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High-Carbonate and Low-Silica Stone in the High Bridge Group (Middle Ordovician), Fayette County, Central Kentucky

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KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY, LEXINGTON SERIES XI, 1980
Donald C. Haney, Director and State Geologist

HIGH-CARBONATE AND LOW-SILICA STONE IN THE HIGH BRIDGE GROUP (MIDDLE ORDOVICIAN), FAYETTE COUNTY, CENTRAL KENTUCKY

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Garland R. Dever, Jr.

ABSTRACT

The High Bridge Group (Middle Ordovician) of central Kentucky, a major source of limestone and dolomite for construction and agricultural stone, is also a potential source of stone for industrial uses requiring carbonate rocks of high chemical purity. Chemical analyses of foot-by-foot samples from a Fayette County core show that several thick zones of high-carbonate and low-silica stone are present in the High Bridge at a minable depth.

INTRODUCTION

The High Bridge Group (Middle Ordovician) is a thick (430 to 570 feet), widespread body of limestone and dolomite which is at a minable depth beneath a large area of central and north-central Kentucky. It is being mined for construction and agricultural stone, and for the production of lime for flux, flue-gas desulfurization, and chemical industries. The Kentucky Geological Survey is conducting a regional study of the High Bridge to determine its chemical characteristics and to outline the occurrence of deposits suitable for industrial uses requiring carbonate rocks of high chemical purity.

The purpose of this report is to present the chemical analyses of foot-by-foot samples of the High Bridge section from a core taken in Fayette County. The core contained several thick zones of high-carbonate and low-silica stone. This is the second publication in a proposed series of reports on the chemical characteristics of High Bridge carbonate rocks; analyses of foot-by-foot samples from a Boone County core were published in the first report (Dever, 1974).

The Fayette County core was given to the Kentucky Geological Survey by the American Smelting and Refining Company (ASARCO). It is on file and available for inspection at the Survey's Sample and Core Library in the Reynolds Building, 670 South Broadway, Lexington. The interval from 185 to 823 feet was split and sampled for analysis. Laboratory analyses were performed by Lucille Cantor and Nelda N. Mitchell of the Survey staff, under the supervision of Thomas A. Kendall, at the Analytical Laboratory, Office of Research and Engineering Services, College of Engineering, University of Kentucky.

GEOGRAPHIC AND GEOLOGIC SETTING

The ASARCO core was taken at a site in southern Fayette County, 13 miles south of Lexington (Fayette County Courthouse) and 1.4 (airline) miles north of the Kentucky River (river mile 160) (Fig. 1). The core hole is on the west side of Kentucky Highway 1975 (Jacks Creek Road), 3.7 miles south of its junction with U. S. Highways 25 and 421. The immediate area is covered by the Coletown topographic quadrangle map and by the geologic map of the Coletown quadrangle (Black, 1967), both at the scale of 1:24,000.

The Kentucky River is maintained as a navigable waterway from its mouth in Carroll County (Ohio River mile 545.9) upstream to Beattyville, Lee County (river mile 254.8). It has 14 locks and dams. Lock dimensions range from 145 by 38 feet to 148 by 52 feet. Access to the Kentucky River from the core hole site is available via several state roads. The site is 3.9 miles from the river (mile 158) via Kentucky Highways 1975 and 169 (Spears Road and Tates Creek Road); it is 4.6 miles from the river (mile 164) via Kentucky Highways 1975 and 1976 (Jacks Creek Road).

Kentucky Highway 1975 furnishes access to the network of interstate, federal, and state highways in Fayette County. The county is served by main

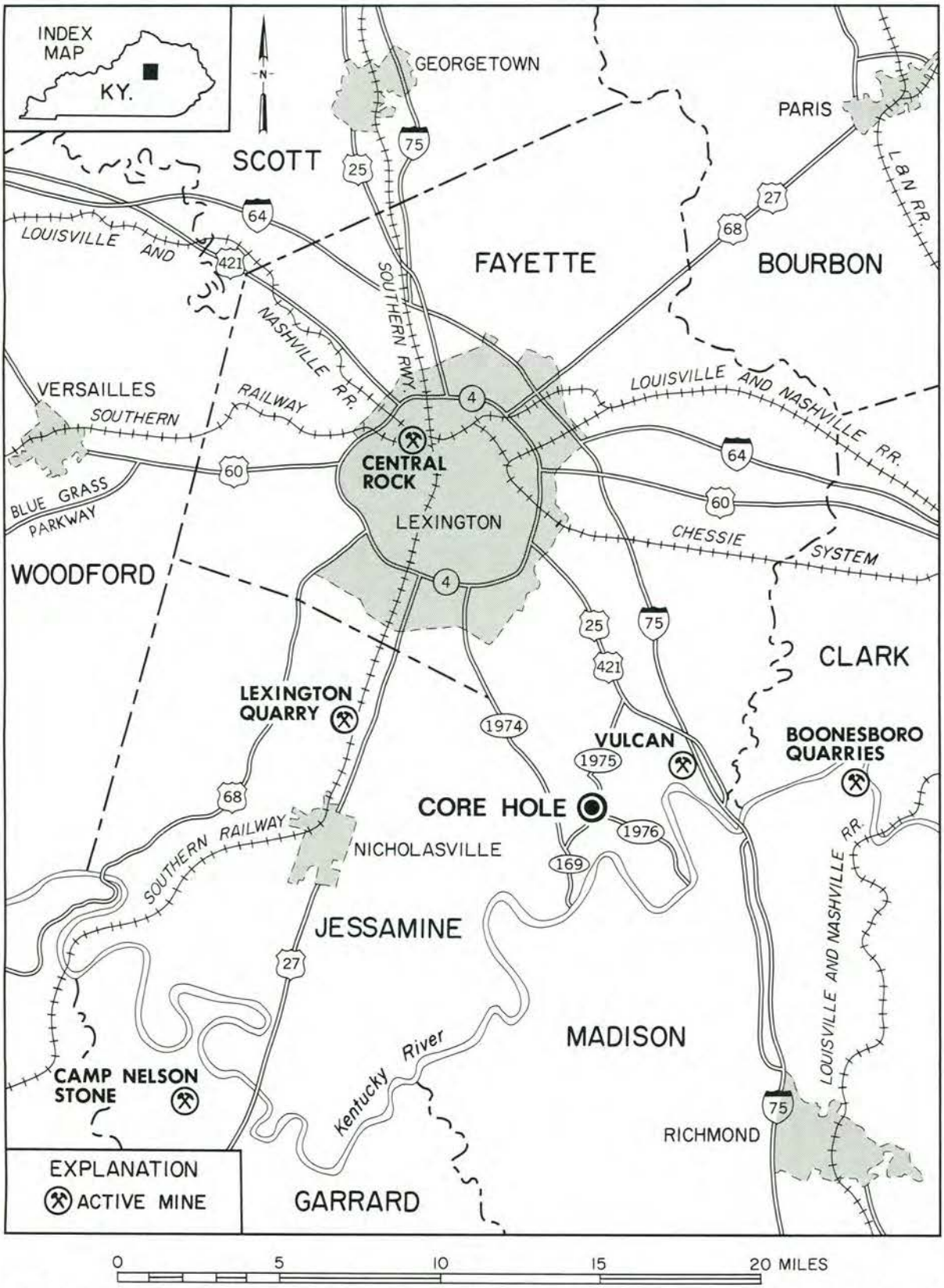

Figure 1. Map of part of central Kentucky showing location of ASARCO core hole, active mines producing construction and agricultural stone from the High Bridge, and transportation network. Mines in Anderson and Franklin Counties, west of map area, are shown in Figure 2.

lines of the Southern Railway, Louisville and Nashville Railroad, and Chessie System (Chesapeake and Ohio Railway).

The core hole is in the Inner Blue Grass region, on the upland surface of the Lexington Plain and near the narrow, commonly steep-walled valley of the entrenched Kentucky River. Maximum relief between the upland and the river in the vicinity is about 500 feet.

The site is near the axis of the Cincinnati arch (Fig. 2). It is on the north (upthrown) side of the Kentucky River fault system which crosses southern Fayette County. Displacement across the fault system is about 250 feet. Surface rocks in the immediate area are principally limestone and shale of the Middle and Upper Ordovician Lexington Limestone and Clays Ferry Formation (Black, 1967). To the east and south of the site, High Bridge limestone and dolomite are exposed along parts of the valleys of the Kentucky River and its tributaries, mainly where their courses are on the upthrown side of the fault system.

HIGH BRIDGE GROUP

General

The High Bridge Group consists of three formations, which are, in ascending order, the Camp Nelson Limestone, Oregon Formation, and Tyrone Limestone (Fig. 3). Total thickness of the High Bridge in the Fayette County core is 572 feet: Camp Nelson, 442 feet; Oregon, 36½ feet; and Tyrone, 93½ feet. The three formations are composed principally of limestone and dolomite; detrital shale is a relatively minor constituent. The Tyrone and Camp Nelson mainly consist of micrograined limestone which is partly mottled with small irregular bodies and thin zones of very finely crystalline dolomite. The Oregon consists of very finely crystalline dolomite and dolomitic limestone, partly interbedded with micrograined limestone. Interpretation of

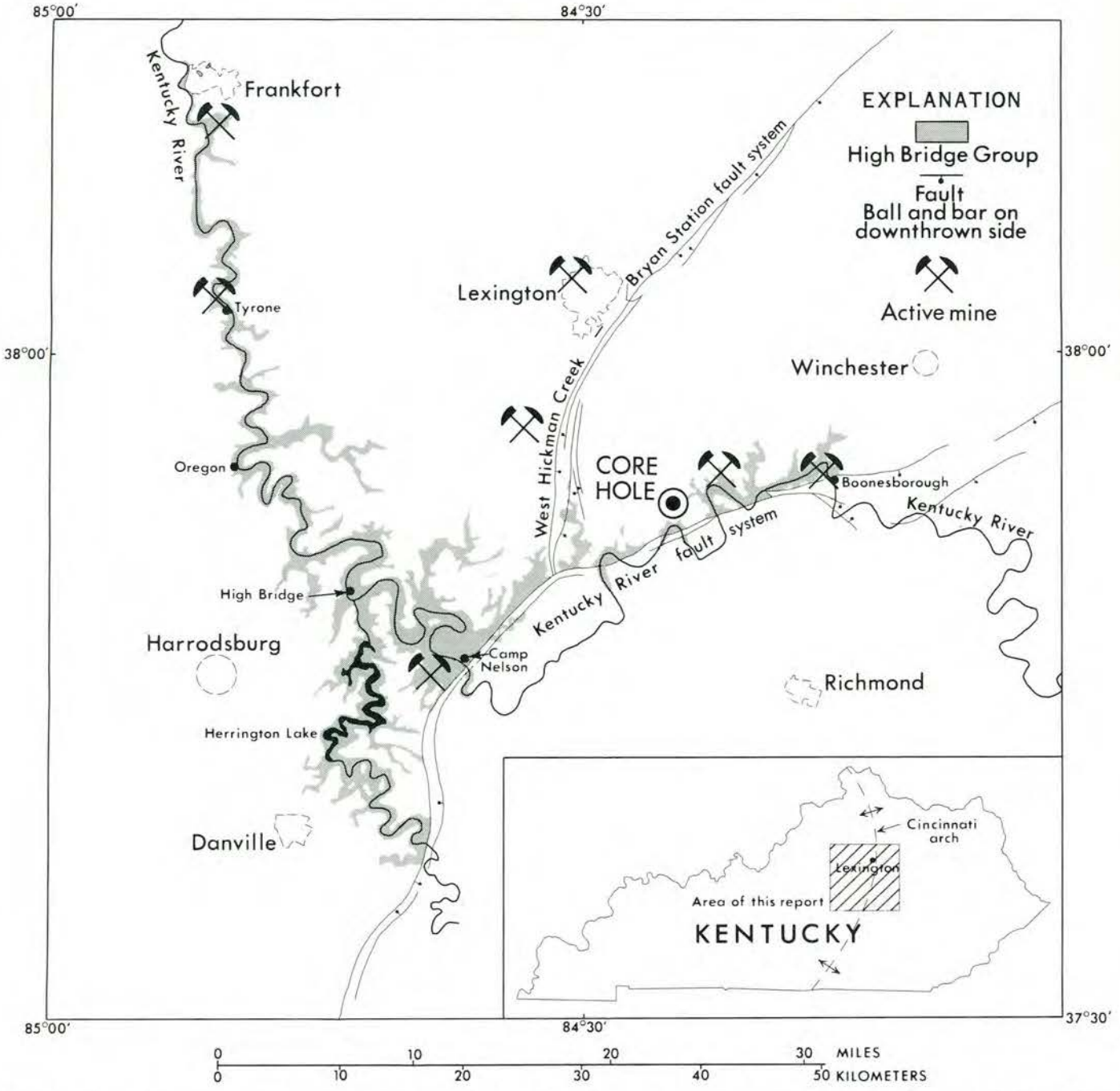

Figure 2. Map showing main outcrop area of High Bridge rocks, principal fault systems, location of ASARCO core hole, and active mines. (Modified from Cressman and Noger, 1976, Fig. 1.).

the depositional environments of the Tyrone, Oregon, and upper Camp Nelson has been presented by Cressman and Noger (1976).

Several thin bentonites which serve as useful markers for local and regional correlation are present in the High Bridge. The two most promi-

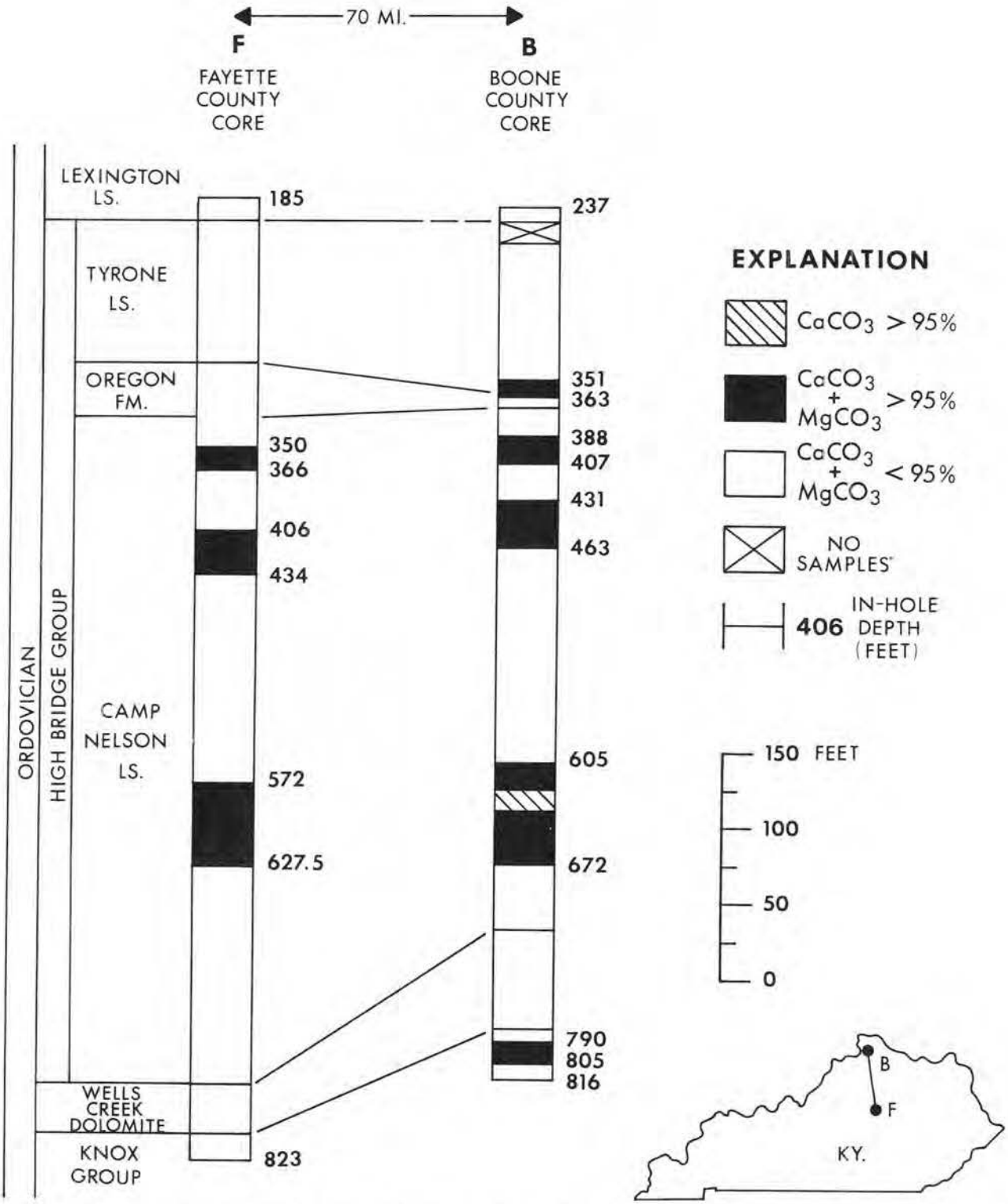

Figure 3. Zones of high-carbonate and high-calcium stone, and stratigraphy of analyzed sections in cores from Fayette and Boone Counties.

nent bentonites occur in the upper Tyrone: (1) the "Mud Cave," present locally at or near the top of the formation; and (2) the "Pencil Cave,"

present across the region, 15 to 30 feet below the top (Wolcott and others, 1972). In the Fayette County core, a third bentonite is present about 10 feet above the base of the Tyrone.

The Tyrone is overlain by the Lexington Limestone; the Camp Nelson is underlain in turn by the Wells Creek Dolomite and, where present, St. Peter Sandstone. The Wells Creek or St. Peter rests unconformably upon the Knox Group. The contact between the micrograined limestone of the Tyrone and the bioclastic limestone of the basal Lexington is distinct, but the contact between the Camp Nelson and Wells Creek appears gradational. The lower Camp Nelson in the Fayette County core is mainly dolomite (in part slightly silty and sandy) with zones and lenses of micrograined limestone; the Wells Creek is silty and sandy dolomite. In this study, the contact between the Camp Nelson and Wells Creek has been placed below the lowest occurrence of micrograined limestone, a characteristic High Bridge lithology.

The Tyrone, Oregon, and up to 320 feet of Camp Nelson (Wolcott, 1969) are exposed discontinuously along the Kentucky River from river mile 175.5, Boonesborough, Madison County, downstream to river mile 56.5 at O'Nan Bend, central Franklin County, 8 miles downstream from Frankfort (Fig. 2). Elsewhere in the State, the High Bridge and its correlatives are in the subsurface.

Potential Industrial Uses

Carbonate rocks of high chemical purity are present in the High Bridge of Fayette County. Chemically pure limestone and dolomite have a variety of industrial uses, for example: raw material for the production of lime, portland cement, and chemical products; flux for steel and other metallurgical industries; fillers; rock dust for underground coal mines; and a reactive agent for flue-gas desulfurization. Specifications for many of these industrial uses require that the stone be essentially free of noncarbonate con-

stituents such as silicon dioxide (SiO_2), aluminum oxide (Al_2O_3), iron oxide (Fe_2O_3), sulfur (S), and phosphorus (P). For certain industrial uses, magnesium carbonate ($MgCO_3$) is a deleterious constituent.

In this report, high-carbonate stone designates carbonate rocks composed of 95 percent or more total carbonates, calcium carbonate plus magnesium carbonate ($CaCO_3 + MgCO_3$). Low-silica stone designates carbonate rocks with a total (free and combined) silicon dioxide (SiO_2) content of 4 percent or less. High-calcium limestone designates carbonate rocks composed of 95 percent or more calcium carbonate ($CaCO_3$).

Three zones of high-carbonate stone, 16 to 55½ feet thick, are present in the Fayette County core (Figs. 3 and 4; Tables 1 and 2). The zones are in the Camp Nelson and show a close correlation with the stratigraphic position of the high-carbonate zones of the Camp Nelson in the Boone County core, 70 miles to the north (Fig. 3). The high-carbonate stone in Fayette County will meet the chemical specifications cited for stone used for blast-furnace flux, the production of low-magnesium lime, and rock dust for underground coal mines (Boynton, 1966; Lamar, 1961; Federal Register Office, 1970). The intervals of low-silica stone, which mainly coincide with the high-carbonate zones, meet the silica specifications for rock dust cited in Public Law 91-173, the Federal Coal Mine Health and Safety Act of 1969 (Federal Register Office, 1970) (Fig. 4; Tables 1 and 2). Zones of high-calcium limestone in the core are only 1 to 2 feet thick.

The High Bridge is being mined at two sites on the Ohio River in north-central Kentucky for the production of lime. The Dravo Lime Company is producing a low-magnesium lime, containing 5 to 7 percent magnesium oxide (MgO), in Mason County for stack-gas scrubbing (Mining Engineering, 1977). A limestone deposit in the Camp Nelson is being mined by the Black River

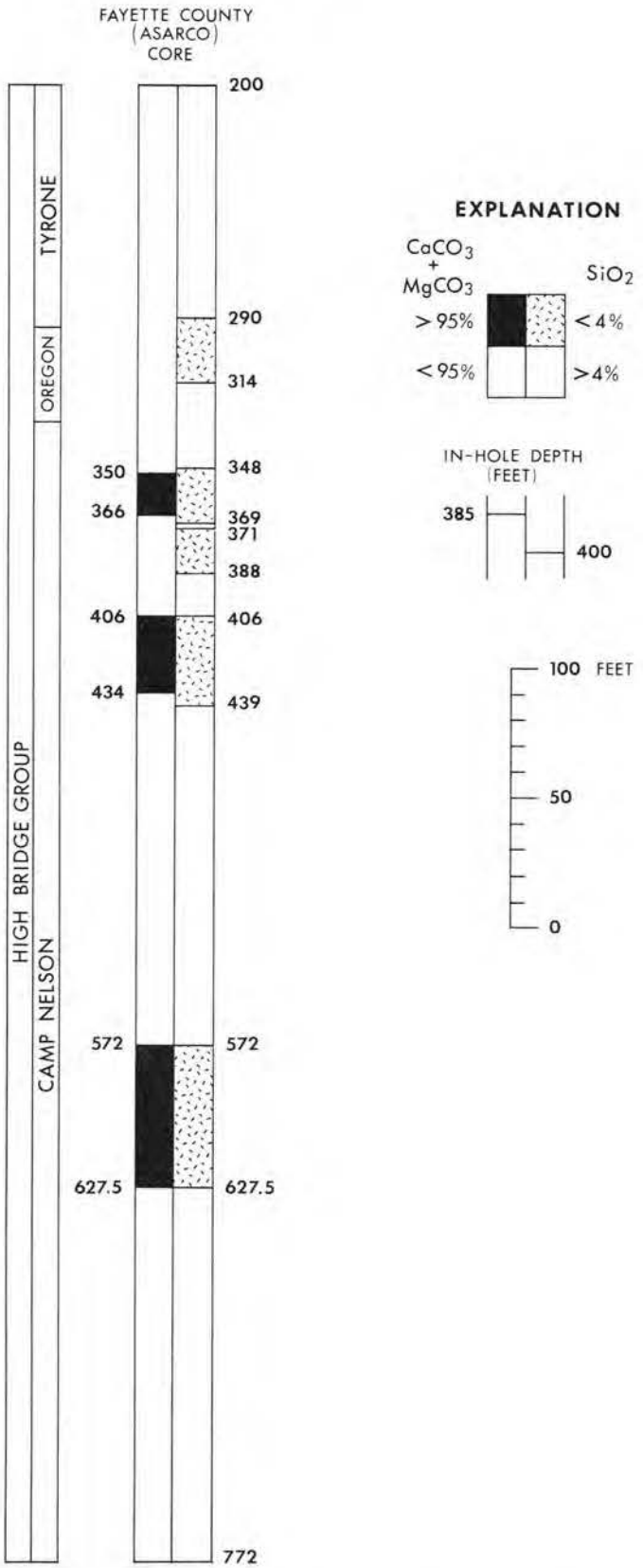

Figure 4. Zones of high-carbonate and low-silica stone in High Bridge section from ASARCO core, Fayette County.

Mining Company in Pendleton County for the production of high-calcium quicklime for steel-furnace flux and chemical industries, and the production of hydrated lime for chemical industries and water treatment. Limestone from the Pendleton County mine also is marketed for the production of rock dust for coal mines.

In central Kentucky, the High Bridge is a major source of construction and agricultural stone for the area's mixture of agricultural and expanding urban markets, centered on Lexington and Fayette County (Fig. 1). The lower Tyrone and Oregon are mined together at five sites in four counties: Anderson (Kentucky Stone Co.); Fayette (Central Rock Co. and Vulcan Materials Co.); Franklin (Harrod-Carter, Inc.); and Jessamine (Lexington Quarry Co.). The

Table 1.--Average Values for Foot-by-Foot Analyses of Zones of High-Carbonate and Low-Silica Stone in High Bridge from ASARCO Core, Fayette County.

	Interval (Feet)	Total Carbonate (%)	$CaCO_3$ (%)	$MgCO_3$ (%)	SiO_2 (%)	Fe_2O_3 (%)	Al_2O_3 (%)	S (%)	P (%)
HIGH CARBONATE	350-366	96.73	84.58	12.15	2.06	0.24	0.77	0.073	0.006
	406-434	97.78	93.85	3.93	1.36	0.12	0.53	0.065	0.005
	572-627½	97.79	80.78	17.01	1.27	0.18	0.50	0.066	0.008
LOW SILICA	290-314	95.83*	77.84	17.99	2.84	0.27	0.48	**	**
	348-369	96.58*	85.35	11.23	2.12	0.23	0.85	0.079	0.007
	371-388	95.70*	85.14	10.56	2.47	0.24	1.19	**	**
	406-439	97.27*	92.58	4.69	1.67	0.13	0.63	0.071	0.006
	572-627½	97.79	80.78	17.01	1.27	0.18	0.50	0.066	0.008

*Interval includes samples with total carbonate content of less than 95 percent (see Table 2).

**Sulfur (S) and phosphorus (P) analyses not run on all samples in intervals.

Oregon is mined in Garrard County (Camp Nelson Stone Co.); the upper Camp Nelson is mined in Madison County (Boonesboro Quarries). The Camp Nelson interval being mined in Madison County is composed of low-silica stone; rock dust for coal mines formerly was produced from the deposit. Dimension stone has been quarried from the Tyrone and Oregon in the central Kentucky outcrop belt, but no operations are active at the present time.

Mining operations in central Kentucky commonly encounter a zone of argillaceous limestone and shale immediately below the Oregon in the uppermost Camp Nelson (correlative with the interval, 332½ to 343 feet, in the ASARCO core, Table 2). Rock in this zone will not meet specifications for construction stone, but the major part of the Camp Nelson underlying the zone appears to be suitable for aggregate and other construction uses.

A market that should prove increasingly important for stone producers is the use of carbonate rocks and lime as the reactive agents in processes being employed to meet federal and state standards for sulfur oxide emissions from coal-burning plants. Flue-gas desulfurization systems employing lime and limestone wet-scrubbing processes are in operation at a number of coal-burning plants and will be used for a majority of the flue-gas desulfurization units which are committed or under construction by electric utilities for coal-fired boilers (Dasti, 1977). As noted above, High Bridge stone currently is mined in Mason County for the production of lime for stack-gas scrubbing. Fluidized-bed combustion systems, in which coal is burned in a fluidized bed of carbonate-rock particles, are undergoing testing and development. With an increased reliance on the use of coal to meet the energy requirements of the United States, greater quantitites of stone will be needed for flue-gas desulfurization, as well as for rock dust, spoil-bank reclamation, and acid-drainage neutralization. A sharp increase in the demand for stone would result from the utilization of fluidized-bed systems for power generation

and industrial boilers.

Results of tests conducted by the Argonne National Laboratory to evaluate carbonate rocks for fluidized-bed systems indicate that dolomite and dolomitic limestone have higher sulfur-sorption values than limestone (Snyder and Wilson, 1977). Preliminary testing of the sulfur-sorption capacity of dolomitic stone from the High Bridge has been commenced. Two samples of Oregon dolomite, taken from stockpiles at the Central Rock Co. mine, Fayette County, were tested by the Process Development Division, Institute for Mining and Minerals Research, University of Kentucky. Average values of 0.20 and 0.22 $\frac{\text{mg. SO3 adsorbed}}{\text{mg. uncalcined stone}}$ were obtained from test runs on the two samples in a thermogravimetric analyzer (D. P. Wesley, written communication, 1980).

All present High Bridge production is from underground mines, both drift and slope mines. With the outcrop belt being restricted to the narrow, entrenched valleys of the Kentucky River and its tributaries, it is expected that future large-scale operations in central Kentucky also will involve underground mining. In selecting a mine site in or near that part of the outcrop belt where the Kentucky River crosses back and forth over the Kentucky River fault system (Fig. 2), it should be noted that individual High Bridge exposures along the course of the river may represent a large, operable deposit or only a small isolated, fault-bounded block on the tip of a meander bend (McGrain and Dever, 1968). The bentonitic clays of the upper High Bridge, where not breached, may form an effective barrier against the downward percolation of ground water, reducing the potential for water problems in underground mining.

Underground operations close to urban markets offer the advantages of requiring less high-cost urban land and producing less surface noise and dust than open-pit operations. Underground mining also offers the potential for year-round operation and avoids high costs for overburden removal and

reclamation. Coring will be required to determine the presence, thickness, and extent of a potential deposit of chemically pure carbonate rock or construction stone in the High Bridge. Cores will provide samples for chemical analysis and physical testing, and furnish information on factors such as roof rock.

Dever and others (1978) have outlined areas along the valleys of the Kentucky River and Ohio River where the depth to the top of the High Bridge is less than 1,000 feet below the level of the valley floor. Structure contours of the top of the Tyrone (top of High Bridge) have been compiled by Black and others (1977a, 1977b, 1977c, 1977d) on maps covering a large area of central Kentucky. Thickness trends in the High Bridge of central and north-central Kentucky are described by Wolcott and others (1972).

CONCLUSIONS

The High Bridge Group in both central and north-central Kentucky contains thick deposits of chemically pure carbonate rock. The general stratigraphic correlation between deposits across the region suggests that they are widespread and represent large reserves of stone for industrial use. In the current pattern of exploitation, which reflects the geographic distribution of industries, available means of transport, and local markets, the High Bridge of central Kentucky is being mined for construction and agricultural stone while the High Bridge of north-central Kentucky along the Ohio River is mined principally for the production of lime for various industrial uses.

The presence of deposits of high-carbonate and low-silica stone in the ASARCO core from Fayette County indicates that the High Bridge of central Kentucky can serve as a source of stone for uses requiring stone of high chemical purity, as well as being a source of construction and agricultural stone. These carbonate rocks also may be suitable for flue-gas desulfuri-

zation and fluidized-bed combustion systems employed in the future by coal-burning plants in central Kentucky.

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Table 2.—Chemical Analyses of American Smelting and Refining Company Core.

County: Fayette — Operator: American Smelting and Refining Co.
Property Owner: K. R. Hayden — Core No. CK-2
Location: West side of Ky. Highway 1975, 3.7 miles south of junction with U. S. Highway 25
Carter Coordinate Location: 2800'FNL and 1180'FEL, sec. 10-Q-61 (Coletown quadrangle)

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
84.18	3.87	9.12	0.50	2.28	99.95	NOT ANALYZED	
70.81	2.53	23.15	1.43	2.05	99.97		
87.09	3.58	7.18	0.53	1.45	99.93		
71.50	5.16	18.07	0.78	3.44	98.95		
69.00	3.14	22.60	4.21	1.08	98.95		
87.27	2.90	7.66	0.48	1.68	99.99		
87.46	2.22	7.39	0.45	2.02	99.54		
85.27	2.38	8.48	0.40	2.86	99.39		
74.61	3.52	17.00	0.63	4.21	99.97		
82.72	3.04	10.71	0.60	2.89	99.96		
87.09	1.60	8.59	0.30	1.95	99.53		
90.46	1.53	6.69	0.30	0.86	99.84		
84.72	2.54	9.03	0.35	2.05	98.69		
83.45	2.06	11.92	0.37	1.42	99.22		
92.19	1.34	4.87	0.44	1.03	99.87		
8[illegible].31	1.67	10.52	0.49	3.63	98.62		
95.11	1.93	2.26	0.20	0.47	99.97		
88.00	4.93	4.56	0.32	1.45	99.26		
87.27	2.81	7.10	0.43	1.69	99.30		
88.55	2.57	6.02	0.37	0.62	99.13		
90.37	2.33	4.60	0.37	1.50	99.17		
87.46	2.59	7.04	0.57	1.93	99.59		
69.24	5.94	16.70	1.22	5.26	98.36		
64.13	6.50	20.00	1.53	5.95	98.11		
62.84	8.28	19.58	1.42	5.73	97.85		
61.31	6.52	22.50	1.49	5.96	97.78		
83.45	3.02	9.70	0.63	2.62	99.42		
82.90	2.95	10.47	0.60	2.31	99.23		
83.27	2.71	10.06	0.54	2.19	98.77		
84.78	2.15	9.97	0.48	2.14	99.52		
76.34	2.59	18.16	0.58	2.31	99.98		
84.36	1.39	10.18	0.25	2.47	98.65		

Elevation: 1025 feet
Sampled by: Garland R. Dever, Jr.
Analyzed by: Analytical Laboratory, College of Engineering, University of Kentucky
Date Sampled: 1972 and 1973

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION: Lithology	Formation
			TOP OF SAMPLED INTERVAL IN CORE	
185-186 186-187 187-188 188-189 189-190 190-191 191-192 192-193 193-194 194-195 195-196 196-197 197-198 198-199 199-200	1	15	Limestone, medium-light- to light-olive-gray and very light-gray, fine- to very coarse-grained, bioclastic; thin zones of very fine-grained calcarenite; scattered fossil fragments; very light- to light-olive-gray chert (in part with bioclastic texture) common; intercalated dark-greenish-gray shale.	LEXINGTON LIMESTONE
200-201 201-202 202-203 203-204 204-205	2	5	Limestone, pale-yellowish-brown to light-olive-gray, micrograined, in part finely laminated, with scattered veinlets and birdseyes of crystalline calcite; small bodies of pinkish- and very light-gray chert in upper 2 feet; traces of pyrite in intervals 202-203 and 204-205 feet; stylolites; few very thin shales and argillaceous seams. "Mud Cave" bentonite at 200½ feet: 3/4-inch clay, light-bluish-gray, translucent, with waxy luster; few small flakes of brownish mica; scattered pyrite.	
205-206 206-207 207-208 208-209 209-210 210-211 211-212	3	7	Limestone, light-olive-gray, very fine-grained to micrograined, in part finely laminated, with birdseyes of crystalline calcite; in part fine- to coarse-grained calcarenite, with few brachiopod fragments, in upper 2 feet; interlaminated with greenish- to dark-greenish-gray, very argillaceous limestone; quartz silt common in interval 207-212 feet; traces of pyrite in intervals 206-207 and 210-212 feet; intercalated greenish-gray, silty shale. Gradational with overlying and underlying ledges.	TYRONE LIMESTONE
212-213 213-214 214-215 215-216 216-217	4	5	Limestone, light-olive-gray, micrograined, with some veinlets and birdseyes of crystalline calcite; in part fine- to medium-grained calcarenite in lower 3 feet; fragments of colonial coral, Tetradium, sparse to abundant; very small bodies of very light-gray chert in lower 3 feet; traces of pyrite in lower 2 feet; few very thin, silty shales and argillaceous seams in upper 3 feet.	

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
			NO SAMPLES				
50.29	0.54	46.88	0.53	1.67	99.91	NOT ANALYZED	
91.28	1.59	4.32	0.20	1.23	98.62		
90.55	3.57	5.00	0.29	0.52	99.93		
93.83	3.67	1.85	0.23	0.16	99.84	0.088	0.004
91.60	5.10	1.70	0.29	0.41	99.10	0.110	0.015
91.83	6.34	1.21	0.24	0.38	100.00	0.090	0.008
92.38	5.81	1.19	0.27	0.33	99.98	0.100	0.006
90.19	6.58	2.29	0.28	0.59	99.93	0.116	0.010
92.56	2.22	3.24	0.15	1.32	99.49	0.152	0.007
93.29	4.76	1.30	0.15	0.45	99.95	0.050	0.007
92.92	4.48	1.73	0.20	0.64	99.97	0.052	0.008
90.37	6.96	1.46	0.25	0.54	99.58	0.184	0.012
79.89	15.28	2.54	0.45	1.22	99.38	0.134	0.018
95.11	1.14	2.19	0.18	0.90	99.52	0.056	0.011
92.65	2.59	2.24	0.17	1.06	98.71	0.056	0.007
85.66	9.47	3.44	0.35	1.03	99.95	0.088	0.012
70.69	21.18	5.30	0.59	1.86	99.62	0.150	0.022
74.34	19.66	3.92	0.54	1.24	99.70	0.106	0.009
84.54	9.48	3.91	0.42	1.38	99.73	0.078	0.008
76.25	17.06	4.15	0.55	1.30	99.31	0.086	0.012
83.54	14.33	1.43	0.40	0.26	99.96	0.026	0.008
89.00	8.71	1.61	0.33	0.18	99.83	0.038	0.005
93.01	5.40	1.15	0.20	0.22	99.98	0.026	0.005
91.64	4.83	2.25	0.25	0.82	99.79	0.080	0.005
68.42	15.07	10.51	0.63	4.31	98.94	NOT ANALYZED	
74.61	8.54	11.27	0.95	4.17	99.54		
67.96	14.32	11.78	0.98	4.25	99.29		
69.14	14.36	10.84	0.90	3.90	99.14		
66.69	12.95	12.30	1.03	5.11	98.08		
75.98	8.94	9.39	0.78	3.94	99.03		
68.73	11.55	12.45	0.20	5.72	98.65		
60.40	19.14	12.65	0.20	5.74	98.13		
86.00	5.25	5.30	0.20	2.75	99.50		
81.40	6.49	7.42	0.23	3.26	98.80		
84.30	6.27	5.94	0.25	2.44	99.20		
78.96	8.12	7.36	0.38	3.30	98.12		
75.34	10.09	9.08	0.20	3.91	98.62		
72.62	15.76	7.25	0.33	3.03	98.99		
90.19	5.26	3.14	0.38	0.85	99.82		
86.93	7.12	3.17	0.34	1.50	99.06		
84.12	10.27	3.34	0.39	1.40	99.52		

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION: Lithology	Formation
217-219	5	2	"Pencil Cave" bentonite. Clay, grayish-yellow- to pale-yellowish-green, translucent, with waxy luster; scattered small flakes of brownish mica.	
219-220 220-221 221-222 222-223 223-224 224-225 225-226 226-227 227-228	6	9	Limestone, yellowish- to pale-yellowish-brown, micrograined; few zones of very fine- to fine-grained calcarenite; mottled with small irregular bodies of very finely crystalline dolomite; layer of light-olive-gray to yellowish-brown chert at top of ledge; small body of very light-gray, chalk-like, siliceous(?) material in interval 226-227 feet; stylolites; thin greenish-gray shale in interval 220-221 feet.	
228-229 229-230 230-231 231-232 232-233 233-234 234-235	7	7	Limestone, very pale-yellowish- to yellowish-brown, with some dark-gray mottling, micrograined, with scattered birdseyes and veinlets of crystalline calcite (principally in upper 2 feet); thin zones of very fine-grained calcarenite; thin zones of very finely crystalline dolomite.	
235-236 236-237 237-238 238-239	8	4	Dolomitic limestone, intricately mottled yellowish-brown and medium-dark-gray, very finely crystalline; in part with zones of micrograined limestone; stylolites.	TYRONE LIMESTONE
239-240 240-241 241-242 242-243	9	4	Limestone, very light-olive- to light-olive-gray, micrograined to very finely crystalline, in part dolomitic; few veinlets of crystalline calcite; trace of pyrite in basal foot.	
243-244 244-245 245-246 246-247 247-248 248-249 249-250 250-251	10	8	Dolomitic limestone, light-olive- to olive-gray, very fine- to fine-grained, argillaceous; zones of micrograined limestone with birdseyes and veinlets of crystalline calcite; intercalated dark-greenish-gray shale and greenish-gray argillaceous seams.	
251-252 252-253 253-254 254-255 255-256 256-257 257-258 258-259 259-260	11	9	Limestone, yellowish- to very pale-yellowish-brown and light-olive-gray, micrograined to microcrystalline, with birdseyes and veinlets of crystalline calcite, in part argillaceous; thin zones of dark-yellowish-brown, very finely crystalline dolomite; scattered stylolites.	

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
75.61	18.05	4.04	0.55	1.58	99.83	NOT ANALYZED	
77.51	17.74	2.90	0.51	1.27	99.93		
73.80	21.23	2.92	0.58	1.27	99.80		
72.17	19.43	4.73	0.58	2.23	99.14		
77.33	14.45	5.54	0.49	2.17	99.98		
88.92	6.10	3.27	0.25	1.25	99.79		
83.58	3.25	9.22	0.28	2.38	98.71		
93.62	4.28	1.59	0.23	0.21	99.93		
91.27	3.67	3.54	0.28	1.21	99.97		
84.36	10.64	3.75	0.28	0.58	99.61		
74.61	20.40	3.62	0.47	0.84	99.94		
70.35	24.25	3.78	0.49	1.12	99.99		
55.60	34.34	7.18	0.83	2.05	100.00		
69.54	18.52	7.48	0.68	2.31	98.53		
78.05	14.05	5.07	0.43	1.59	99.19		
83.76	8.32	5.15	0.30	1.55	99.08		
84.75	5.44	5.26	0.30	1.96	97.71		
84.21	6.64	5.89	0.33	1.83	98.90		
84.75	8.13	5.14	0.33	1.57	99.92		
82.13	11.64	3.88	0.40	1.46	99.51		
84.12	6.70	5.24	0.34	2.08	98.48		
75.07	1.53	15.12	0.23	4.45	96.40		
66.92	1.38	21.78	0.25	5.84	96.17		
78.42	11.55	7.04	0.43	1.47	98.91		
80.05	14.18	3.30	0.30	0.80	98.63		
85.66	8.42	3.84	0.24	1.19	99.35		
93.45	2.74	2.76	0.18	0.76	99.89	0.024	0.006
89.46	5.90	3.50	0.20	0.94	100.00	0.058	0.012
85.57	8.10	3.38	0.20	1.59	98.84	0.022	0.010
86.75	6.76	4.00	0.25	1.24	98.60	0.032	0.011
87.83	8.01	3.00	0.23	0.69	99.76	0.028	0.006
85.48	10.80	2.60	0.28	0.66	99.82	0.096	0.006
84.39	10.43	3.24	0.30	0.92	99.48	0.184	0.007
71.04	25.20	2.96	0.35	0.10	99.65	0.050	0.006
72.35	24.00	3.07	0.30	0.10	99.82	0.062	0.006
74.61	22.14	2.48	0.28	0.10	99.61	0.034	0.006
72.53	24.12	2.49	0.28	0.06	99.48	0.048	0.010
69.00	26.95	2.93	0.32	0.25	99.45	0.076	0.015
73.89	21.59	2.95	0.40	0.11	98.94	0.126	0.008
81.40	14.34	3.03	0.23	0.10	99.20	0.068	0.014
83.22	13.45	2.47	0.25	0.10	99.49	0.084	0.004
76.97	18.24	2.93	0.24	0.59	98.97	0.084	0.004
71.35	22.86	3.68	0.32	1.08	99.29	0.108	0.008
68.27	26.45	3.67	0.33	0.71	99.43	0.094	0.004
75.34	19.33	2.98	0.28	0.43	98.36	0.082	0.005
86.75	9.28	2.42	0.20	0.71	99.36	0.062	0.011

Sampled by:
Analyzed by:
Date Sampled:

DESCRIPTION				
Sample Level (Feet)	Ledge No.	Thickness (Feet)	Lithology	Formation
260 -261 261 -262 262 -263 263 -264 264 -265	12	5	Dolomitic limestone, very pale-yellowish- to yellowish-brown, microcrystalline to very finely crystalline; in part micrograined limestone in lower 2 feet; scattered stylolites.	
265 -266 266 -267 267 -268 268 -269 269 -270	13	5	Limestone, yellowish- to very pale-yellowish-brown and light-olive-gray, micrograined to microcrystalline, with birdseyes and veinlets of crystalline calcite; thin zones of very finely crystalline dolomite; scattered stylolites.	
270 -271 271 -272 272 -273 273 -274 274 -275 275 -276	14	6	Dolomitic limestone and dolomite, yellowish-brown, with dark-gray mottling, very finely crystalline, in part argillaceous; in part micrograined limestone (more common and partly brecciated in lower 2 feet); scattered stylolites.	TYRONE LIMESTONE
276 -277 277 -278 278 -279 279 -280 280 -281 281 -282 282 -283 283 -284 284 -285 285 -286 286 -287 287 -288 288 -289 289 -290 290 -291 291 -292 292 -293½	15	17½	Limestone, yellowish- to very pale-yellowish-brown and light-olive-gray, with dark-gray mottling in upper part of ledge, micrograined; in part with zones of very fine- to medium-grained calcarenite; interlayers and, in interval 283-286 feet, irregular bodies of very finely crystalline dolomite; small body of very light-olive-gray chert at 283½ feet; scattered stylolites; very thin argillaceous seams in interval 280-283 feet. Bentonite at 283 feet: 2-inch clay, yellowish- to light-olive-gray, translucent, with slightly waxy luster; scattered small flakes of brownish mica.	
293½-295 295 -296 296 -297 297 -298 298 -299 299 -300 300 -301 301 -302 302 -303 303 -304 304 -305 305 -306 306 -307	16	30½	Dolomitic limestone and dolomite, yellowish- to very pale-yellowish-brown, with some medium-dark- to dark-gray mottling, very finely crystalline; interlayers and thin zones of micrograined limestone throughout ledge, dominant in intervals 306-309 and 322-323 feet; very thin vertical veinlets of crystalline calcite in interval 314-317 feet; scattered stylolites.	OREGON FORMATION

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
90.87	6.17	1.84	0.15	0.40	99.43	0.048	0.003
89.19	7.99	2.10	0.15	0.54	99.97	0.072	0.003
82.58	13.94	2.90	0.20	0.37	99.99	0.052	0.012
76.70	19.02	3.01	0.25	0.73	99.71	0.030	0.004
75.24	21.15	2.67	0.25	0.69	100.00	0.098	0.006
76.48	19.81	2.38	0.28	0.62	99.57	0.106	0.005
65.11	28.77	3.43	0.38	1.01	98.70	NOT ANALYZED	
60.58	32.86	4.16	0.47	1.25	99.32		
64.29	27.94	4.97	0.40	1.47	99.07		
70.63	23.93	3.87	0.35	1.02	99.80		
59.82	32.48	4.83	0.55	1.56	99.24		
60.67	32.97	4.29	0.50	1.26	99.69		
67.03	26.80	4.53	0.38	1.22	99.96		
76.51	13.94	6.13	0.38	1.60	98.56		
76.97	15.78	3.95	0.25	1.48	98.43		
84.12	9.85	3.51	0.28	0.91	98.67		
75.88	18.83	3.57	0.29	0.94	99.51		
72.62	17.90	5.39	0.44	1.63	97.98		
65.47	16.80	10.48	0.68	3.94	97.37		
62.66	16.30	11.79	0.85	4.82	96.42		
59.31	19.67	12.00	0.85	4.33	96.16		
64.65	27.79	4.73	0.53	1.51	99.21		
68.82	24.10	4.17	0.48	1.46	99.03		
84.39	10.08	2.97	0.27	0.99	99.70		
86.18	7.92	3.84	0.25	1.51	99.70		
55.57	23.69	13.75	0.87	4.91	98.79		
89.46	5.30	2.78	0.30	1.30	99.08		
88.18	3.45	4.05	0.35	1.88	97.91		
90.28	2.14	4.65	0.33	2.45	99.85		
64.03	10.68	15.82	1.28	6.40	98.21		
57.85	14.13	17.08	1.30	7.58	97.94		
59.40	14.92	15.08	1.19	6.50	97.09		
59.12	15.76	16.17	1.13	5.88	98.06		
57.85	18.70	14.42	1.09	5.71	97.77		
58.49	19.82	13.15	0.98	5.09	97.53		
87.09	7.53	3.24	0.34	0.92	99.12		
90.74	6.52	2.05	0.24	0.43	99.98		
83.99	8.97	4.24	0.44	1.37	99.01		
84.54	7.74	4.74	0.32	1.61	98.95		
87.27	6.76	4.02	0.25	1.24	99.54		
96.01	1.94	1.13	0.15	0.74	99.97	0.060	0.020
88.46	6.34	3.54	0.20	1.40	99.94	0.174	0.016

Sampled by:
Analyzed by:
Date Sampled:

DESCRIPTION				
Sample Level (Feet)	Ledge No.	Thickness (Feet)	Lithology	Formation
307 -308 308 -309 309 -310 310 -311 311 -312 312 -313 313 -314 314 -315 315 -316 316 -317 317 -318 318 -319 319 -320 320 -321 321 -322 322 -323 323 -324	16-Continued			OREGON FORMATION
324 -325 325 -326 326 -327 327 -328 328 -329 329 -330	17	6	Dolomitic limestone and dolomite, yellowish-brown, with intricate medium-dark- to dark-gray mottling, very finely crystalline to microcrystalline; one stylolite; very thin argillaceous seams.	
330 -331 331 -332½ 332½-334 334 -335 335 -336 336 -337	18	7	Limestone, yellowish- to dark-yellowish-brown and light-olive-gray, micrograined to microcrystalline, with scattered veinlets and birdseyes of crystalline calcite, in part dolomitic; mottled with small bodies and thin zones of very finely crystalline dolomite in lower 3 feet; very thin nodular beds of very finely crystalline dolomitic limestone with intercalated shale in interval 332½-334 feet; few stylolites in upper 2½ feet; very thin argillaceous seams, mainly in lower 2 feet.	CAMP NELSON LIMESTONE
337 -338 338 -339 339 -340 340 -341 341 -342 342 -343	19	6	Dolomitic limestone, olive- to light-olive-gray, with some medium- to medium-dark-gray mottling, interlaminated very finely crystalline and microcrystalline, argillaceous; in part micrograined limestone in basal foot; traces of pyrite in intervals 337-338 and 340-342 feet; thin argillaceous seams in basal foot.	
343 -344 344 -345 345 -346 346 -347 347 -348 348 -349 349 -350	20	7	Limestone, very dark-yellowish- to dark-yellowish-brown, micrograined, with scattered birdseyes and veinlets of crystalline calcite; mottled with irregular bodies and thin irregular zones of very finely crystalline dolomite; few brachiopods.	

Table 2.—Continued.

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
88.28	7.11	2.96	0.25	1.23	99.83	0.094	0.007
87.82	9.49	1.70	0.25	0.68	99.94	0.072	0.011
86.00	10.20	2.41	0.25	1.11	99.97	0.090	0.008
89.82	7.20	1.86	0.18	0.94	100.00	0.070	0.009
84.54	10.80	2.95	0.28	1.30	99.87	0.102	0.005
85.73	10.01	2.05	0.23	0.89	98.91	0.038	0.018
86.72	11.45	1.31	0.20	0.28	99.96	0.056	0.005
88.00	9.19	1.87	0.23	0.66	99.95	0.078	0.005
86.09	10.25	2.43	0.25	0.95	99.97	0.090	0.004
88.18	9.50	1.43	0.20	0.60	99.91	0.060	0.005
82.45	13.06	3.52	0.23	0.68	99.94	0.086	0.006
80.81	15.76	2.10	0.25	1.03	99.95	0.072	0.006
81.23	16.51	1.46	0.25	0.25	99.70	0.022	0.003
75.84	22.32	1.02	0.30	0.49	99.97	0.068	0.004
83.36	13.97	1.80	0.23	0.49	99.85	0.098	0.005
78.53	17.69	2.14	0.30	0.76	99.42	0.078	0.004
82.49	12.23	2.83	0.30	1.48	99.33	0.122	0.004
83.81	12.22	2.30	0.25	1.38	99.96	0.084	0.004
88.18	8.71	1.74	0.18	0.67	99.48	0.058	0.005
81.44	11.64	4.34	0.33	2.18	99.93	0.118	0.006
80.53	12.32	4.02	0.35	2.23	99.45	0.138	0.006
85.63	11.55	2.03	0.20	0.53	99.94	0.046	0.005
84.36	11.82	2.53	0.28	0.82	99.81	0.090	0.006
86.64	9.36	2.47	0.23	0.96	99.66	0.088	0.005
85.36	11.22	2.06	0.25	0.94	99.83	0.092	0.005
80.71	14.77	2.77	0.25	1.17	99.67	0.094	0.013
82.04	13.05	2.96	0.28	1.27	99.60	0.106	0.009
82.99	11.78	3.02	0.30	1.38	99.47	0.100	0.006
81.08	12.66	3.49	0.35	1.68	99.26	0.132	0.006
89.00	8.39	0.91	0.15	1.19	99.64	0.152	0.005
89.10	8.66	1.16	0.15	0.81	99.88	0.056	0.015
87.73	8.56	2.32	0.28	1.04	99.93	0.102	0.019
83.56	9.10	3.53	0.33	2.04	98.56	0.128	0.006
89.46	7.65	1.54	0.18	1.04	99.87	0.038	0.013
88.18	8.37	1.96	0.20	1.09	99.80	0.078	0.013
88.00	9.00	1.97	0.15	0.85	99.97	0.068	0.005
80.35	13.12	3.86	0.35	1.88	99.56	NOT ANALYZED	
83.27	10.58	3.55	0.30	1.70	99.40		
73.70	14.95	6.26	0.45	2.97	98.33		
74.98	13.31	6.02	0.48	3.04	97.83		
77.16	13.85	4.46	0.35	2.14	97.96		
76.52	15.97	4.33	0.35	1.55	98.72		
72.24	19.22	4.87	0.40	2.13	98.86		
73.24	18.57	4.53	0.40	2.31	99.05		
68.69	21.42	5.33	0.45	2.87	98.76		
69.78	21.86	4.34	0.45	2.30	98.73		
73.15	20.89	3.57	0.30	1.61	99.52		
80.17	15.50	2.58	0.30	1.29	99.84		
74.16	15.79	5.49	0.45	3.18	99.07		
80.62	12.01	3.54	0.34	1.90	98.41		
81.26	11.54	4.58	0.35	1.58	99.31		

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION Lithology	Formation
350-351				
351-352				
352-353				
353-354				
354-355				
355-356				
356-357				
357-358				
358-359				
359-360				
360-361				
361-362				
362-363			Limestone, yellowish- to pale-yellowish-brown and light-olive-gray, micrograined, with scattered birdseyes and veinlets of crystalline calcite; some thin zones of very fine- to medium-grained calcarenite; mottled with irregular bodies and thin irregular zones of very finely crystalline dolomite; scattered fossil fragments and bioclastic grains (brachiopods and crinoids); very thin vertical veinlets of calcite in interval 378-379 feet; small bodies of light-colored, chalk-like chert in interval 360-361 feet; small bodies of light-colored, chalk-like, siliceous(?) material in interval 364-366 feet; stylolites; some very thin argillaceous seams in lower part.	CAMP NELSON LIMESTONE
363-364				
364-365				
365-366				
366-367				
367-368				
368-369				
369-370	21	39		
370-371				
371-372				
372-373				
373-374				
374-375				
375-376				
376-377				
377-378				
378-379				
379-380				
380-381				
381-382				
382-383				
383-384				
384-385				
385-386				
386-387				
387-388				
388-389				
389-390				
390-391			Limestone, medium-gray and yellowish-brown to olive-gray, micrograined; mottled with irregular bodies and thin zones of very finely crystalline dolomite; one stylolite; some very thin argillaceous seams, mainly in upper part.	
391-392				
392-393	22	7		
393-394				
394-395				
395-396				
396-397			Limestone, yellowish-brown, micrograined, with few birdseyes of crystalline calcite; mottled with irregular bodies of very finely crystalline dolomite; stylolites; few very thin argillaceous seams.	
397-398				
398-399	23	10		
399-400				
400-401				

Table 2.—Continued.

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
76.62	14.39	5.79	0.40	2.24	99.44	NOT ANALYZED	
81.08	11.34	4.75	0.35	1.86	99.38		
86.18	8.79	3.65	0.25	1.07	99.94		
83.08	8.65	5.14	0.34	2.12	99.33		
87.64	6.03	4.18	0.38	1.45	99.68		
96.01	1.87	1.51	0.15	0.43	99.97	0.100	0.006
94.74	2.95	1.46	0.15	0.70	100.00	0.106	0.003
94.83	3.37	1.07	0.18	0.51	99.96	0.072	0.004
94.74	3.72	1.28	0.15	0.10	99.99	0.054	0.005
95.66	3.10	0.74	0.12	0.21	99.83	0.030	0.006
94.65	2.07	2.86	0.15	0.26	99.99	0.046	0.006
93.65	2.27	3.07	0.15	0.53	99.67	0.048	0.006
95.38	2.15	2.08	0.13	0.24	99.98	0.066	0.004
94.43	3.65	1.20	0.10	0.48	99.86	0.054	0.004
93.29	4.04	1.25	0.15	0.45	99.18	0.068	0.006
93.29	4.50	0.64	0.10	0.36	98.89	0.066	0.011
95.47	1.78	0.96	0.10	0.39	98.70	0.060	0.006
94.20	3.70	0.77	0.13	0.32	99.12	0.030	0.004
96.02	1.09	0.81	0.10	0.71	98.73	0.038	0.006
95.84	1.34	1.04	0.10	0.51	98.83	0.052	0.004
94.29	3.98	0.92	0.06	0.73	99.98	0.026	0.004
92.92	5.53	0.80	0.10	0.59	99.43	0.036	0.006
83.36	13.00	1.66	0.18	0.89	99.09	0.108	0.007
90.01	8.53	0.48	0.10	0.38	99.50	0.048	0.009
87.55	10.27	0.92	0.15	0.36	99.25	0.064	0.006
94.47	3.75	1.02	0.10	0.54	99.88	0.056	0.006
94.47	2.84	0.86	0.15	0.72	99.04	0.062	0.006
94.20	3.40	1.23	0.10	0.87	99.80	0.086	0.011
93.65	2.95	1.31	0.13	0.89	98.93	0.084	0.006
92.74	3.84	2.04	0.10	0.75	99.47	0.080	0.006
94.29	3.08	1.79	0.13	0.36	99.65	0.052	0.006
92.98	3.40	1.59	0.14	0.57	98.68	0.092	0.006
90.92	4.11	2.93	0.19	1.09	99.24	0.142	0.006

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION: Lithology	Formation
401-402 402-403 403-404 404-405 405-406	23-Continued			
406-407 407-408 408-409 409-410 410-411 411-412 412-413 413-414 414-415	24	9	Limestone, yellowish-brown, micrograined; in part fine- to coarse-grained calcarenite in interval 411-414 feet; minor mottling with small bodies and thin seams of very finely crystalline dolomite; few brachiopods; stylolites. Gradational with underlying ledge.	
415-416 416-417 417-418 418-419 419-420 420-421	25	6	Limestone, yellowish- to very dark-yellowish-brown, micrograined, with scattered veinlets and birdseyes of crystalline calcite; in part very fine- to fine-grained calcarenite in interval 418-419 feet; some mottling with irregular bodies and very thin zones of very finely crystalline dolomite; few brachiopods; stylolites. Gradational with overlying ledge.	CAMP NELSON LIMESTONE
421-422 422-423 423-424 424-425 425-426 426-427	26	6	Limestone, very light- to light-olive-gray, with minor medium-gray mottling, micrograined to microcrystalline, with some scattered birdseyes and veinlets of crystalline calcite; some thin zones and small irregular bodies of yellowish-brown, very finely crystalline dolomite; few brachiopods; traces of pyrite in lower 3 feet; few stylolites.	
427-428 428-429 429-430 430-431 431-432 432-433 433-434	27	7	Limestone, very dark-yellowish- to dark-yellowish-brown, micrograined, with scattered birdseyes and veinlets of crystalline calcite; in part very fine- to coarse-grained calcarenite (dominant lithology in lower 3 feet); few very thin zones of very finely crystalline dolomite; some brachiopods in interval 429-434 feet; few very thin argillaceous seams.	

Table 2.—Continued.

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
86.64	7.73	3.12	0.18	1.28	98.95	0.116	0.006
85.45	8.60	3.26	0.18	1.17	98.66	0.128	0.006
84.27	9.92	3.39	0.18	1.18	98.94	0.118	0.007
84.54	9.77	3.94	0.20	1.33	99.78	0.074	0.008
86.45	8.47	3.28	0.20	1.00	99.40	0.108	0.006
87.09	6.35	4.02	0.18	1.12	98.76	0.126	0.007
89.73	3.68	3.45	0.18	1.34	98.38	0.132	0.008
91.46	5.08	2.14	0.15	1.13	99.96	0.078	0.007
92.56	3.52	2.44	0.15	1.17	99.84	0.068	0.007
90.92	5.45	2.33	0.15	0.97	99.82	0.092	0.007
84.81	10.03	3.72	0.20	1.14	99.40	0.044	0.007
87.82	8.50	2.45	0.18	0.78	99.73	0.076	0.010
92.38	4.28	2.29	0.15	0.86	99.96	0.078	0.008
89.46	6.31	2.61	0.15	0.91	99.44	0.090	0.015
83.27	7.35	5.48	0.33	2.33	98.76	NOT ANALYZED	
83.63	7.03	5.83	0.35	3.07	99.91		
87.73	6.34	3.77	0.27	1.67	99.78		
92.01	3.07	4.21	0.19	0.51	99.99		
86.09	2.09	10.30	0.53	0.61	99.62		
93.47	5.01	0.81	0.18	0.23	99.70		
89.10	5.72	4.20	0.25	0.37	99.64		
89.82	8.20	1.22	0.25	0.27	99.76		
88.00	7.89	2.53	0.20	1.24	99.86		
84.54	9.75	3.33	0.30	1.50	99.42		
83.81	9.42	3.98	0.28	2.04	99.53		
81.72	10.80	4.14	0.27	1.99	98.92		
74.34	9.70	9.20	0.37	3.99	97.60		
84.18	7.71	4.23	0.33	1.98	98.43		
88.55	7.95	1.97	0.20	0.82	99.49		
89.10	8.00	1.63	0.20	0.64	99.57		
89.64	5.94	2.34	0.20	1.32	99.44		
85.45	7.88	3.48	0.30	1.85	98.86		
82.08	7.46	5.80	0.38	2.34	98.06		
76.71	9.00	8.47	0.50	3.35	98.03		
80.62	8.06	6.50	0.40	2.58	98.16		
85.82	6.43	4.27	0.33	1.92	98.77		
92.38	2.66	2.08	0.20	0.62	97.94		
93.29	1.66	2.18	0.18	0.80	98.11		
92.74	1.45	2.09	0.18	0.76	97.22		
89.46	4.63	2.80	0.23	1.43	98.55		
88.73	5.41	3.75	0.20	1.29	99.38		
87.09	5.23	4.66	0.28	1.70	98.96		
87.64	5.50	4.39	0.28	1.94	99.75		
92.19	2.86	2.68	0.20	1.16	99.09		
84.72	5.69	5.51	0.33	2.19	98.44		
91.46	3.86	2.93	0.23	0.94	99.42		
86.36	5.03	5.46	0.30	2.10	99.25		
91.92	2.31	3.50	0.23	1.46	99.42		
92.83	2.28	3.16	0.18	1.20	99.65		
90.55	3.40	3.57	0.30	1.60	99.42		
90.74	3.25	3.46	0.28	1.46	99.19		

Sampled by:
Analyzed by:
Date Sampled:

DESCRIPTION				
Sample Level (Feet)	Ledge No.	Thickness (Feet)	Lithology	Formation
434-435 435-436 436-437 437-438 438-439 439-440 440-441 441-442 442-443 443-444 444-445 445-446 446-447 447-448 448-449 449-450 450-451 451-452 452-453 453-454 454-455 455-456 456-457 457-458 458-459 459-460 460-461 461-462 462-463 463-464 464-465 465-466 466-467 467-468 468-469 469-470	28	36	Limestone, yellowish- to dark-yellowish-brown and olive- to light-olive-gray, micrograined, with few scattered veinlets and birdseyes of crystalline calcite; some very fine- to coarse-grained, bioclastic calcarenite; mottled with irregular bodies and thin zones of very finely crystalline dolomite; scattered fossil fragments (mainly brachiopods); small bodies and thin zones of very light-olive- to very light-gray chert, in part chalk-like, in intervals 451-453 and 454-455 feet; scattered stylolites; some very thin, dark-greenish-gray argillaceous seams, mainly in lower part.	CAMP NELSON LIMESTONE
470-471 471-472 472-473 473-474 474-475 475-476 476-477 477-478 478-479 479-480 480-481 481-482 482-483 483-484 484-485	29	24	Limestone, yellowish- to dark-yellowish-brown and olive- to light-olive-gray, micrograined, with few scattered veinlets and birdseyes of crystalline calcite; few zones of very fine- to coarse-grained, bioclastic calcarenite; some to minor mottling with irregular bodies and thin zones of very finely crystalline dolomite; micrograined limestone grades downward into very finely crystalline to microcrystalline, silty, dolomitic limestone in lower 2 feet; scattered fossil fragments (mainly brachiopods; locally, colonial coral, Tetradium); traces of pyrite in intervals 471-472 and 493-494 feet; scattered stylolites; few very thin, dark-greenish-gray argillaceous seams. Gradational with underlying ledge.	

Table 2.—Continued.

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
92.56	2.77	2.67	0.20	1.35	99.55	NOT ANALYZED	
93.92	3.32	1.82	0.18	0.73	99.97		
94.56	2.39	1.62	0.15	1.12	99.84		
94.17	1.90	2.69	0.10	0.92	99.78		
94.19	2.56	2.43	0.15	0.55	99.88		
91.10	4.08	3.03	0.15	1.61	99.97		
85.36	6.48	4.79	0.25	1.68	98.56		
86.36	5.81	5.35	0.20	1.81	99.53		
70.78	15.28	9.95	0.33	2.66	99.00		
62.31	21.32	11.99	0.48	3.37	99.47		
62.59	21.35	12.24	0.48	3.25	99.91		
62.31	21.24	11.10	0.48	3.66	98.79		
62.68	16.26	13.59	0.45	4.35	97.33		
63.99	18.11	13.94	0.50	2.53	99.07		
67.67	17.12	12.21	0.40	1.86	99.26		
82.06	8.06	8.16	0.25	1.43	99.96		
69.15	12.43	14.22	0.40	2.07	98.27		
80.40	6.83	9.01	0.25	2.13	98.62		
83.72	5.47	7.66	0.25	2.06	99.16		
87.22	4.44	6.08	0.15	1.63	99.52		
86.69	4.48	6.51	0.20	2.08	99.96		
87.41	6.06	5.28	0.25	0.99	99.99		
86.39	5.82	6.10	0.25	1.38	99.94		
84.64	4.60	7.60	0.25	2.10	99.19		
85.28	6.24	6.96	0.25	1.21	99.94		
92.56	3.57	2.97	0.15	0.55	99.80		
92.92	3.30	2.88	0.15	0.75	100.00		
74.59	5.73	13.86	0.35	4.57	99.10		
85.93	2.95	8.04	0.20	2.41	99.53		
86.85	3.62	6.98	0.18	1.91	99.54		
90.45	4.16	4.07	0.18	0.94	99.80		
89.80	5.68	3.35	0.18	0.93	99.94		
90.73	6.09	2.37	0.18	0.57	99.94		
77.50	10.63	8.04	0.35	2.62	99.14		
88.14	6.97	3.32	0.23	1.26	99.92		
76.62	14.42	6.56	0.35	2.04	99.99		
94.21	3.73	1.55	0.15	0.33	99.97		
95.54	2.66	1.28	0.13	0.34	99.95		
75.52	16.87	4.73	0.35	1.40	98.87		
82.72	12.17	3.71	0.28	0.78	99.66		
87.62	9.12	2.46	0.23	0.50	99.93		
90.64	6.12	2.39	0.23	0.56	99.94		
86.06	9.68	3.14	0.20	0.91	99.99		
88.18	7.56	3.00	0.20	0.84	99.78		
88.74	6.34	3.57	0.20	0.95	99.80		
84.73	8.27	4.06	0.23	1.53	98.82		
87.69	8.10	2.67	0.23	1.05	99.74		
83.99	10.54	3.11	0.25	1.53	99.42		
86.99	6.16	3.02	0.18	1.65	98.00		
84.87	6.81	5.63	0.20	1.95	99.46		

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION Lithology	Formation
485-486 486-487 487-488 488-489 489-490 490-491 491-492 492-493 493-494	29-Continued			
494-495 495-496 496-497 497-498 498-499 499-500 500-501 501-502	30	8	Dolomitic limestone, olive- to light-olive-gray and yellowish-brown, with some medium-dark-gray mottling, very finely crystalline, silty; in part micrograined limestone in lower 2 feet; some very thin greenish- to dark-greenish-gray shales and argillaceous seams in upper 4 feet. Gradational with overlying ledge.	
502-503 503-504 504-505 505-506 506-507 507-508 508-509 509-510 510-511 511-512 512-513 513-514 514-515 515-516 516-517 517-518 518-519 519-520 520-521 521-522 522-523 523-524 524-525 525-526 526-527 527-528 528-529 529-530 530-531 531-532 532-533 533-534 534-535	31	42	Limestone, yellowish- to very dark-yellowish-brown and light-olive-gray, with minor medium-dark-gray mottling, micrograined to microcrystalline, with some birdseyes and veinlets of crystalline calcite; few zones of very fine- to medium-grained calcarenite; mottled with irregular bodies and thin zones of very finely crystalline dolomite; scattered fossil fragments, mainly in upper part; some quartz silt, mainly in upper part; traces of pyrite in interval 512-514 feet; few very thin, greenish-gray argillaceous seams.	CAMP NELSON LIMESTONE

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
83.22	6.42	6.69	0.23	2.40	98.96	NOT ANALYZED	
76.80	9.19	8.58	0.33	3.06	97.96		
95.41	1.59	1.82	0.10	1.05	99.97		
89.63	2.03	4.76	0.15	2.07	98.64		
90.00	3.14	4.41	0.20	1.70	99.45		
81.39	8.72	6.49	0.28	2.64	99.52		
85.97	7.45	3.38	0.25	1.23	98.28		
88.72	5.18	2.86	0.25	0.97	97.98		
93.30	4.26	1.56	0.20	0.67	99.99		
92.66	3.28	1.93	0.20	0.89	98.96		
89.27	5.21	2.76	0.18	1.34	98.76		
83.40	7.82	3.93	0.25	2.10	97.50		
88.90	5.54	3.12	0.18	1.43	99.17		
91.28	5.65	1.68	0.23	0.85	99.69		
89.07	8.21	1.96	0.23	0.51	99.98		
88.46	8.33	2.03	0.25	0.80	99.87		
91.28	6.03	1.96	0.25	0.41	99.93		
88.18	6.43	3.23	0.20	1.56	99.60		
78.98	11.93	6.46	0.30	2.28	99.95		
74.52	10.78	8.44	0.35	3.35	97.44		
77.98	8.38	8.38	0.33	3.08	98.15		
77.98	10.16	7.18	0.40	2.79	98.51		
87.73	5.96	3.61	0.20	1.41	98.91		
81.53	10.15	5.27	0.33	1.75	99.03		
87.09	7.24	3.38	0.20	1.06	98.97		
88.46	6.23	2.99	0.20	1.03	98.91		
83.45	9.03	4.09	0.15	0.68	98.40		
91.65	4.35	2.31	0.12	0.76	99.19	0.130	0.015
91.19	5.17	2.25	0.13	0.73	99.47	0.058	0.015
92.32	4.43	2.01	0.14	0.88	99.78	0.092	0.009
84.64	9.71	2.60	0.19	1.51	98.65	0.140	0.024
86.77	8.45	2.50	0.15	1.29	99.16	0.228	0.029
87.69	8.60	1.78	0.13	1.34	99.54	0.158	0.015
92.41	5.15	0.79	0.13	0.81	99.29	0.060	0.006
88.89	9.16	0.76	0.14	0.90	99.85	0.070	0.013
82.23	12.36	2.98	0.19	1.45	99.21	0.078	0.031
79.27	13.73	4.18	0.20	2.01	99.39	0.164	0.020
92.13	6.53	0.67	0.10	0.48	99.91	0.118	0.006
89.54	8.41	1.05	0.18	0.57	99.75	0.090	0.015
88.80	9.59	1.09	0.12	0.35	99.95	0.050	0.011
89.78	8.36	1.10	0.12	0.51	99.87	0.116	0.010

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION Lithology	Formation
535-536 536-537 537-538 538-539 539-540 540-541 541-542 542-543 543-544	31-Continued			
544-545 545-546 546-547 547-548 548-549 549-550 550-551 551-552 552-553	32	9	Limestone, light-olive- to very light-olive-gray and yellowish-brown, with minor medium-dark-gray mottling, micrograined, with scattered birdseyes and veinlets of crystalline calcite; some very fine- to medium-grained calcarenite; some thin zones of yellowish- to dark-yellowish-brown, very finely crystalline dolomite; traces of pyrite in intervals 545-546 and 552-553 feet; very thin, greenish-gray argillaceous seam in basal foot.	
553-554 554-555 555-556 556-557	33	4	Dolomitic limestone, light-olive- to greenish-gray, microcrystalline to very finely crystalline, slightly argillaceous; in part micrograined limestone; some fine- to medium-grained calcarenite; traces of pyrite in interval 554-556 feet; few very thin argillaceous seams in interval 554-555 feet.	CAMP NELSON LIMESTONE
557-558 558-559 559-560 560-561 561-562 562-563 563-564 564-565	34	8	Limestone, light-olive-gray to dark-yellowish-brown, with minor medium-dark-gray mottling, micrograined, in part finely laminated, with scattered birdseyes and veinlets of crystalline calcite; thin zones of very finely crystalline dolomite, mainly in upper 5 feet; traces of pyrite in interval 559-562 feet.	
565-566 566-567 567-568	35	3	Limestone, dark-yellowish- to yellowish-brown, with minor medium-dark-gray mottling, micrograined, with scattered birdseyes and veinlets of crystalline calcite; mottled with irregular bodies of very finely crystalline dolomite.	
568-569 569-570 570-571 571-572 572-573 573-574 574-575 575-576	36	8	Limestone, very light-olive- to light-olive-gray and dark-yellowish- to pale-yellowish-brown, micrograined, in part finely laminated, with some birdseyes and veinlets of crystalline calcite; zones of very finely crystalline dolomite; traces of pyrite in interval 573-574 feet; few stylolites. Gradational with underlying ledge.	

Table 2.—Continued.

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
86.27	11.69	1.35	0.17	0.48	99.96	0.042	0.005
81.03	16.04	1.77	0.20	0.79	99.83	0.092	0.007
79.74	17.98	1.58	0.20	0.38	99.88	0.078	0.006
77.97	20.03	1.36	0.18	0.44	99.98	0.118	0.007
81.67	17.04	0.80	0.20	0.21	99.92	0.094	0.005
79.18	19.25	1.00	0.23	0.34	100.00	0.080	0.007
78.81	19.34	1.18	0.21	0.25	99.79	0.068	0.004
77.89	20.05	1.31	0.18	0.53	99.96	0.080	0.007
74.65	22.74	1.96	0.20	0.43	99.98	0.080	0.004
75.30	22.53	1.52	0.20	0.36	99.91	0.084	0.008
83.62	14.95	0.41	0.18	0.46	99.62	0.170	0.007
76.87	21.62	0.86	0.17	0.44	99.96	0.060	0.012
72.34	25.22	1.43	0.24	0.63	99.86	0.066	0.007
74.46	22.55	1.97	0.25	0.62	99.85	0.098	0.010
80.38	17.08	1.51	0.18	0.44	99.59	0.080	0.004
85.75	13.03	0.66	0.18	0.26	99.88	0.068	0.009
92.13	3.20	3.30	0.16	0.99	99.78	0.116	0.005
80.48	15.30	2.77	0.23	1.09	99.87	0.090	0.011
73.08	24.39	1.36	0.26	0.55	99.64	0.052	0.004
76.31	22.22	0.59	0.21	0.40	99.73	0.018	0.008
75.02	23.07	0.78	0.24	0.54	99.65	0.020	0.006
74.65	22.46	1.36	0.23	0.46	99.16	0.040	0.010
75.11	21.85	1.86	0.20	0.93	99.95	0.052	0.008
76.50	19.26	1.86	0.23	1.09	98.94	0.056	0.009
84.73	10.73	2.28	0.18	1.27	99.19	0.072	0.009
91.39	5.96	1.34	0.14	0.76	99.59	0.054	0.009
92.32	5.08	1.43	0.17	0.33	99.33	0.082	0.009
86.77	11.39	1.44	0.17	0.20	99.97	0.056	0.010
86.54	12.13	0.91	0.19	0.16	99.93	0.034	0.008
85.47	12.58	1.35	0.18	0.40	99.98	0.082	0.011
89.36	9.33	0.66	0.15	0.49	99.99	0.068	0.010
87.69	9.51	1.40	0.13	0.74	99.47	0.074	0.011
88.47	9.19	1.42	0.13	0.49	99.70	0.054	0.009
86.03	11.87	1.31	0.18	0.55	99.94	0.074	0.005
85.47	13.31	0.89	0.13	0.19	99.99	0.050	0.004
79.24	18.64	1.26	0.17	0.27	99.58	0.066	0.006
77.98	19.94	1.50	0.14	0.35	99.91	0.056	0.005
75.30	21.39	1.95	0.18	0.66	99.48	0.044	0.010
80.57	18.31	0.87	0.15	0.09	99.99	0.046	0.005
78.35	20.62	0.70	0.20	0.09	99.96	0.036	0.010
72.05	26.01	1.46	0.22	0.25	99.99	0.040	0.007
70.30	27.73	1.63	0.20	0.12	99.98	0.054	0.008
79.92	18.50	0.68	0.22	0.44	99.76	0.034	0.008
74.93	23.60	0.72	0.20	0.50	99.95	0.018	0.010
78.07	20.72	0.74	0.18	0.45	99.98	0.044	0.006
76.76	21.43	0.60	0.24	0.39	99.42	0.066	0.011
78.53	19.91	0.47	0.18	0.81	99.90	0.056	0.014
73.63	23.25	1.22	0.23	1.02	99.35	0.062	0.016
74.74	22.08	1.39	0.20	0.86	99.27	0.050	0.012
80.85	16.78	0.99	0.17	0.84	99.63	0.034	0.013
79.18	18.96	1.30	0.21	0.27	99.92	0.054	0.013

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION Lithology	Formation
576-577 577-578 578-579 579-580 580-581 581-582 582-583 583-584 584-585 585-586 586-587 587-588 588-589 589-590 590-591 591-592	37	16	Limestone, light-olive-gray and very pale yellowish-brown, micrograined to microcrystalline; some very fine- to fine-grained calcarenite; mottled with small irregular bodies and, in upper 2 feet, thin zones of very finely crystalline dolomite (in part dark-yellowish-brown and olive-gray); scattered fossil fragments (locally, colonial coral, Tetradium); stylolites. Gradational with overlying and underlying ledges.	
592-593 593-594 594-595 595-596 596-597 597-598 598-599 599-600 600-601 601-602 602-603 603-604 604-605 605-606 606-607	38	15	Dolomitic limestone, very light-olive-gray to dark-yellowish-brown, microcrystalline to very finely crystalline; interlayers of micrograined limestone (in part gradational with the dolomitic limestone), with some birdseyes and veinlets of crystalline calcite; some thin zones of very finely crystalline dolomite (in part yellowish-brown) in the micrograined limestone; traces of pyrite in intervals 599-600 and 604-605 feet; some stylolites. Gradational with overlying ledge.	CAMP NELSON LIMESTONE
607-608 608-609 609-610 610-611 611-612 612-613 613-614 614-615 615-616 616-617 617-618 618-619 619-620 620-621 621-622 622-623 623-624 624-625 625-626 626-627½	39	20½	Limestone, very pale-yellowish- to yellowish-brown, micrograined, with few birdseyes and veinlets of crystalline calcite; with earthy appearance in interval 614-627½ feet; thin zones of bioclastic calcarenite in interval 614-622 feet; mottled with irregular bodies and thin zones of very finely crystalline dolomite (in part olive-gray and yellowish-brown); some brachiopods in interval 609-611 feet; some stylolites.	

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
63.00	19.11	12.46	0.39	3.36	98.32	NOT ANALYZED	
63.00	22.00	9.77	0.37	3.02	98.16		
70.49	22.68	4.17	0.31	1.21	98.86		
69.84	15.21	9.40	0.29	2.83	97.57		
68.22	16.78	9.08	0.33	3.13	97.54		
64.80	24.13	7.02	0.27	2.13	98.35		
68.40	13.30	11.36	0.41	3.35	96.72		
69.75	20.08	5.68	0.31	2.35	98.17		
65.68	18.33	10.64	0.33	3.11	98.09		
84.92	7.15	4.79	0.23	1.88	98.97		
87.14	6.56	3.92	0.18	1.58	99.38		
87.32	9.12	2.20	0.18	0.70	99.52		
89.36	7.67	1.94	0.18	0.70	99.85		
89.73	6.49	2.55	0.14	0.99	99.90		
93.61	3.86	1.72	0.12	0.66	99.97		
92.16	4.78	1.87	0.15	0.65	99.61		
87.30	5.84	3.12	0.17	1.12	97.55		
80.01	10.23	5.87	0.24	2.05	98.40		
73.26	12.65	8.12	0.41	2.66	97.10		
85.14	10.19	3.37	0.28	0.98	99.96		
81.54	12.09	3.66	0.35	1.45	99.09		
87.84	7.56	3.07	0.28	1.18	99.93		
88.92	5.78	3.25	0.24	1.24	99.43		
86.04	9.74	1.89	0.26	0.97	98.90		
85.68	7.42	4.21	0.23	1.62	99.16		
83.88	11.31	2.55	0.23	1.15	99.12		
88.92	5.85	2.29	0.21	0.69	97.96		
79.20	11.58	4.86	0.32	1.79	97.75		
81.99	8.86	4.54	0.30	2.68	98.37		
73.98	13.05	7.20	0.24	3.26	97.73		
72.81	13.34	8.65	0.30	3.58	98.68		
66.87	14.91	10.59	0.28	4.30	97.95		
76.50	12.17	5.75	0.23	2.61	97.26		
64.98	23.30	7.38	0.34	2.51	98.51		
62.10	25.43	8.46	0.38	2.68	99.05		
56.52	27.13	11.13	0.43	3.37	98.58		
55.80	31.80	8.81	0.50	2.27	99.18		
57.06	31.36	7.67	0.45	2.04	98.58		
66.69	22.94	6.93	0.35	1.90	98.81		

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION: Lithology	Formation
627½-629 629 -630 630 -631 631 -632 632 -633 633 -634 634 -635 635 -636 636 -637	40	9½	Dolomitic limestone, medium-dark- to medium-gray, in part light-olive-gray and dark-greenish-gray, very finely crystalline, slightly argillaceous and silty; few zones of micrograined to microcrystalline limestone; some brachiopods in interval 631-632 feet; stylolites in lower 3 feet.	
637 -638 638 -639 639 -640 640 -641 641 -642 642 -643 643 -644 644 -645 645 -646 646 -647 647 -648 648 -649 649 -650 650 -651 651 -652 652 -653 653 -654 654 -655 655 -656 656 -657 657 -658 658 -659 659 -660 660 -661	41	24	Limestone, olive-gray and yellowish- to dark-yellowish-brown, micrograined to microcrystalline, with some birdseyes of crystalline calcite; some thin zones of fine- to medium-grained calcarenite; mottled with small irregular bodies and thin zones of very finely crystalline dolomite; slightly argillaceous and silty, mainly in lower part; scattered fossils (ostracodes and brachiopods) in lower part; some stylolites.	CAMP NELSON LIMESTONE
661 -662 662 -663 663 -664 664 -665 665 -666 666 -667	42	6	Dolomite and dolomitic limestone, light-olive-gray to yellowish-brown, with medium-dark- to medium-gray laminations and mottling, very finely crystalline; very thin, vertical veinlet of crystalline calcite in interval 663-664 feet; 3/4-inch silty shale in interval 663-664 feet. Gradational with underlying ledge.	

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
78.48	17.72	2.61	0.28	0.83	99.92	NOT ANALYZED	
74.16	22.44	2.29	0.30	0.73	99.92		
68.94	27.46	2.47	0.33	0.77	99.97		
73.62	20.19	4.26	0.28	1.51	99.86		
78.39	17.68	2.04	0.30	0.75	99.16		
88.83	9.53	1.01	0.23	0.33	99.93		
88.83	8.72	1.64	0.25	0.54	99.98		
79.83	12.51	4.93	0.20	1.89	99.36		
84.69	12.02	2.24	0.25	0.79	99.99		
91.26	7.15	1.04	0.18	0.35	99.98		
79.38	12.04	4.76	0.25	2.28	98.71		
69.30	13.57	10.65	0.33	3.90	97.75		
90.54	5.84	2.69	0.15	0.69	99.91		
87.03	8.42	2.92	0.15	0.91	99.43		
82.89	11.03	3.19	0.15	1.24	98.50		
84.42	10.93	3.01	0.20	1.11	99.67		
71.82	19.65	5.13	0.25	1.79	98.64		
78.39	17.07	3.03	0.24	1.20	99.93		
79.29	16.13	3.13	0.25	1.14	99.94		
78.48	16.48	3.53	0.23	1.23	99.95		
95.22	2.60	1.45	0.15	0.56	99.98		
95.04	3.41	0.84	0.15	0.52	99.96		
94.77	3.33	0.95	0.15	0.43	99.63		
86.22	8.75	3.08	0.15	1.42	99.62		
69.84	15.53	8.44	0.43	3.05	97.29		
66.78	13.76	9.77	0.53	4.23	95.07		
53.91	24.03	11.68	0.60	5.06	95.28		
55.26	30.00	8.46	0.47	3.18	97.37		
49.50	33.69	9.76	0.53	3.83	97.31		
51.48	35.99	8.60	0.50	2.21	98.78		
55.26	35.00	7.02	0.60	1.72	99.60		
56.52	35.40	5.66	0.43	1.76	99.77		
56.70	37.75	3.92	0.43	1.07	99.87		
57.24	38.34	2.76	0.53	0.79	99.66		
58.14	37.00	2.96	0.43	0.94	99.47		
51.66	35.83	8.64	0.38	2.61	99.12		
57.96	37.45	3.14	0.40	0.94	99.89		
54.90	39.24	4.12	0.48	1.00	99.74		
54.05	38.86	4.89	0.36	1.47	99.63		
52.38	35.41	6.61	0.35	2.29	97.04		
53.82	38.63	5.42	0.33	1.74	99.94		
53.64	39.64	4.37	0.33	1.85	99.83		
54.36	39.95	3.36	0.51	1.75	99.93		
54.90	38.02	3.17	0.33	1.66	98.08		
54.00	39.37	3.99	0.33	1.97	99.66		
54.27	40.68	3.55	0.33	0.98	99.81		
54.72	40.03	3.75	0.33	1.03	99.85		
55.80	41.04	2.10	0.35	0.70	99.99		
55.98	36.20	3.97	0.56	1.41	98.12		
58.32	35.75	3.88	0.46	1.23	99.64		

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION: Lithology	Formation
667-668 668-669 669-670 670-671 671-672 672-673 673-674 674-675 675-676 676-677 677-678 678-679 679-680 680-681 681-682 682-683 683-684 684-685 685-686 686-687	43	20	Limestone, yellowish-brown, micrograined, with some birdseyes and veinlets of crystalline calcite; mottled with zones and irregular bodies of very finely crystalline dolomite (dark-yellowish- to yellowish-brown and medium-gray); in part dark-greenish-gray, silty, argillaceous dolomite in interval 677-679 feet; some stylolites. Gradational with overlying ledge.	
687-688 688-689 689-690 690-691 691-692 692-693	44	6	Limestone, dark-yellowish- to yellowish-brown, micrograined, with few birdseyes and veinlets of crystalline calcite; minor mottling with small irregular bodies of very finely crystalline dolomite in upper 4 feet; micrograined limestone interlayered with silty dolomite in lower 2 feet; few ostracodes in interval 690-691 feet; very thin argillaceous seams in lower 2 feet. Gradational with underlying ledge.	CAMP NELSON LIMESTONE
693-694 694-695 695-696 696-697 697-698 698-699 699-700 700-701 701-702 702-703 703-704 704-705 705-706 706-707 707-708 708-709 709-710 710-711 711-712 712-713 713-714 714-715 715-716 716-717	45	24	Dolomite, very pale-yellowish- to pale-yellowish-brown and light-olive-gray, with medium-dark-gray laminations, very finely crystalline, with earthy appearance; slightly silty in upper part; few very thin veinlets of crystalline calcite in interval 713-714 feet; few stylolites; very thin, silty, argillaceous seams and shales in intervals 693-697, 702-703, and 706-707 feet. Gradational with overlying ledge.	

Table 2.—Continued.

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
60.84	27.56	5.53	0.39	2.79	97.01	NOT ANALYZED	
67.77	24.73	4.95	0.32	1.61	99.38		
70.38	24.06	3.70	0.25	1.14	99.53		
70.92	23.19	3.69	0.24	1.44	99.46		
56.70	27.79	10.06	0.49	3.28	98.32		
71.73	23.71	3.39	0.37	0.65	99.85		
74.25	21.65	2.62	0.28	0.85	99.65		
64.98	26.72	4.47	0.33	1.66	98.16		
70.74	23.89	3.95	0.29	0.97	99.84		
60.66	30.17	5.72	0.35	1.68	98.58		
61.20	27.76	7.25	0.33	2.64	99.18		
61.92	30.68	4.72	0.34	1.51	99.17		
59.94	33.81	3.87	0.43	1.22	99.27		
64.17	30.41	3.76	0.45	0.96	99.75		
63.00	30.78	4.41	0.48	1.26	99.93		
68.49	26.20	3.32	0.46	1.36	99.83		
71.01	23.01	4.07	0.31	1.52	99.92		
74.70	15.80	6.19	0.32	2.34	99.35		
76.19	16.90	4.62	0.30	1.80	99.81		
76.41	17.40	4.24	0.28	1.43	99.76		
72.90	17.43	6.63	0.47	2.48	99.91		
81.63	15.23	2.10	0.38	0.54	99.88		
79.83	16.82	2.08	0.41	0.78	99.92		
78.93	11.82	5.76	0.33	2.11	98.95		
66.24	14.56	12.17	0.38	4.44	97.79		
76.14	14.51	6.66	0.28	2.04	99.63		
84.36	11.63	3.23	0.26	0.49	99.97		
77.67	17.13	2.43	0.33	0.60	98.16		
59.76	33.26	4.47	0.47	1.43	99.39		
60.03	30.77	5.30	0.53	2.15	98.78		
57.06	33.19	6.68	0.50	1.98	99.41		
66.69	20.79	8.44	0.45	2.66	99.03		
63.36	18.79	11.43	0.50	3.79	97.87		
78.30	13.17	4.29	0.30	1.54	97.60		
57.60	32.48	6.70	0.58	2.01	99.37		
56.25	30.47	8.73	0.70	2.78	98.93		
55.08	29.41	9.77	0.60	3.30	98.16		

Sampled by:
Analyzed by:
Date Sampled:

Sample Level (Feet)	Ledge No.	Thickness (Feet)	DESCRIPTION: Lithology	Formation
717-718 718-719 719-720 720-721 721-722 722-723 723-724 724-725 725-726 726-727 727-728 728-729 729-730 730-731 731-732 732-733 733-734 734-735 735-736 736-737 737-738 738-739 739-740 740-741 741-742 742-743 743-744 744-745	46	28	Dolomite, olive- to light-olive-gray and yellowish- to very pale-yellowish-brown, with some medium-dark-gray laminations and mottling, microcrystalline to very finely crystalline; thin zones and lenses of olive- to light-olive-gray and yellowish-brown, micrograined limestone; some stylolites; very thin, silty, argillaceous seams in intervals 717-719, 721-722, 734-735, 737-738, and 741-742 feet.	GAMP NELSON LIMESTONE
745-746 746-747 747-748	47	3	Dolomite, very pale-yellowish-brown, with medium- to medium-dark-gray laminations and mottling, very finely crystalline, with earthy appearance; scattered veinlets and small pockets of crystalline calcite in basal foot; ½-inch dark-greenish-gray shale in interval 746-747 feet.	
748-749 749-750 750-751	48	3	Dolomite, light-olive-gray to yellowish-brown, with medium-dark- to medium-gray laminations and mottling, very finely crystalline to microcrystalline, laminated; thin zones of olive- to light-olive-gray, micrograined limestone, in part laminated; very thin, silty, argillaceous seams and shales.	
751-752 752-753 753-754	49	3	Dolomite, very pale-yellowish-brown, with medium- to medium-dark-gray mottling; light-greenish-gray in basal part; very finely crystalline, with earthy appearance; in part faintly laminated; slightly argillaceous; speckled with crystalline calcite.	

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
67.68	16.82	10.38	0.45	2.72	98.05	NOT ANALYZED	
80.18	14.81	3.34	0.42	0.42	99.17		
65.97	23.52	7.27	0.59	1.97	99.32		
62.06	26.75	7.81	0.62	2.31	99.55		
61.11	29.11	6.19	0.68	1.64	98.73		
66.78	27.26	3.54	0.70	1.00	99.28		
68.04	21.99	6.39	0.68	1.41	98.51		
62.46	26.60	5.94	0.72	1.78	97.50		
69.66	20.18	5.65	0.70	1.40	97.59		
84.42	8.29	4.97	0.50	1.07	99.25		
76.23	15.28	4.98	0.57	1.54	98.60		
85.14	7.98	3.68	0.38	1.23	98.41		
93.24	3.12	2.44	0.24	0.52	99.56		
79.20	15.26	3.43	0.54	1.28	99.71		
65.07	22.53	8.34	0.58	2.68	99.20		
55.62	30.60	8.19	0.68	3.17	98.26		
56.88	31.25	8.18	0.57	2.16	99.04		
61.20	29.89	6.32	0.43	1.47	99.31		
49.86	32.10	10.56	0.60	3.71	96.83		
47.52	30.63	13.07	0.70	4.78	96.70		
56.16	27.55	11.18	0.62	3.19	98.70		
55.44	29.59	10.48	0.39	2.99	98.89		
48.92	32.21	12.25	0.59	3.89	97.86		
45.41	32.69	13.84	0.58	4.71	97.23		
56.34	31.93	8.82	0.50	2.06	99.65		
59.04	31.14	7.14	0.44	1.45	99.21		
47.43	30.74	14.91	0.54	5.13	98.75		
53.64	33.12	10.59	0.47	2.14	99.96		
50.85	34.97	11.16	0.50	1.87	99.35		
45.05	34.37	15.30	0.65	3.75	99.12		
43.38	34.41	13.78	0.78	4.38	96.73		
39.83	32.04	18.14	0.69	6.56	97.26		
44.28	34.90	12.99	0.72	4.39	97.28		
42.66	34.56	14.89	0.63	4.73	97.47		
40.23	34.04	17.79	0.59	6.12	98.77		
43.88	33.78	15.08	0.70	4.55	97.99		
43.38	34.28	14.96	0.72	4.32	97.66		
38.61	32.36	19.70	0.63	6.30	97.60		
46.17	33.49	14.55	0.62	3.64	98.47		
41.76	32.18	18.60	0.68	4.82	98.04		
40.32	32.29	17.45	0.70	5.86	96.62		
32.04	26.05	27.71	0.70	8.52	95.02		
49.59	33.96	11.82	0.68	3.23	99.28		
43.11	33.97	14.44	0.58	5.47	97.57		

Sampled by:
Analyzed by:
Date Sampled:

DESCRIPTION

Sample Level (Feet)	Ledge No.	Thickness (Feet)	Lithology	Formation
754-755 755-756 756-757 757-758 758-759 759-760 760-761 761-762 762-763 763-764 764-765 765-766 766-767 767-768 768-769	50	15	Dolomite, yellowish- to dark-yellowish-brown and light-olive-gray, with some medium-dark-gray laminations and mottling, very finely crystalline to microcrystalline; in part laminated; in part with relict, bioclastic, calcarenitic texture; zones and lenses of yellowish- to dark-yellowish-brown, micrograined limestone (in part fractured and brecciated; in part intraclastic), locally with birdseyes and veinlets of crystalline calcite; some brachiopods and ostracodes in interval 765-768 feet; traces of light-colored chert in intervals 758-760 and 762-763 feet; trace of pyrite in interval 760-761 feet; few stylolites; very thin argillaceous seams and shales; small amounts of quartz silt and sand locally. Gradational with underlying ledge.	CAMP NELSON LIMESTONE
769-770 770-771 771-772	51	3	Dolomite, light-olive-gray and yellowish-brown, with medium- to medium-dark-gray mottling, very finely crystalline to microcrystalline, with earthy appearance; trace of light-colored chert in interval 770-771 feet; few stylolites. Transitional ledge.	
772-773 773-774 774-775 775-776 776-777 777-778 778-779 779-780 780-781 781-782 782-783 783-784 784-785 785-786 786-787 787-788 788-789 789-790 790-791 791-792 792-793 793-794 794-795 795-796 796-797 797-798	52	32	Dolomite, light- to medium-light-gray and light-olive-gray, with medium-light- to medium-gray mottling, very finely crystalline, with earthy appearance; locally finely crystalline; in part light-greenish- to dark-greenish-gray, slightly argillaceous in interval 780-798 feet; scattered traces of light-colored chert; scattered traces of pyrite; few stylolites; quartz silt and sand (small amount to abundant) throughout ledge, in part concentrated in laminae; some very thin argillaceous seams and thin shales; 3-inch dark-greenish-gray shale at base.	WELLS CREEK DOLOMITE

Table 2.—**Continued.**

County: Fayette
Property Owner: K. R. Hayden
Location:

Operator: American Smelting and Refining Co.
Core No. CK-2

CHEMICAL ANALYSIS							
% $CaCO_3$	% $MgCO_3$	% SiO_2	% Iron Oxide	% Alumina	% Total	% S	% P
43.56	34.50	15.20	0.80	3.78	97.84	NOT ANALYZED	
44.82	34.26	15.30	0.60	3.46	98.44		
49.68	36.36	9.80	0.50	2.21	98.55		
51.12	35.09	9.59	0.35	2.30	98.45		
43.92	31.57	14.75	0.33	5.21	95.78		
39.69	29.03	19.01	0.48	7.24	95.45		
38.70	28.12	28.00	0.75	2.56	98.13		
47.52	30.59	19.30	0.60	1.81	99.82		
46.35	37.21	12.97	0.30	1.98	98.81		
44.10	35.34	15.76	0.34	2.89	98.43		
44.19	36.12	14.52	0.34	2.56	97.73		
50.22	40.10	7.98	0.25	1.06	99.61		
51.12	41.23	6.54	0.25	0.47	99.61		
50.22	41.38	7.41	0.25	0.37	99.63		
49.50	40.46	8.65	0.28	1.05	99.94		
48.69	39.71	9.62	0.25	1.39	99.66		
48.42	39.66	9.72	0.23	1.71	99.74		
47.14	38.32	10.50	0.28	2.14	98.38		
46.27	36.00	13.82	0.25	3.27	99.59		
44.01	22.95	15.83	0.28	3.32	98.14		
45.29	36.75	12.26	0.28	2.35	96.93		
42.87	34.78	15.91	0.30	2.76	96.62		
43.06	35.04	20.11	0.58	0.68	99.47		
48.81	39.93	9.94	0.33	0.73	99.74		
43.43	35.42	19.36	0.32	1.20	99.73		

Sampled by:
Analyzed by:
Date Sampled:

DESCRIPTION

Sample Level (Feet)	Ledge No.	Thickness (Feet)	Lithology	Formation
798-799 799-800 800-801 801-802 802-803 803-804	52-Continued			WELLS CREEK DOLOMITE
804-805 805-806	53	2	Dolomite, medium-light- to medium-gray, very finely crystalline, with earthy appearance; with sub-rounded to angular fragments of dolomite (as in upper Knox, Ledge 54) and chert (in part as in upper Knox, Ledge 54); abundant quartz silt and sand.	
806-807 807-808 808-809 809-810 810-811 811-812 812-813 813-814 814-815 815-816 816-817 817-818 818-819 819-820 820-821 821-822 822-823	54	17	Dolomite, light- to medium-light-gray and very light-olive-gray, very finely crystalline to microcrystalline; in part with earthy appearance and in part with saccharoidal appearance; in part vuggy; mottled with small irregular bodies of very light-gray, chalk-like, siliceous material; few small irregular bodies of very light-gray chert in basal foot; scattered traces of pyrite; few stylolites in lower part; quartz silt and sand locally, in part concentrated in laminae; light-greenish-gray shale in very thin seams (locally in vug) in interval 815-820 feet.	KNOX GROUP

BOTTOM OF SAMPLED INTERVAL