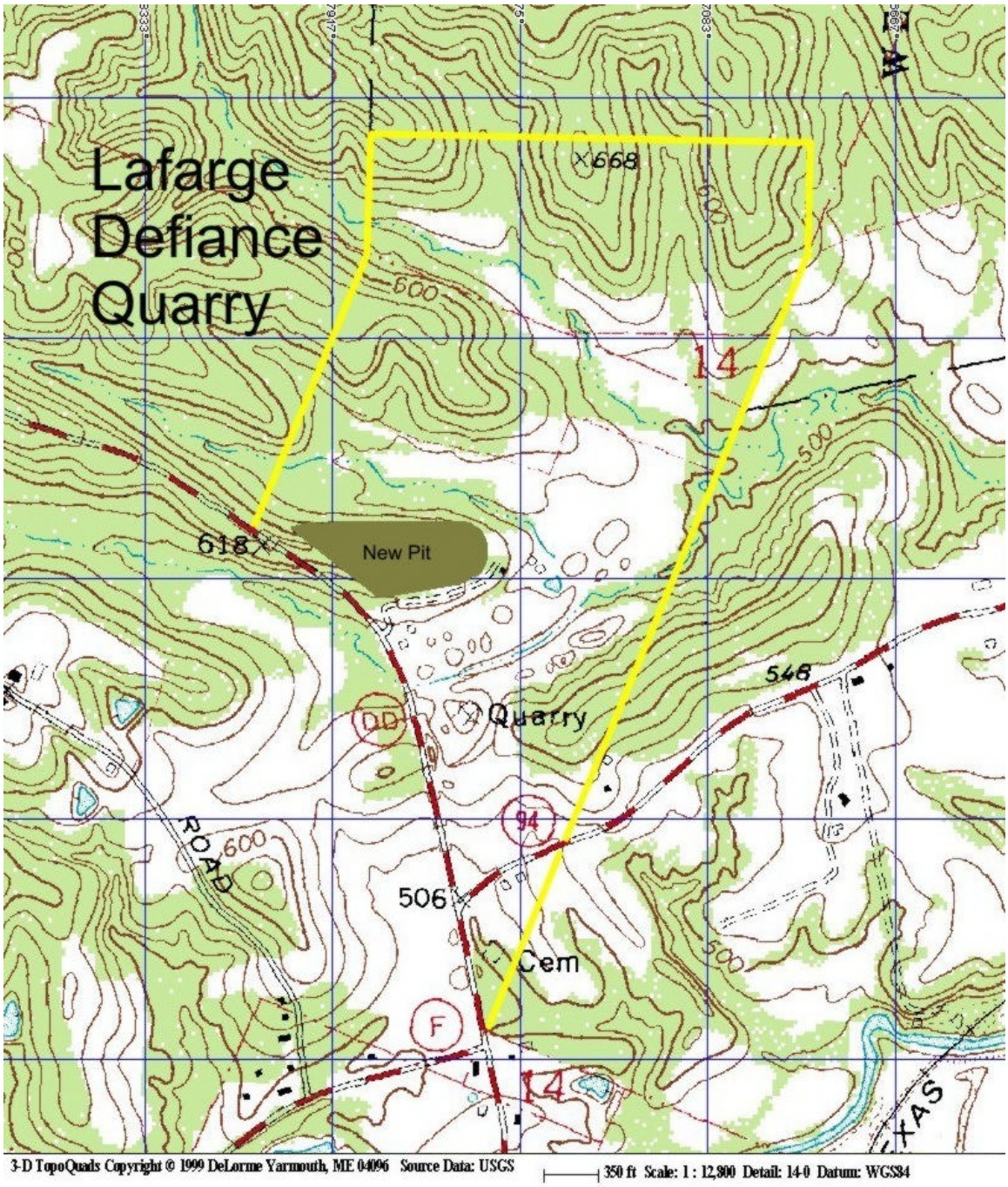



FLOOR PIT #2
0'
5'
10'
FERN GLEN
89'
CHOUTEAU
68'
water
pit #1


0'
5'
10'

Saturday, September 29, 2001, Stop 1: Lafarge Corporation – Defiance Quarry

St. Charles County
Defiance 7.5 Minute Quadrangle
Land Grant Survey 937; T. 45 N., R. 2 E.



Owner:
Lafarge Corporation
Construction and Materials Division
Defiance Quarry No. 2
P. O. Box 68
Defiance, MO 63341
636-798-2505
Kurt Lucas, Plant Manager

The original pit of the Defiance Quarry, located just north of the Highway 94 and Highway DD intersection, exposed about 295 feet of rock upward from the Joachim Dolomite (Ordovician System, Mohawkian Series) to the Fern Glen Limestone (Mississippian System, Osagean Series) which occurs beneath unconsolidated materials. Rock in the original pit included 17.8 ft. of Joachim Dolomite, 111.3 ft. of Plattin Group limestone; 27 ft. of Decorah Group, a maximum of 81 ft. of Kimmswick Limestone; 9 to 45 ft. of the Sulphur Springs Group; 1 ft. of Bachelor Sandstone, a maximum 17.8 ft. of undifferentiated Chouteau Group; and a maximum of 32 ft. of the Fern Glen Formation. Overburden in the original pit varied from 8 to 35 feet thick and was composed primarily of residuum, silty clay loam, silt loam, and sandy loam (Beste, 1994, p. 1). About 1993, a new pit was opened north of the original pit. Quarrying has been carried down to the level of old ledge 15, now designated ledge 14.

The Macy Limestone (Plattin Group, Mohawkian Series, Ordovician System) is composed of the lower Hook Member and upper Zell Member. The Hook is characterized by finely-crystalline fuccoidal limestone separated by irregular dolomitic limestone partings. The Zell is a finely-crystalline, slabby, limestone with green shale partings (Thompson, 1991, p. 166). The Plattin Group contains high-quality limestone suitable for many construction and industrial uses. The Plattin is a moderate-quality chemical and a high-quality physical property stone resource used for portland cement concrete aggregate, asphaltic concrete aggregate, bituminous surfacing, base and surfacing stone, riprap, and aglime (Missouri Geological Survey, 1971, p. 99). At Defiance Quarry, the Plattin produces aggregate for commercial concrete and portland cement concrete paving (Beste, 1994, p. 12).

The Decorah Group (Mohawkian Series, Ordovician System) unconformably overlies the Plattin Group. It consists of brown, green, and gray shale and clay at the base, is overlain by interbedded thin limestone and green to brown shale in the lower part, and contains thin- to medium-bedded limestone with thin fossiliferous shale partings at the top (Thompson, 1991, p. 179-180). The Decorah is divided into the lower Spechts Ferry Formation and upper Kings Lake Limestone.

The Spechts Ferry Formation is separated into a lower Castlewood Member and upper Glencoe Member. The Castlewood Limestone Member consists of a persistent lower bed of dark brown shale one-half inch or less thick overlain by an inch or two of green shale. The Deicke K–bentonite Bed is a light gray, plastic clay 2 to 5 inches thick that occurs either in the green shale or on top of the basal brown shale. A gray, very fine-grained, dense, medium-bedded to massive with incipient wavy to nodular bedding, slightly argillaceous limestone about 3 feet thick is present above the basal shale (Thompson, 1991, p. 187). The overlying Glencoe Shale Member contains green, gray, or brown shale interbedded with thin beds of fine-grained limestone, coquina, or calcarenite, usually 1 to 2 feet thick. The Millbrig K-bentonite Bed, the most persistent Ordovician bentonite bed in the Mississippi Valley, occurs within these strata as a light gray, possibly orange stained, plastic clay 2 to 4 inches thick. A persistent bed of limestone is present above the bentonite, separated in places by 2 to 6 inches of gray or green shale. The upper limestone is brown, occasionally gray, fine-grained, argillaceous, fossiliferous, and usually 1 to 2 feet thick (Thompson, 1991, p. 187-190). The Castlewood limestone is suitable as aggregate for portland concrete construction paving, while limestone within the Glencoe is used for graded base rock (Beste, 1994, p. 12).

The Kings Lake Limestone is a dark gray, finely-crystalline to coquinoidal, silty and dolomitic, fossiliferous limestone interbedded with thin red shale partings. The Kings Lake is separated into the lower Mincke, which is more silty and argillaceous, and upper Tyson Members (Thompson, 1991, p. 190-191). Ledges 10 and 11 at Defiance, correlated with the Mincke, are suitable for aggregate in portland cement concrete masonry. Ledge 9, correlated with the Tyson, is used as aggregate in commercial concrete (Beste, 1994, p. 11-12).

The Kimmswick Limestone (Mohawkian Series, Ordovician System) disconformably overlies the Tyson Member, Kings Lake Limestone. The Kimmswick is white to light gray, coarsely-crystalline, medium-bedded to massive limestone. Its distinctive weathered surface has a pitted or honeycombed appearance. Chert is rare but may occur in the lower or upper parts of the formation (Missouri Geological Survey, 1971, p. 99; Thompson, 1991, p. 190-191, 206). The House Springs K-bentonite Bed occurs about 3 feet 3 inches above the base of the Kimmswick (Thompson, 1991, p. 211). The Kimmswick Limestone is a high-quality stone suitable for most chemical and industrial uses. It is the highest-quality chemical stone resource available in St. Charles County and is also a high-quality stone resource from the perspective of its physical properties. Locally, it is used for portland cement and asphaltic concrete aggregate, bituminous surfacing, base and surface stone, riprap, and aglime. It was formerly used for lime manufacture, and is used for cement manufacture and marble production in other parts of the state (Missouri Geological Survey, 1971, p. 99). At Defiance, the Kimmswick is used for aggregate in portland cement concrete paving (Beste, 1994, p. 9-11).

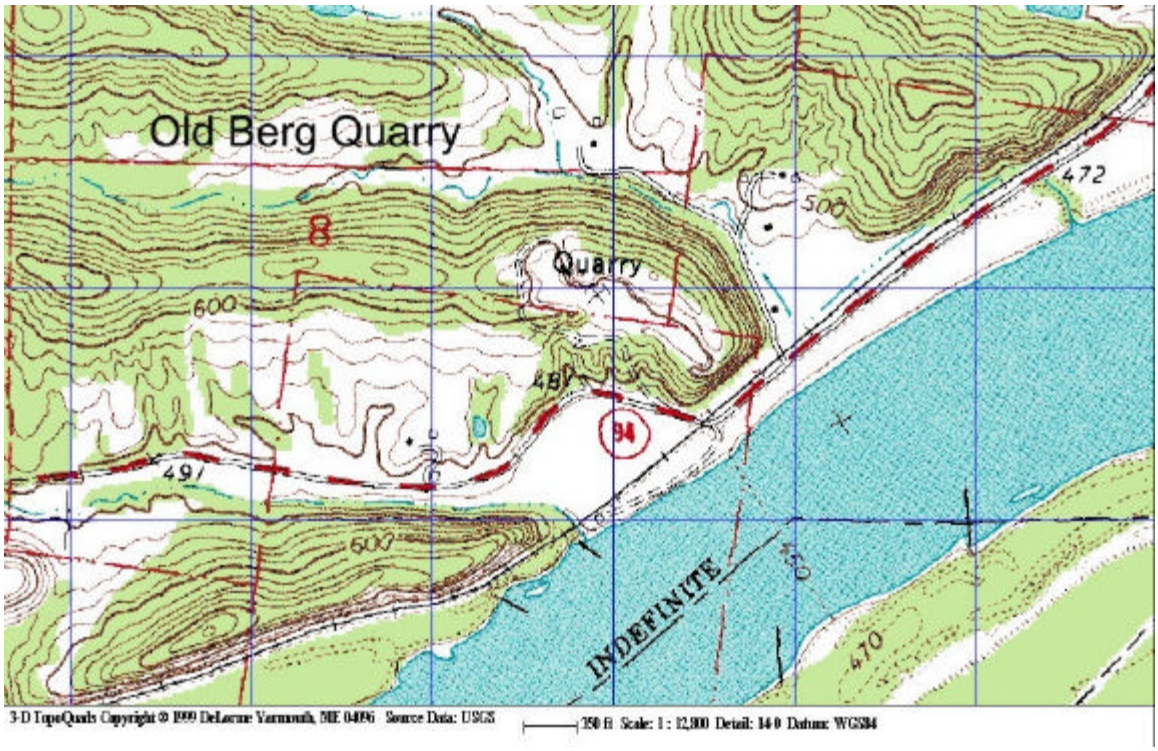
The Bushburg Sandstone (Kinderhookian Series, Mississippian System) covers a major erosional unconformity developed at the top of the Kimmswick. The Bushburg is a yellowish-brown, fine- to coarse-grained, friable, porous, quartz sandstone that is generally present in a single massive bed (Thompson, 1986, p. 26). The Chouteau Group and Fern Glen Formation overlie the Bushburg. Their lithologic and stratigraphic relationships are discussed on page 11. Although Chouteau Group limestone beds are not considered a high-quality stone resource, they produce commercially important quantities of construction aggregates and riprap in St. Charles County (Missouri Geological Survey, 1971, p. 95, 99). At Defiance Quarry, Chouteau ledges 2 and 3 are suitable for graded base rock (Bests, 1994, p. 9). Stone produced from the Fern Glen Formation is commonly used as riprap (Missouri Geological Survey, 1971, p. 102). At Defiance, ledges 1a and 1b are in the Fern Glen. Ledge 1a is suitable for graded base, ledge 1b is suitable for commercial stone.

The following description and correlation of rocks exposed in the new pit at Defiance Quarry is adapted from Beste (1994, p. 9-14).

Ledge 1a		
MISSISSIPPIAN SYSTEM-OSAGEAN SERIES	Elevation	Thickness
Fern Glen Formation (29 ft)	608 ft	
20. Dolomitic limestone, buff to yellow, contains 30 to 40 percent chert, 10 to 16 feet thick		13 ft
Ledge 1b		
Meppen Limestone Member (16 ft)	595 ft	
19. Limestone, pinkish-orange to greenish-gray, coarse-grained, medium-bedded, 13 feet to 16 feet thick		16 ft
Ledge 2		
KINDERHOOKIAN SERIES		
Chouteau Group, undifferentiated (18 ft)	579 ft	
18. Dolomitic limestone, gray to brown, medium -grained, medium-bedded		9 ft 10 in
	569 ft 2 in	
17. Shale, black		2 in
Ledge 3	569 ft	
16. Limestone, dark gray, medium-grained, massive		8 ft
Bushberg Sandstone (10 ft)	561 ft	
15. Sandstone, reddish-brown, quartz grains, friable, may be cemented by iron oxide, goethite concretions may be present, 5 feet to 42 feet thick		10 ft
unconformity		
Ledge 4		
ORDOVICIAN SYSTEM-MOHAWKIAN SERIES		
Kimmswick Limestone (71 ft)	551 ft	
14. Limestone, gray, fine- to medium-crystalline, Crinoid & Receptaculites fossils, contains chert band about 4 feet above base, 0 to 20 feet thick		10 ft
Ledge 5	541 ft	
13. Limestone, light gray, coarse-crystalline, chert occurs as white irregular pods and stringers, 1inch band of chert nodules near bottom contained in a 2 foot zone of sparse chert		7 ft
Ledge 6	534 ft	
12. Limestone, light gray, coarse-crystalline		21 ft
Ledge 7	513 ft	
11. Limestone, light gray, coarse-crystalline, with chert nodules in zone 2 feet to 3 feet 6 inches and 16 feet below the top, 25 feet to 27 feet thick		27 ft
Ledge 8	486 ft	
10. Limestone, gray to tan, fine- to medium-bedded, contains large chert nodules at top, interval contains House Springs K-bentonite Bed		5 ft
	481 ft	
9. Shale, black, pyritic, interbedded with fossiliferous, lithographic limestone		1 ft
disconformity		
Ledge 9		
Decorah Group		
Kings Lake Limestone (17 ft 6 in)		
Tyson Member (6 ft 6 in)	480 ft	
8. Limestone, dark gray, medium-grained, grading downward into shaly limestone, 6 to 7 feet thick		6 ft 6 in
Ledge 10		
Mincke Limestone Member (11 ft)	473 ft 6 in	
7. Limestone, dark gray, thin-bedded, shaly with thin shale seams, 4 feet 6 inches to 5 feet thick		5 ft
Ledge 11	468 ft 6 in	
6. Limestone, dark gray, thin-bedded, shaly with thin shale seams, 5 feet to 6 feet thick		6 ft
Ledge 12		
Spechts Ferry Formation (11 ft 6 in)		
Glencoe Shale Member (5 ft 6 in)	462 ft 6 in	
5. Shale, olive-green to gray, with beds of crystalline limestone, contains Millbrig K-bentonite Bed		5 ft 6 in
Ledge 13		
Castlewood Limestone Member (6 ft)	457 ft	
4. Limestone, tan, with some chert		5 ft 6 in
	451 ft 6 in	
3. Clay shale, gray to green, contains Deicke K-Bentonite Bed		6 in
Ledge 14		
PLATTIN GROUP (34 ft +)		
Macy Limestone (34 ft +)	451 ft	
2. limestone, light gray to brownish-gray, fine-grained, thick-bedded, chert free		22 ft
Ledge 15	429 ft	
1. Limestone, light gray, medium-grained, massive, vuggy, with several thin beds of chert		12 ft
	417 ft	
Total Thickness		191 ft

Saturday, September 29, 2001, Stop 2: Kassabaum Development - Berg Quarry

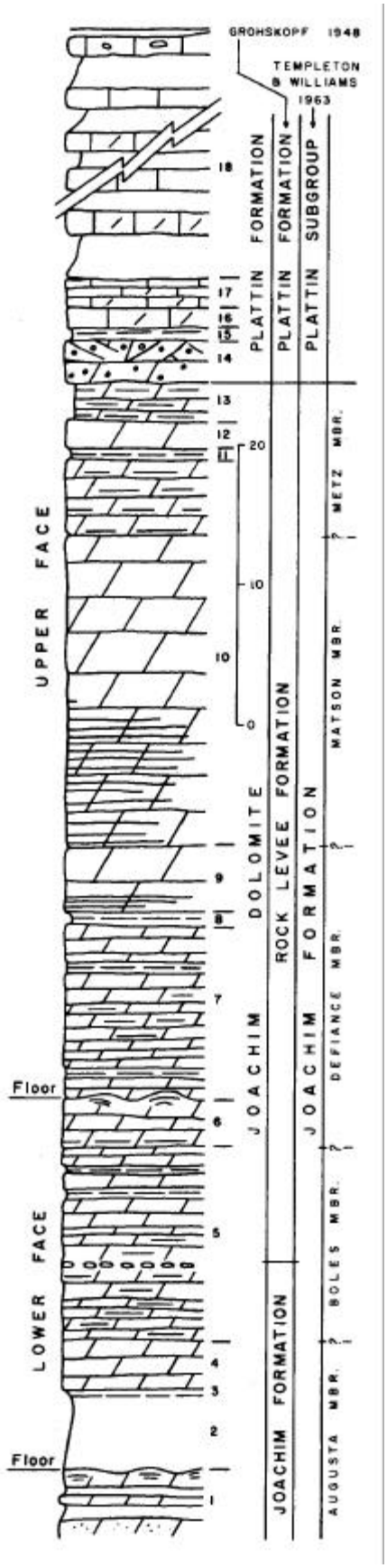
St. Charles County, Labadie 7.5 Minute Quadrangle
N ½, NE ¼, Sec. 8, T. 44 N., R. 2 E. and Land Grant Surveys and 384 and 1246
3 ½ miles east of Augusta on Missouri Highway 94



Owner
Douglas G. Kassabaum, Architect
Kassabaum Development
231 Papan Ave.
St. Louis, MO 63119
314-644-6456
Joe Dupree 636-482-4820

The following measured stratigraphic section is adapted from Martin and Wells (1966, stop 7, p. 33) and Thompson (1991, fig. 51, p. 85). The Martin and Wells (1966, stop 7, p. 33) graphic section is presented on page 23.

	Elevation	Thickness
ORDOVICIAN SYSTEM-MOHAWKIAN SERIES		
PLATTIN GROUP (27 ft 6 in)		
Beckett Limestone (23 ft 6 in)	664 ft 6 in	
19. Alternating ledges of limestone and clay; limestone and dolomitic limestone, gray, mottled grayish-brown and pink, finely-crystalline, dense, contains chert in some beds		20 ft
	644 ft 6 in	
18. Dolomite, brown, thinly-bedded, a 3 inch discontinuous, fine-grained, calcareous sandstone occurs at base		2 ft
	642 ft 6 in	
17. Limestone, dolomitic in part, gray to yellow-brown, fine- to medium-crystalline		1 ft 6 in
Bloomsdale Limestone (4 ft)		
Establishment Shale Member (1 ft)	641 ft	
16. Shale, forms reentrant		1 ft
Brickeys Member (3 ft)	640 ft	
15. Dolomite and dolomitic limestone, yellowish-brown, massive, oolitic, faintly cross-bedded in upper 2 feet		3 ft
Base of PLATTIN GROUP		
Joachim Dolomite (81ft)		
Metz Member (9 ft 6 in)	637 ft	
14. Dolomite, yellowish-brown, argillaceous, thin, shaly bedding, forms reentrant		2 ft
	635 ft	
13. Dolomite, yellowish-brown, massive		2 ft
	633 ft	
12. Shale, green		6 in
	632 ft 6 in	
11. Dolomite, yellowish-brown, finely-crystalline, medium-bedded with shale partings, contains minute vugs		5 ft
Matson Member (23 ft)	627 ft 6 in	
10. Dolomite, yellowish-brown to grayish-brown, finely crystalline, medium-bedded to massive, laminated in lower 7 feet 3 inches, fetid odor, contains minute vugs (pinpoint porosity)		23 ft
Defiance Member (20 ft 6 in)	604 ft 6 in	
9. Dolomite, gray with bluish gray mottling, finely crystalline to dense, massive, thinly laminated in lower part		4 ft 6 in
	600 ft	
8. Shale, green		6 in
	599 ft 6 in	
7. Dolomite, gray, finely-crystalline, argillaceous, thin- to medium-bedded, blocky, interbedded green and tan shale partings 2 to 6 inches thick		12 ft
UPPER QUARRY FLOOR (preserved on the west side of the quarry)	587 ft 6 in	
6. Dolomite, gray, weathers yellowish-brown, finely-crystalline, argillaceous, medium-bedded, contains occasional tan shale partings, breccia occurs at base, hemispheroidal algae (stromatolitic) occur at top of unit		3 ft 6 in
Boles Member (14 ft)	584 ft	
5. Dolomite, gray to reddish-brown, fine- to very fine-crystalline, argillaceous, thin- to medium-bedded, interbedded with green and gray shale and reddish-brown shale laminae, wavy surfaces, a 1 inch thick chert band occurs 5 feet 6 inches above base		14 ft
Augusta Member (14 ft)	570 ft	
4. Dolomite, gray, mottled dark gray, finely-crystalline, medium-bedded		3 ft 6 in
	566 ft 6 in	
3. Shale, green		6 in
	566 ft	
2. Covered interval		6 ft
LOWER QUARRY FLOOR	560 ft	
1. Dolomite, grayish-brown to yellowish-brown, finely-crystalline, contains quartz sand grains and interbedded calcareous sandstone, hemispheroidal alga occurs at top		4 ft
	556 ft	
Total Thickness		108 ft 6 in


GROHSKOPF 1948
TEMPLETON & WILLIAMS 1963
PLATTIN FORMATION
PLATTIN FORMATION
PLATTIN SUBGROUP
UPPER FACE
LOWER FACE
Floor
Floor
JOACHIM DOLOMITE
ROCK LEVEE FORMATION
JOACHIM FORMATION
JOACHIM FORMATION
AUGUSTA MBR.
BOLES MBR.
DEFIANCE MBR.
MATSON MBR.
METZ MBR.
18
17
16
14
13
12
11
10
9
8
7
6
5
4
3
2
1
20
10
0

The Joachim Dolomite lies unconformably above the St. Peter Sandstone (Thompson, 1991, p. 87). The contact between the St. Peter and the basal Abernathy Member of the Joachim Dolomite is exposed west of the Berg Quarry along the main road leading through Augusta Shores at about 560 feet elevation approximately 1200 feet FNL and 2200 feet FWL of Sec. 8, T. 44N., R. 2 E. Strata within the Joachim strike about N 23^{o} E and dip from 7 to 9^{o} southeast. The Joachim is slightly less than 100 feet thick in this vicinity. It thickens from less than 50 feet in northwest and northeast Missouri to greater than 300 feet in Cape Girardeau County in the southeast part of the state (Thompson, 1991, p. 87). The Abernathy Member is a silty, sandy, dolomite containing beds of medium-grained dolomitic sandstone and reddish-brown shale. A persistent bed of fine- to medium-grained quartz sandstone occurs at the top of the Abernathy (Thompson, 1991, p. 88). Strata within the Berg Quarry are nearly horizontal suggesting that a monocline is present immediately to the west.

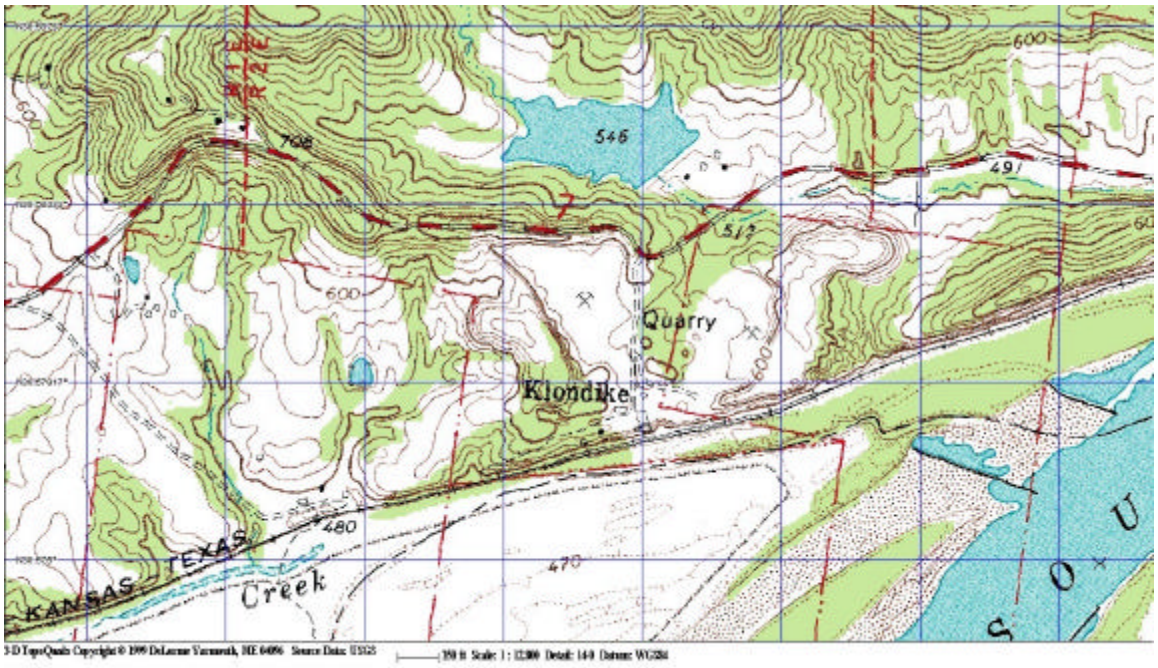
Approximately 77 feet of Joachim Dolomite and 26 feet of overlying Plattin Group dolomitic limestone were quarried at the Berg Quarry. The Augusta, Boles, Defiance, Matson, and Metz Members of the Joachim Dolomite are exposed by quarrying operations. The quarry floor is developed in the Augusta Member which is a slightly silty, thickly-bedded dolomite and limestone with a few green shale layers up to 16 inches thick in the lower part (Thompson, 1991, p. 90). The base of the Augusta Member is estimated to be 5 to 10 feet below the lower quarry floor (Martin and Wells, 1966, p. 32). The overlying Boles Member consists of dense, thin- to medium-bedded, silty dolomite interbedded with vuggy dolomite and reddish-brown to greenish-gray shale partings and beds (Thompson, 1991, p. 93). The Defiance Member is mostly a medium-bedded to massive, silty dolomite with some interbedded shale. The lowest 3 feet 6 inches contains a basal breccia and weathers to a rough, brown face. Chert may occur within the lower part of the Defiance Member. The upper part of the Defiance weathers to a smooth, white to gray face (Thompson, 1991, p. 96). The Matson Member is a yellowish to grayish-brown, thick-bedded to massive, chert-free dolomite that weathers to a resistant horizon with a rough face (Thompson, 1991, p. 97). The uppermost Metz Member is a yellowish-brown, thin-bedded, moderately shaly, pure to silty, chert-free dolomite (Thompson, 1991, p. 101).

The Bloomsdale Limestone, unconformably overlies the Metz Member of the Joachim Dolomite and forms the basal formation of the Plattin Group at this location. The Plattin Group is slightly greater than 100 feet thick in the vicinity. The Plattin Group, like the Joachim, thickens from 50 feet or less in northwest and northeast Missouri to greater than 300 feet in the southeast part of the state (Thompson, 1991, p. 128). The Bloomsdale is divided into a lower Brickeys Member and an upper Establishment Shale Member. The Brickeys is a yellowish-brown, massive, oolitic, dolomite to dolomitic limestone with incipient cross-bedding in the upper part. The Establishment Shale Member is a bluish-green shale interbedded with greenish-gray to buff, argillaceous, chalky limestone beds (Thompson, 1991, p. 142). The Beckett Limestone occurs above the Establishment Shale Member and is the uppermost unit exposed at the Berg Quarry. It consists of burrowed limestone, dolomitic limestone, and dolomite with thin, nodular bedding (Thompson, 1991, p. 151).

The Berg Quarry was operated intermittently to supply riprap for Missouri River stabilization projects. This quarry and the adjacent Augusta Shores Subdivision are owned by Kassabaum Development. Salvage of waste rock at the quarry continues in response to demand for large limestone-dolomite blocks for retaining walls and for decorative stone in landscaping applications.

Saturday, September 29, 2001, Stop 3: St. Charles County Parks and Recreation Department - Klondike Quarry

St. Charles County, Labadie 7.5 Minute Quadrangle
S ½, Sec. 7, T. 44 N., R. 2 E. and Land Grant Survey 1721
3 miles east of Augusta on Missouri Highway 94



Owner:
Curt Loupe, Director
Andrew Degginger, Environmental/Outdoor skills Manager
St. Charles County Parks and Recreation Department
St. Charles County Administration Building
201 North Second Street, Suite 510
St. Charles, MO 63301
636-949-7535

This photograph shows operations at the Klondike Quarry (Martin and Wells, 1966, fig. 8, p. 34).

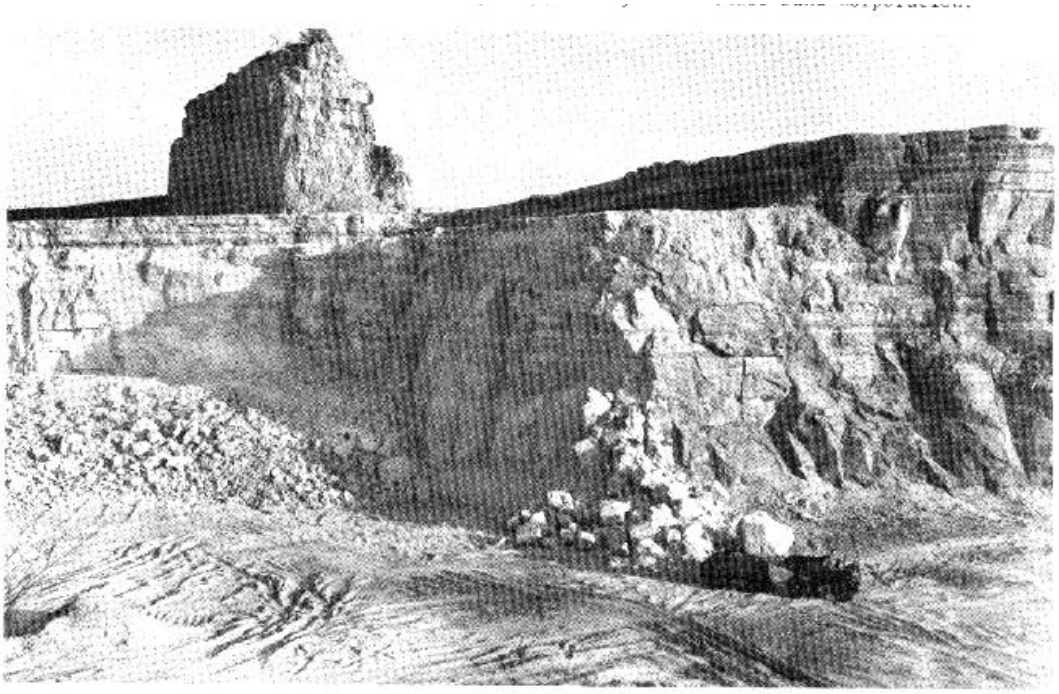
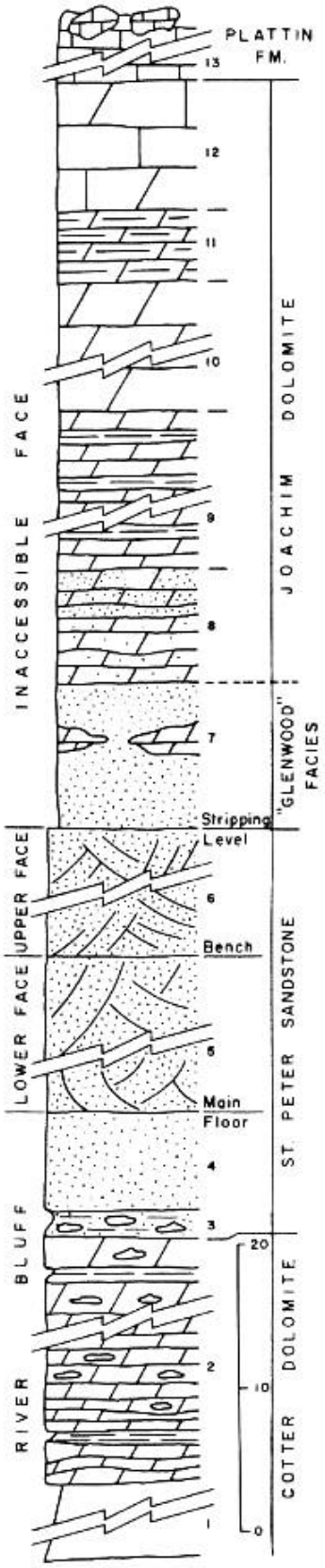


Fig. 8. Pensylvania Glass Sand Company, Mavern Rock Quarry, St. Charles County, Missouri.

The description of rocks exposed at the Klondike Quarry is adapted from Martin and Wells (1966, p.35). Some unit thicknesses were estimated. Their graphic section is presented on page 28.

ORDOVICIAN SYSTEM-MOHAWKIAN SERIES	Elevation	Thickness
Joachim Dolomite-*Plattin Group* (76+ ft)	740 ft	
13. Limestone, rubbly, 10 feet to 15 feet thick		~10 ft
	730 ft	
12. Limestone or dolomite, 8 feet to 10 feet thick		~8 ft
	722 ft	
11. Dolomite, shaly		~5 ft
	717 ft	
10. Dolomite, massive		~15 ft
	702 ft	
9. Dolomite, even-bedded, interbedded thin shale partings, 20 feet to 25 feet thick		~20 ft
	682 ft	
8. Dolomite, yellowish-brown, finely-crystalline, medium- to massive-bedded, dolomite contains disseminated quartz sand grains, interbedded with thin sandstone and sandy shale beds, irregular bedding surfaces		8 ft
Glenwood Facies	674 ft	
7. Sandstone, green, medium- to fine-grained, contains a sandy, discontinuous dolomite bed up to 2 feet 6 inches thick		10 ft
St. Peter Sandstone (~105 ft) BASE OF STRIPPING LEVEL	664 ft	
6. Sandstone, green, yellow, and white, fine- to medium-grained, composed primarily of rounded and frosted quartz grains, friable to cemented, iron-stained, 25 feet to 30 feet thick		~25 ft
	639 ft	
5. Sandstone, white, fine- to medium-grained, composed primarily of rounded and frosted quartz grains, friable to cemented, cross-bedded, ripple marks, minor iron-staining, 70 feet to 80 feet thick		~70 ft
	569 ft	
4. Sandstone, white, fine- to medium-grained, composed primarily of rounded and frosted quartz grains, interval contains pyrite, green iron-staining on grains, limonite banding along bedding planes, flecks of white chert in basal 5 feet, 7 feet to12 feet thick		~8 ft
Approximate quarry floor	561 ft	
3. Interbedded shale and green sandstone, interval contains chert nodules and occasional rounded and weathered dolomite clasts from unit below, 2 feet to 3 feet 6 inches thick		~2 ft
unconformity		
CANADIAN SERIES		
Cotter Dolomite (75+ ft)	559 ft	
2. Dolomite, yellowish-brown to gray, finely-crystalline and earthy “cotton rock,” argillaceous in part, interbedded green shale, gray and green shale partings, interval contains oolitic chert nodules and lenses, lower part is thin- to medium-bedded and blocky, upper part is massive and contains some breccia		55 ft
	504 ft	
1. Covered to level of Missouri, Kansas, and Texas railroad tracks		~20 ft
	484 ft	
Total Thickness		256 ft


PLATTIN FM.
13
12
11
10
9
8
7
6
5
4
3
2
1
INACCESSIBLE FACE
UPPER FACE
LOWER FACE
BLUFF
RIVER
JOACHIM DOLOMITE
"GLENWOOD" FACIES
Stripping Level
Bench
Main Floor
ST. PETER SANDSTONE
COTTER DOLOMITE
20
10
0

Approximately 100 feet of St. Peter Sandstone was formerly quarried by the Tavern Rock Sand Company and the Pennsylvania Glass Sand Corporation at the Klondike Quarry. This abandoned open pit is now owned by St. Charles County Parks Department.

The St. Peter Sandstone is fairly uniform in grain size and purity. Sand grains range from fine- to medium-grained in size. Individual grains are rounded and usually frosted. Massive cross-bedding and ripple marks may occur throughout the formation. The St. Peter varies from friable to well indurated. Fresh exposures are white. Iron oxide, the main impurity, typically stains and case-hardens weathered surfaces. The upper 15 to 25 feet may contain a higher percentage of iron oxide as it tends to be stained yellow to red (Martin and Wells, 1966, p. 34). Dake (1918, p. 162) reports the following analyses of unwashed, quarry-run sand supplied by the Tavern Rock Sand Company:

SiO_2	99.7%
Al_2O_3	0.013%
Fe_2O_3	0.057%
CaO	0.060%
MgO	0.070%
Ignition loss	0.100%
Total	100.00%

Bob Beste, Lafarge Corporation, provided the following chemical analyses of two random St. Peter Sandstone grab samples collected September 21, 1993 from the Klondike Quarry:

Sample 1

Selected Elemental Percentages (0.0001% = 1 ppm)		Elemental Content (% x 20 =a lb/s ton) a lb/s ton [1]troy oz/s ton [2]kg/s ton [3]gm/s ton [4]s ton ore [5]a lb/s ton oxide		Price [1]USGS, 1998 [2]Skillings, 2001, p. 11	Value ($/s ton)	60% Value
Antimony (Sb)	0.0050%	0.10		$0.71/lb[1]	0.07	$0.04
Arsenic (As)	0.0064%	0.13		$0.46/lb[1]	0.06	0.04
Barium (Ba)	0.0086%	0.17				
Bismuth (Bi)	0.0025%	0.050		$3.60/lb[1,2]	0.18	0.11
Cadmium (Cd)	0.0023%	0.046		$0.30/lb[2]	0.01	
Cesium (Cs)	0.0113%	0.226	102[3]	$63.30/gm[1]	6,456.60	3873.96
Chromium (Cr)	0.0753%	1.51	0.000755[4]	$67.13/s ton ore[1]	0.05	0.03
Cobalt (Co)	0.0021%	0.042		$10.80/lb ingots[2]	0.45	0.27
Copper (Cu)	0.0080%	0.16		$0.70/lb electrolytic[2]	0.11	0.07
Hafnium (Hf)	0.0056%	0.11	0.05[2]	$187.39/kg[1]	9.37	5.62
Indium (In)	0.0022%	0.044	0.64[1]	$415.00/troy oz[2]	265.60	159.36
Lead (Pb)	0.0068%	0.14		$0.39/lb[2]	0.05	0.03
Manganese (Mn)	0.0027%	0.054				
Molybdenum (Mo)	0.0023%	0.046	0.021[2]	$5.80/kg[1]	0.12	0.07
Nickel (Ni)	0.0110%	0.22		$2.66/lb electrolytic[2]	0.59	0.35
Niobium (Nb)	0.0024%	0.048		$3.00/lb[1]	0.14	0.08
Platinum (Pt)	0.0030%	0.060	0.88[1]	$548.00/troy oz refined[2]	482.25	289.35
Silver (Ag)	0.0030%	0.060	0.88[1]	$4.24/troy oz[2]	3.73	2.24
Tantalum (Ta)	0.0319%	0.638	0.92[5]	$34.00/lb TaO_5[1]	31.28	18.77
Tellurium (Te)	0.0065%	0.13		$18.00/lb[1]	2.34	1.40
Thallium (Tl)	0.0048%	0.096		$580.00/lb[1]	55.68	33.41
Thorium (Th)	0.0061%	0.12		no demand		
Tin (Sn)	0.0047%	0.094		$3.05/lb[2]	0.29	0.17
Titanium (Ti)	0.0120%	0.24		$4.38/lb[1]	1.05	0.63
Tungsten (W)	0.0325%	0.650	0.29[2]	$7.20/kg[2]	2.09	1.25
Uranium (U)	0.0028%	0.056				
Zinc (Zn)	0.0058%	0.12		$0.42/lb[2]	0.05	0.03
Zirconium (Zr)	0.0207%	0.414	0.188[2]	$23.15/kg[1]	4.35	2.61
Total Discounted Value						$4389.89

Abbreviations: ppm = parts per million, a lb/s ton = avoirdupois pound/ short ton, troy oz = troy ounce, kg = kilogram, gm = gram.

Selected Oxide Percentages (% x 20 = lb/s ton)

Al_20_3	0.3600%	7.200 lb/s ton
CaO	2.7000%	54.000 lb/s ton
Cr_2O_3	0.1100%	2.200 lb/s ton
CuO	0.0100%	0.200 lb/s ton
Fe_2O_3	0.9500%	19.000 lb/s ton
MgO	1.9000%	38.000 lb/s ton
MnO	0.0035%	0.070 lb/s ton
PbO	0.0070%	0.140 lb/s ton
P_2O_5	0.0110%	0.022 lb/s ton
K_2O	0.1500%	3.000 lb/s ton
SiO_2	88.9000%	1778.000 lb/s ton
Na_2O	0.1100%	2.200 lb/s ton
SO_3	0.0530%	1.060 lb/s ton
TiO_2	0.0200%	0.400 lb/s ton
SnO_2	0.0060%	0.120 lb/s ton
WO_3	0.0410%	0.820 lb/s ton
ZnO	0.0072%	0.144 lb/s ton
ZrO_2	0.0280%	0.560 lb/s ton
Ta_2O_5	0.0390%	0.780 lb/s ton
NiO	0.0410%	0.410 lb/s ton

Additional Properties

Chlorine (Cl)	0.0350%
Total Alkalies	0.21%
Loss on Ignition	4.4400%

Total oxides, chlorine, and ignition loss = 99.9217%

Sample 2

Selected Oxide Percentages (% x 20 = Lbs./Ton)

Al_20_3	1.1000%
CaO	0.1300%
Fe_2O_3	0.9700%
MgO	0.5700%
K_2O	0.2200%
SiO_2	91.7200%
Na_2O	0.0600%

Additional Properties

Total Alkalies	0.20%
Loss on Ignition	4.4400%
Total Oxides	94.7700%

Screen tests of two sand samples from the Klondike Quarry are given by Dake (1918, p. 126f):

Tyler Screen Size	Sample No. 77 (% passing)	Sample No. 78 (% passing)
10	100	100
20	100	100
30	93.84	92.31
40	77.82	77.11
50	59.10	54.53
60	45.69	26.39
70	40.50	15.50
80	35.18	7.75
90	32.49	5.93
100	21.16	2.43
150	1.56	0.49
200	0.75	0.37
Effective size	0.120	0.180
Uniformity Coefficient	2 18	1.72

The Klondike Quarry is located near the eastern end of a 45-mile belt of outcropping St. Peter Sandstone roughly parallel to the Missouri River extending westward into northeastern Callaway County. On the south side of the Missouri River, the outcrop trends diagonally southeast across Franklin, St. Louis, and Jefferson Counties to the Mississippi River bluff at Crystal City in Jefferson County. From this point the St. Peter roughly parallels the Mississippi River southeast through Ste. Genevieve, Perry, and Cape Girardeau Counties to Cape Girardeau, a distance of about 100 miles. The St. Peter Sandstone has been brought to the surface by the Cap au Gres Fault in Lincoln County and by several domes along the Lincoln fold in Lincoln and Pike Counties (Martin and Wells, 1966, p. 34).

The St. Peter averages about 75 feet thick in east-central Missouri and varies between 50 and 150 feet thick. A major unconformity is present at the base of the formation. St. Peter Sandstone overlies Cotter Dolomite north of the Missouri River and in parts of Franklin and Jefferson Counties. In Jefferson County and southward, the younger Everton Formation occurs below the St. Peter (Martin and Wells, 1966, p. 34). A 3 to 5 foot thick interval of interbedded green shale and cherty sandstone occurs at the base of the St. Peter. Within the quarry, the contact of the St. Peter with the overlying Joachim Dolomite is placed at the top of the stripping level. The green sandstone with a discontinuous bed of dolomite is transitional into the overlying interbedded sandy dolomite and sandstone of the Joachim Dolomite (Martin and Wells, 1966, p. 36).

During 1966, Tavern Rock Quarry was one of five operations extracting St. Peter Sandstone in St. Charles, St. Louis, and Jefferson Counties. The sand is used in the manufacture of glass and ferrosilicon, as well as for molding and other industrial sand uses (Martin and Wells, 1966, p. 36). Presently, General Materials operates a pit and plant at 13098 Gravois Road, St. Louis, Missouri and U. S. Silica operates a plant in Pacific, Missouri. Both are located in St. Louis County. UNIMIN Corporation operates its Festus pit and plant near Pevely in Jefferson County.

Extensive industrial sand resources are present in St. Charles County along the St. Peter outcrop belt extending from east of Augusta westward to the county line. Additional St. Peter is present along Femme Osage Creek and its tributaries in southwest St. Charles County. The St. Peter has been successfully mined underground in St. Louis and Jefferson Counties. It is possible that the sandstone could be extracted by underground methods in St. Charles County. Access to nearby rail and river transportation is a critical factor for continued development of industrial sand resources in St. Charles County (Rueff and Hayes, 1991, p. 92).

The Klondike Quarry was adversely impacted by changing market and transportation factors. Quarrying operations at Klondike ended after a southern Illinois bottle plant burned and was not rebuilt. Abandoning the adjacent Missouri, Kansas, and Texas Railroad withdrew the option of rail transport for Klondike sand. Competition within the quarrying industry and cancellation of a critical U. S. Army Corps of Engineers contract for Missouri River riprap killed attempts to recover the large volume of waste rock removed from above the St. Peter and dumped on the east and west sides of the quarry. After setting idle for some time, Klondike Quarry was purchased by St. Charles County Parks and Recreation Department.

REFERENCES

Beste, Robert C., and Woody, Robert E., 1992, The petrography and stratigraphy of St. Charles Quarry in St. Charles, Missouri: Triangle Materials Testing and Consulting, unpublished report, 80 p.

Beste, Robert C., 1994, The petrography and stratigraphy of Defiance Quarry in Defiance, Missouri: Triangle Materials Testing and Consulting, unpublished report, 105 p.

Dake, C. L., 1918, The sand and gravel resources of Missouri: Missouri Bureau of Geology and Mines, v. 25, 2nd series, 274 p.

Martin, James A., and Wells, Jack S., 1966, Guidebook to Middle Ordovician and Mississippian strata, St. Louis and St. Charles Counties, Missouri: Missouri Department of Business and Administration, Division of Geological Survey and Water Resources, Report of Investigations Number 34, 1996 Annual Meeting American Association of Petroleum Geologists, 48 p.

Missouri Geological Survey, 1975, The resources of St. Charles County, Missouri – land, water, and minerals: Missouri Department of Natural Resources, Missouri Geological Survey, prepared for the St. Charles County Planning and Zoning Commission, 237 p.

Rueff, A. W. and Hayes, Edie, 1991, Chemical and Physical properties of selected stone resources in northeast Missouri: Missouri Department of Natural Resources, Division of Geology and Land Survey, Open File Report Series, OFR-91-83-MR, 2nd edition, 156 p.

Skillings Mining Review Staff, 2001, Metal/Ore Prices, July 16, 2001: Skillings Mining Review, v. 90, no. 28, 15 p., July 21, 2001.

Thompson, Thomas L., 1986, Paleozoic succession in Missouri, Part 4, Mississippian System: Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations No. 70, 182 p.

Thompson, Thomas L., 1991, Paleozoic succession in Missouri, Part 2, Ordovician System: Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations No. 70, 282 p.

United States Geological Survey, 1998, Metal prices in the United States through 1998: http://minerals.usgs.gov/minerals/pubs/metal_prices/metal_prices1998.pdf, 181 p.