ILLINOIS STATE GEOLOGICAL SURVEY

Urbana, Illinois

PETROGRAPHIC CHARACTERIZATION OF CHALKS AND MARLS RELATED TO THE PORE STRUCTURE OF THEIR CALCINED PRODUCTS

Quarterly Progress Report
September, 1972

Richard D. Harvey, Robert R. Frost, and
Josephus Thomas, Jr.

Contract No. 68-02-0212

with the

U. S. Environmental Protection Agency

INTRODUCTION

One of the ~~most~~ more promising processes being considered by power companies and other users of fossil fuels to control SO_2 emissions is the wet lime-limestone scrubbing process. In previous studies to determine the most efficient type of carbonate rock to use in this process it was found that highly porous marls and chalks gave relatively high reactivity rates and capacities to absorb SO_2. The purposes of this study are to locate and sample a number of deposits of marls and chalks, to characterize the samples petrographically and chemically, and to determine their grain-size and pore volume distribution. High pore volume and fine grain texture are thought to indicate high SO_2 reactivities. Also, the pore volume and surface area of calcined marls and chalks are to be related to properties of the uncalcined carbonates.

Results and discussion of data on samples of lake marls from 37 outcrops and deposits and samples of shell and coquina from 5 deposits have been completed and reported (Interim Report, June 1972). This quarterly report gives the location and geologic identification of chalk and a few other carbonate strata examined since the Interim report and the chemical analyses and pore volume test results of the samples.

General Characteristics of Chalks and Their Origin

Chalk is a variety of fine-grained limestone that is especially porous and partly incoherent and is primarily composed of minute ~~marine~~ fossils fragments of coccolithophores. These are spherical unicellular organisms, ~~called coccoliths. Coccoliths are skelatal elements, generally wheel-shaped,~~ that float in marine waters, and secret $CaCO_3$ platelets, called coccoliths, that cover the outer surface of the organism. These cocoliths are generally wheel or spike shaped

~~produced by a class of plantonic algae known as Coccolithophyceae. Coccoliths~~ and consist of 10 or more tabular crystals interlocked together to form a particle generally 4 to 12 microns in diameter. Fragments of coccoliths make up the major portion of chalk strata. Other types of fossils that occur in chalks are foraminifera; bivalve shell fragments, especially Inoceramus; and few teeth from sharks. The fossil and fossil fragments in chalks are composed of calcite with exception of the shark teeth in chalks which are phosphatic in composition. The foraminifera are common and the cavities within their tests are filled with coarsely crystalline calcite. Other minerals in chalks are quartz, various clay minerals, mainly illite and montmorillonite, and traces of pyrite. Quartz is mainly silt sized (4 to 62 μ) detrital grains. Chalks were formed by the settlement of planktonic skeletal materials on the bottom of shallow seas. Tributary rivers and streams carry silt, and clay particles into the sea and they are deposited along with the fossil fragments, mainly along the margins of the sea. Chalks grade to limestones as porosity decreases and hardness or coherency of the rock increases. Since some chalk formations contain beds that are dense and hard, these are classified as chalky limestone or limestone. Beds of chalk are usually ½ to 2 feet thick separated by thin partings 1/8 to 2 inches thick of calcareous (coccoliths) shales. These shales are high in clay minerals and represent a period of high input of sediment load from tributaries and consequently a break in the deposition of chalk. In cases where the shales are high in montmorillonite type of clay, the shale is thought to be a volcanic dust and such a rock is called a bentonite. In cases where the calcareous mineral is 10 to 50 percent of the rock and the quartz and clays are high, the rock is called a calcareous siltstone or claystone. However, in the geologic literature of the southern states, these rocks are frequently classified as marls.

Principle Occurrences of Chalk in the United States

Chalk strata occur in the United States principally in Kansas, Texas, Arkansas, Mississippi, and Alabama. These strata are geologically related by fact of their geographic occurrence, similarity of fossil contents and age relations of the strata that overlie and underlie the chalks. The principal chalk strata are geologically classified as the Niobrara ~~Formation~~ Chalk in the Kansas and adjacent states, the Austin Chalk ~~Group~~ in ~~southern~~ central and northeastern Texas, and the Selma ~~Chalk~~ Group in the Alabama-Mississippi area. Each of these units are recognized as part of the Upper Cretaceous Series of rock strata. The Cretaceous System are the rocks deposited during the Cretaceous Period, approximately 60 to 130 million years ago.

Samples

The location of deposits examined and sampled for this part of the project are designated 7201 and 7230. Their locations are shown on figure 1 and given in detail in the appendix. The appendix also gives the thickness of the strata represented by the sample and the geologic formation name. In addition to the chalks, one deposit of coquina (7203), two deposits of "calcite-rich" caliche (7215 and 7218), and two deposits of an unusual marl in western Kansas (7216C and 7217) were sampled for this study.

The geologic formation and members, where applicable, from which samples were collected for this project were determined from published literature and geologic maps and these are shown diagrammatically in figure 2. As the rocks from a single formation or member generally have similar mineralogical and textural properties, the test results on our samples can be more broadly applied to the area from which they were collected.

The diagram shows the relative position (age and stratigraphic position) of the rock units sampled. Each of the formations identified by name on figure 2 were sampled except the Arkadelphia Marl and the Corsicana Marl (the uppermost units shown in the Texas and Arkansas columns), the Edwards Limestone, lower Cretaceous in Texas, and the Ripley Sand Formation in Mississippi and Alabama. The Arkadelphia and Corsicana are mainly siltstones and claystones with minor calcite contents and were thus deemed unsuitable for this study. Each of the other strata designated were examined at places where the rocks were exposed at the surface and usually at quarries of operating companies.

Results of Sample Studies

Chemical analyses of the samples 7201 to 7230 are given in table 1. The results are given in terms of the "as-received" condition and to obtain analytical values on a moisture free basis the percentage values must be adjusted upwards by an amount proportional to the given H_2O values. The two columns on the far right side of table 1 were computed from the CaO and ignition loss (not reported). These results show that samples 7206 and 7207 are very impure chalks. The caliche samples, 7215 and 7218, are thought to be fairly typical of caliche deposits in the southwest and they contain 60% and 52% $CaCO_3$ respectively. Two samples designated marls, 7216C and 7217, are of low purity. The commercially processed coquina sample from the Yorktown formation in Virginia contains more than 87 percent $CaCO_3$. The samples designated as chalks range from 70 to 96.3 percent $CaCO_3$.

The pore volume and mean pore size of the samples, as measured by mercury porosimetry, are given in table 2. These tests were made using 16 x 18 U. S. mesh sieve fraction of the samples (1.0 to 1.2 mm screen openings).

These results show the coquina (7203D) and the caliche (7218) to have relatively low pore volumes compared to the chalks which range from 0.11 to 0.30 cc/g (average 0.17). The limestones and chalky limestones (appendix) gave pore volumes between 0.06 and 0.11 cc/g. All of the samples tested have mean pore sizes between 0.12 and 0.76 μ except the marl (7216C) which had a mean pore size of 3.6 μ.

Compared to the data on marls (Interim Report), chalks generally have about ½ the pore volume of lake marls and the pore sizes in lake marls commonly range to much larger diameters.

Future Work

Petrographic studies of the samples with the Quantimet and the electron microscope are in progress. X-ray diffraction analyses of the samples for their mineralogical content are also in progress. In this connection analyses are being made of the type of clay minerals present in the HCl insoluble residues. Tests of the pore structure and surface area of calcined samples of the chalks have been initiated and will continue during the next period.

The contract funds that have been expended on the project through September, 1972 are $21,793.25. The account balance is $14,228.75. A milestone chart showing the progress of expenditures and activities is attached.

TABLE 1 - CHEMICAL ANALYSES ~~IN WEIGHT PERCENTAGES~~ OF CHALK AND CHALKY LIMESTONE SAMPLES

(Analyses by Analytical Chemistry Section, Illinois State Geological Survey)

Sample Number	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	H_2O	CO_2	SO_3	as FeS_2	Organic Carbon	CaO in Calcine	$CaCO_3$	$CaCO_3$
7201 Marianna	6.48	1.79	0.74	2.04	47.30	0.08	0.17	0.69	39.47	0.33	0.44	nil	79.0	89.8	84.5
7202 Memphis	14.2	5.26	1.98	0.82	39.63	0.14	0.67	1.22	31.97	1.62	2.25	0.67	59.2	72.7	70.8
~~7203D~~	~~7.31~~	~~nil~~	~~1.55~~	~~0.13~~	~~49.09~~	~~0.43~~	~~0.07~~	~~0.62~~	~~38.78~~	~~0.39~~		~~nil~~	~~80.7~~	~~[illegible]~~	~~87.7~~
7204	1.93	0.26	0.30	0.14	53.45	0.03	0.08	0.36	41.97	nil		0.17	92.7	95.45	95.4
7205	14.2	5.34	2.44	0.46	40.38	0.14	0.63	1.71	30.80	0.74	0.98	0.77	60.4	70.0	72.1
7206	~~17.6~~ 28.5	7.19	3.26	1.00	29.52	0.15	1.36	1.91	23.96	1.28	1.70	0.43	40.1	54.5	52.7
7207	~~25.9~~ 26.9	7.35	3.61	0.81	29.71	0.15	1.36	2.20	23.89	1.23	1.64	0.47	40.6	54.3	53.0
7208C	4.83	1.94	0.98	0.16	50.35	0.07	0.29	0.66	39.59	nil		nil	84.3	90.0	89.9
7209	5.26	1.27	1.32	0.23	50.54	0.05	0.31	0.72	38.92	nil		0.10	83.7	88.5	90.2
7210A	3.61	0.56	0.34	0.08	52.23 .933	0.13	0.17	0.59	40.93 .930	0.03	0.04	0.09	89.4	93.1	93.3
7210B	3.42	1.42	0.37	0.12	50.37	0.10	0.13	0.68	39.96	0.82	1.09	1.75	87.4	90.9	89.9
7211	6.35	1.53	0.68	0.15	47.95	0.11	0.29	1.11	37.65	nil		0.19	78.6	85.6	85.6
7212A	3.00	0.54	0.66	0.16	52.28	0.06	0.23	0.36	41.15	nil		0.05	89.8	93.6	93.4
7213	1.93	1.19	0.41	0.27	51.90	0.05	0.34	0.55	41.23	nil		0.07	88.6	93.8	92.7
7214A	0.88	0.03	0.37	nil	53.91	0.03	0.15	0.33	41.10	nil		0.41	93.6	93.5	96.3
7214B	2.44	0.06	0.79	0.33	52.58	0.05	0.16	0.31	41.79	nil		0.04	90.6	95.0	93.9
7214C	3.78	1.14	1.07	0.61	50.79	0.08	0.24	0.44	40.50	0.08	0.11	0.04	86.0	92.1	90.7
~~7215~~	~~33.3~~	~~1.73~~	~~0.42~~	~~0.85~~	~~33.60~~	~~0.30~~	~~0.92~~	~~0.60~~	~~26.99~~	~~0.03~~		~~0.06~~	~~40.3~~	~~61.4~~	~~60.0~~
7216C	66.1	11.20	3.58	0.35	5.10	1.39	2.91	3.10	3.64	0.05		0.22	5.5	8.3	9.1
~~7217~~	~~19.6~~	~~1.38~~	~~0.20~~	~~nil~~	~~42.34~~	~~0.12~~	~~0.27~~	~~1.82~~	~~32.97~~	~~nil~~		~~0.05~~	~~63.8~~	~~75.0~~	~~75.6~~
~~7218~~	~~28.4~~	~~2.32~~	~~0.57~~	~~1.28~~	~~29.22~~	~~0.24~~	~~0.83~~	~~1.65~~	~~23.70~~	~~0.04~~		~~0.09~~	~~38.8~~	~~53.9~~	~~52.2~~
7219	3.81	0.54	0.59	0.22	51.84	0.07	0.33	0.75	40.27	0.14	0.19	0.07	87.5	91.6	92.6
7220	2.94	1.00	0.50	0.57	51.82	0.06	0.15	0.72	41.15	0.11	0.15	nil	88.1	93.6	92.5
7221A	7.63	1.42	0.86	0.23	48.20	0.06	0.24	1.64	37.78	nil		0.09	78.6	85.9	86.1
7221B	6.63	1.29	1.02	0.33	48.20	0.09	0.34	1.06	38.22	1.03	1.37	0.39	78.7	86.9	86.1
7222A	6.01	2.61	1.03	0.06	48.41	0.07	0.49	1.03	38.12	nil		0.12	79.4	86.7	86.4
7222B	6.62	1.71	1.27	0.31	47.93	0.09	0.53	0.82	37.95	1.19	1.58	0.20	77.9	86.3	85.6
7223	7.40	1.05	0.44	0.44	49.21	0.03	0.11	0.53	40.20	nil		0.03	83.1	91.4	87.9
7224	7.69	2.27	1.26	0.02	47.84	0.06	0.33	1.04	37.58	0.14	0.19	0.11	78.0	85.5	85.4
7225	18.1	2.43	0.76	0.17	41.83	0.12	0.76	1.16	32.98	0.26	0.35	0.27	63.4	75.0	74.7
7226A	9.83	2.85	0.83	0.27	45.64	0.08	0.56	1.64	36.04	0.31	0.41	0.26	62.4	82.0	81.5
~~7227A~~	~~11.0~~	~~4.36~~	~~2.30~~	~~0.43~~	~~41.41~~	~~0.13~~	~~0.65~~	~~2.39~~	~~33.11~~	~~2.70~~		~~0.29~~	~~61.6~~	~~75.3~~	~~73.9~~
7227B	5.46	1.37	0.62	0.23	49.01	0.07	0.31	0.92	39.08	0.18	0.24	0.18	81.2	88.9	87.5
7228	19.6	2.42	1.16	0.60	39.22	0.14	0.66	1.34	31.22	0.11	0.15	0.20	58.1	71.0	70.0
7230	9.95	4.04	1.28	0.46	44.85	0.11	0.73	1.44	34.21	0.64	0.85	0.43	69.5	77.8	80.1

Clays in these rks are ~ 50% Mont. and 50% Illite: ave $Si/Al = \frac{2.8+1.4}{2} = \frac{4.2}{2} = 2.1$

Ave $\frac{Mw}{\#Al} = \frac{345+168}{2} = \frac{513}{2} = 257 = 260$

TABLE 2 - PORE STRUCTURE OF 16 X 18 MESH PARTICLES

Sample number	% $CaCO_3$	Rock type	Pore Volume (cc/g)	Porosity	Mean pore size (μ)
7201	84.5	Chalk	0.302	44.9	0.76
7202	70.8	Chalk	0.212	36.3	0.15
7203D		Coquina	0.039		0.56
7204	95.4	Chalk	0.115	23.7	0.43
7205	72.1	Chalk	0.232	38.5	0.13
7206	52.7	Chalk	0.145	28.0	0.17
7207	53.0	Chalk	0.163	30.4	0.18
7208B	89.9	Chalk	0.202	35.3	0.25
7208C	84.3	Chalk	0.216	36.8	0.35
7209	90.2	Chalk	0.242	39.6	0.40
7210A	93.3	Limestone	0.092	19.9	0.51
7210B	89.9	Limestone	0.107	22.4	0.24
7211	85.6	Limestone			
7212A	93.4	Chalk	0.217	37.0	0.39
7213	92.7	Chalk	0.183	33.1	0.47
7214A	96.3	Chalk	0.186	33.5	0.49
7214B	93.9	Chalk	0.192	34.2	0.47
7214C	70.7	Chalk	0.224	37.7	0.40
7216C	9.1	Siltstone Marl	0.232	38.1	3.60
7218	52.2	Caliche	0.039	9.5	0.25
7219	92.6	~~Chalk~~ Limestone	0.064	14.8	0.31
7220	92.5	Limestone	0.062	14.4	0.18
7221A	86.1	Chalk	0.132	26.3	0.20
7221B	86.1	Chalk	0.131	26.1	0.18
7222A	86.4	Chalk	0.143	27.9	0.18
7222B	85.6	Chalk	0.152	29.1	0.18
7223	87.9	Limestone	0.071	16.1	0.15
7224	85.4	Chalk	0.133	26.4	0.18
7225	74.7	Chalk	0.118	24.1	0.12
7226A	81.5	Chalk	0.118	24.2	0.12
7227B	87.5	Chalk	0.121	24.6	0.20
7228	70.0	Chalk	0.111	23.0	0.18
7230	80.1	Chalk	0.179	32.6	0.15

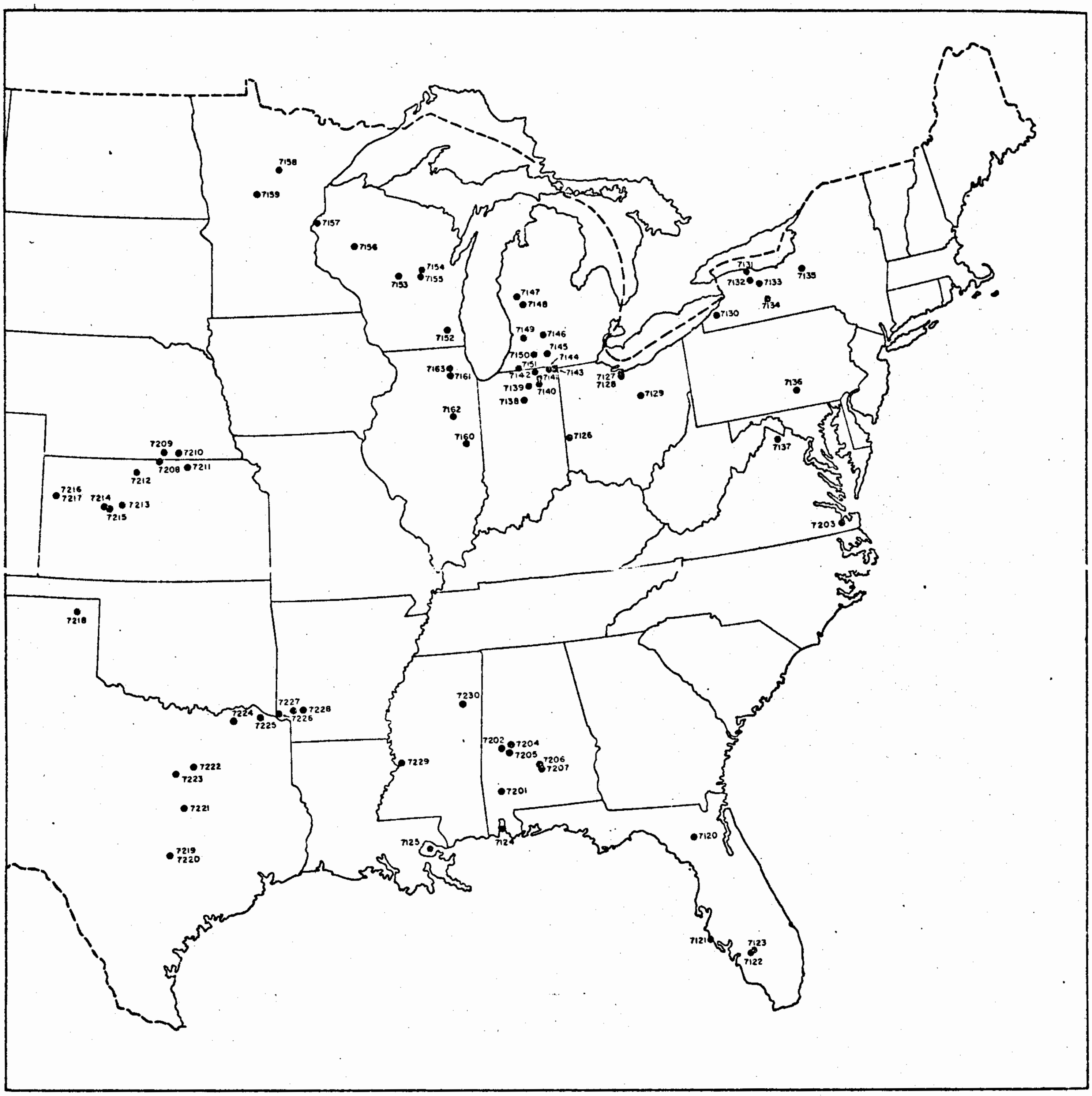
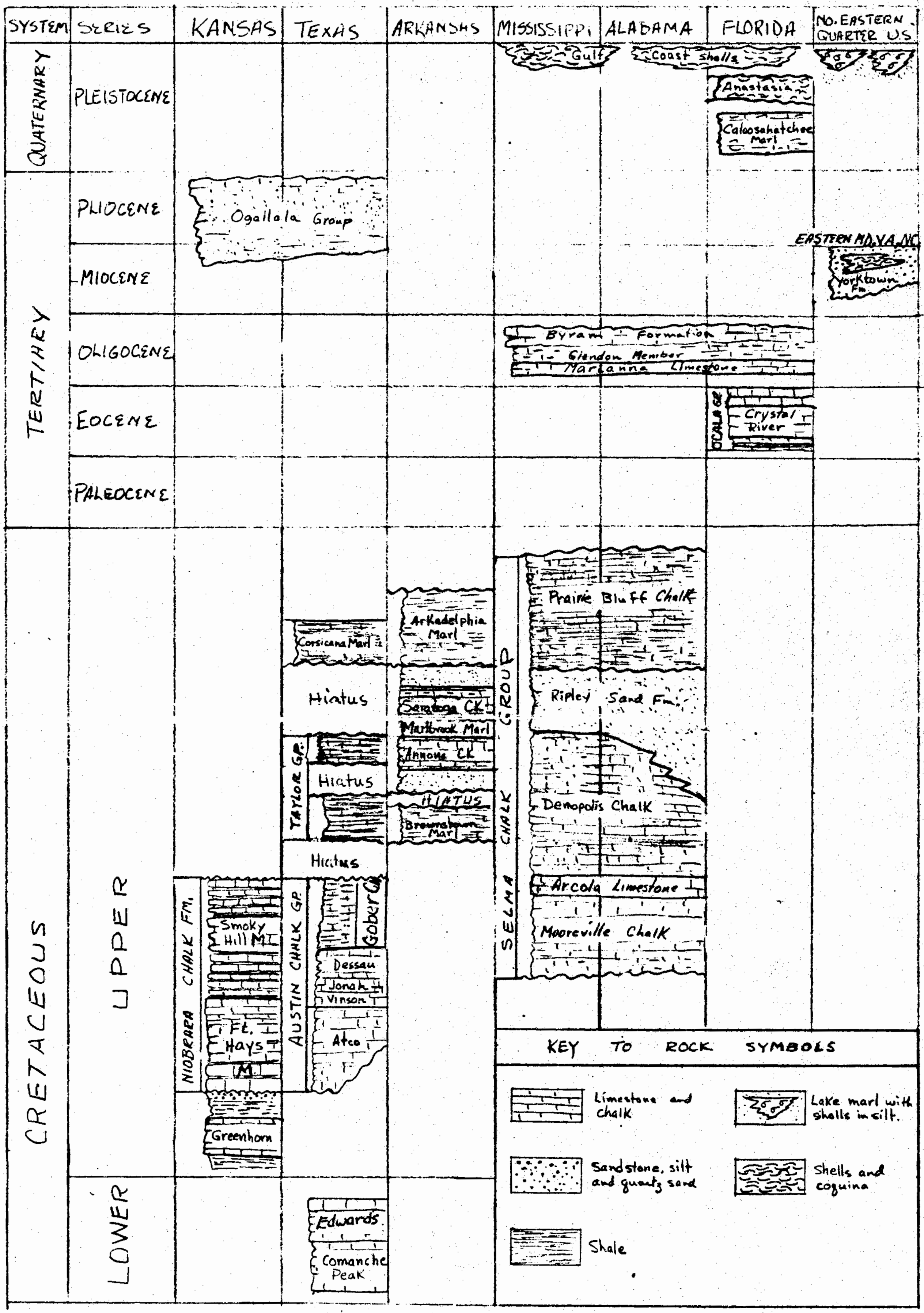


Fig. 1. - Sample localities

FIG. 2. GEOLOGIC TIME-ROCK COLUMNAR DIAGRAM OF ROCKS STUDIED*



*Many other rock formations occur but are not shown here. Vertical scale does not represent true thickness of rock units or duration of time. A hiatus represents a period during which no rocks were deposited.

APPENDIX

SOURCES OF SAMPLES AND REMARKS ON THE DEPOSITS

Number	Thickness Represented (ft.)	Type	Source, Location and Quadrangle (map)	Remarks on the deposit and geologic unit sampled
7201	60	Chalk	Lone Star Industries Inc., quarry, west side Tombigbee River, 2.2 mi. NE St. Stephens, Washington Co. AL.	Marianna Limestone (Oligocene).
7202	50±	Chalk	Lone Star Industries Inc., quarry, Demopolis, Marengo Co. AL.	Demopolis Chalk Formation, Selma Group, (Upper Cretaceous).
7203	15	Coquina	Lone Star Industries Inc., pit, east side Rt 10, 1¼ mi. N Chuckatuck VA.	Yorktown Formation, coquina facies (Miocene). Sample 7203 is composite of three samples taken from the upper 15 ft. exposed in pit. 7203D from stockpile after plant processing.
7203D	30-50	Coquina		
7204	3-5	Chalk	Outcrop, on Rt. 12, ½ mi. west Jct. with R61, 4.8 mi S. Newbern, Hale Co. AL.	Arcola Limestone Member, Mooreville Chalk, Selma Gp., (Upper Cretaceous). Sample from soft chalky beds.
7205	20-25	Chalk	Outcrop, north side Rt 80 at Faunsdale, Marengo Co. AL.	Demopolis Chalk (upper part) Selma Group (Upper Cretaceous).
7206	15	Chalk, clayey	Outcrop, along Rt 263, 0.4 mi S of Jct with Rt. 21, near Braggs, Lowndes Co. AL.	Prairie Bluff Chalk (lower part) Selma Group (Upper Cretaceous).
7207	8	Chalk, clayey	Outcrop, along Rt. 263, 2.8 mi So. Jct. Lowndes Co. Rt. 7 and Alabama Rt 21, Southwest Braggs, Lowndes Co. AL.	Prairie Bluff Chalk Selma Group (Upper Cretaceous). Sample taken from beds just above the phosphatic and cobbly chalk beds at base of the Prairie Bluff.
7208B	3	Chalk & calcareous shale	Ideal Cement Co., Superior, NE; quarry located 6 mi. SW Superior in Kansas, Sec. 6, 15-7W, Jewell Co., KS.	Smokey Hill Member (lower 3 ft.) of Niobrara Chalk (Upper Cretaceous). Chalk and chalky shale (beds 0.5" to 8" thick) interbedded. Overlies 7208C.
7208C	20	Chalk		Ft. Hays Limestone Member Niobrara Chalk. Beds 0.8 to 3 ft. thick separated by 0.5" shale partings. Quarried by ripping.
7209	16-17	Chalk	Nelson Quarry of Hopper Bros., Weeping Water, NE. Located 1 mi S Nelson NE on E side Rt. 14, SE¼, SE¼ Sec. 36, 3N-7W, Nuckolls Co. NE.	Ft. Hays Limestone (Upper Cretaceous) Beds generally 1" to 3" thick separated, by thin shale partings.

Number	Thickness Represented	Type	Source, Location and Quadrangle (map)	Remarks on the deposit and geologic unit sampled
7210A	12	Limestone, chalky and clayey	Hebron Quarry of Hooper Bros., Weeping Water, NE. Located 2.6 mi. W of Gilead on Rt. 136 then 0.6 mi. N, Thayer Co. NE.	Greenhorn Limestone (Upper Cretaceous). Upper buff beds generally 2" to 4" thick; overlies 7210B.
7210B ✓	16-17	Limestone, chalky and clayey		Lower grey strata, in 2" to 4" beds, partly nodular and fossiliferous.
7211	3*	Limestone, chalky and clayey	Haddam Quarry of Hooper Bros., Weeping Water, NE. Located ¼ mi. N Rt. 36, 0.7 mi. E Jct. Rt's. 22 and 36, Washington Co. KS.	Greenhorn Limestone (Upper Cretaceous). Very small quarry, intermittant operations.
7212A	38	Chalk	Discontinued quarry along RR tracks, 1½ mi. W Cedar, KS, SE¼ SE¼ Sec. 35, 4S-15W, Smith Co. KS.	Ft. Hays Limestone Mbr. of Niobrara Chalk (Upper Cretaceous). In beds 0.5 to 3 ft. thick.
7212B	0.5	Shale, chalky		Sample representative of the 5 shale beds (each < 2" thick) interbedded with chalk (7212A).
7213	10*	Chalk	Outcrop, west side gravel road at Utility Sta. 3½ mi. N and 2 mi. W. Hays, KS., Cen. E line Sec. 7, 13S-18W, Ellis Co. KS	Ft. Hays Limestone Mbr. of Niobrara Chalk (Upper Cretaceous). In beds 1-2 ft. thick interbedded with two 3" beds of chalky shale that were excluded from sample.
7214A	17	Chalk	Outcrop, bluff on S side, west end, Cedar Bluff Res., Sec. 6, 13S-22W, Trego Co. KS.	Ft. Hays Limestone Mbr. of Niobrara Chalk (Upper Cretaceous). Upper most beds (0.8 to 3 ft) ~~thick, partly covered on top slope surface.~~
7214B	19.3	Chalk		Middle beds; excludes samples of 4 beds (4" to 6" each) of chalky shale within this unit.
7214C	18.2	Chalk		Lower beds (the base of the Ft. Hays). Sample excludes the three beds (3" to 6" thick) of calcareous shale within this unit.
7215	33	Caliche, sandy	Outcrop, west side Rt. 147, 3 mi. S. Dam of Cedar Bluff Res., SE¼ Sec. 14, 15S-22W, Trego Co. KS.	Ogallala Formation (Pliocene).
7216C	6-10	Siltstone, calcareous ~~Marl, diatomaceous and silty~~	Outcrop, south side North Fork Smoky Hill River on Garvey Ranch, 15 mi. N and 5 mi. E of Wallace KS., NE¼ NE¼ Sec. 11, 11S-38W, Wallace Co. KS.	Ogallala Formation (Pliocene). Small exposure of ~~impure, non-marine type of marl.~~ calcareous siltstone
7217	8-12	Marl, diatomaceous	Delore Div., NL Industries quarry, South side North Fork Smoky Hill River, 15 mi. N and 4 mi. E of Wallace KS, SE¼, NW¼ Sec. 11, 11S-38W, Wallace Co. KS.	Ogallala Formation (Pliocene). Source of raw material for Delore Div. Plant located in Edson, KS.

Number	Thickness Represented (ft.)	Type	Source, Location and Quadrangle (map)	Remarks on the deposit and geologic unit sampled
7218	35	Caliche	Texas Highway Dept. quarry, Herndon Quarry, 16 mi. S. Perryton, TX on Rt. 83, Ochiltree Co., TX.	Ogallala Formation (~~Miocene~~-Pliocene) Hard and soft beds (1 to 3 ft.) are crushed for use in road construction.
7219	25-30	Limestone, chalky	Outcrop in bluff along Walnut Creek ½ mi. SE of Jct. with Dessau - Austin Rd., 7.5 mi. NE Austin, Travis Co., TX.	Dessau ~~Chalk~~ Mbr. of Austin Chalk (Upper Cretaceous). Weathered outcrop beds of chalk, 2 to 3 ft. thick, separated by 0.5 to 1 ft. beds of shaley chalk.
7220	9	Limestone, chalky	Outcrop in bluff of Walnut Creek, ½ mi. W of Jct. with Interstate 35, 8 mi. NE center of Austin, Travis Co., TX.	"Jonah ~~Limestone~~ Chalk" Mbr. of Austin Chalk (Upper Cretaceous). Moderately dense and nodular limestone beds 2 to 3 ft. thick separated by chalk beds 0.6 to 1.5 ft. thick. Underlies Dessau Chalk at this exposure.
7221A	15-25	Chalk (Buff)	Universal Atlas Cement Co. quarry, 1.5 mi. SW Woodway, Ellis Co., TX.	Atco ~~[illegible]~~ Chalk Mbr. of Austin Chalk (Upper Cretaceous). Buff colored chalk beds 1 to 3 ft. thick separated by 0.5" shale partings and occassional 3" to 6" calcareous shales beds.
7221B	15-35	Chalk (grey)		Grey colored chalk, underlies the bluff chalk (7221A). Thickness of chalk quarried is 40 to 50 ft.
7222A	40	Chalk (buff)	Gifford-Hill Portlant Cement Co. quarry, located 2.5 mi. N of Midlothian TX on old Rt. 67 and 0.5 mi. west, Ellis Co., TX.	Atco ~~Vinson Chalk~~ Chalk Mbr. of Austin Chalk (Upper Cretaceous). Upper beds and along vertical joints are buff chalk.
7222B		Chalk (grey)		Lower beds are grey chalk. Lower most bed contains black phosphatic nodules, 1 - 3 mm diameter.
7223	5*	Limestone, chalky	Outcrop on property of Texas Lime Co., Cleburne Tx., located at base of bluff S side road 1 mi. S of State Park and 13 mi. SW Cleburne, Johnson Co. TX.	Comanche Peak Limestone (Lower Cretaceous) Chalky limestone with 2" to 3" nodules of dense limestone abundant throughout this exposure. The base of the limestone unit is covered.
7224	4*	Chalk	Prospect pit, east side farm road, 2 mi. N and ½ mi. W of Roxton, Lamar Co., TX.	Gober Chalk Mbr. Austin Chalk (Upper Cretaceous). Sample from stockpile.
7225	2.5*	Chalk	Abandoned quarry at Jct. of Rts. 114 and 82 on east side of Clarksville, Red River Co., TX	~~Taylor Group~~ Pecan Gap Chalk (Upper Cretaceous). Quarry pit is filled with water. Sampled uppermost beds.

Number	Thickness Represented (ft.)	Type	Source, Location and Quadrangle (map)	Remarks on the deposit and geologic unit sampled
7226A	30-35	Chalk	Arkansas Cement Corp. quarry, 3 mi. SW Forman, Little River Co., AR.	Annona Chalk (Upper Cretaceous) Quarried by ripping.
7227B	40-45	Chalk	Ideal Cement Co. quarry, ½ mi. NW Okay, Howard Co., AR.	Annona Chalk (Upper Cretaceous).
7228	20	Chalk	Outcrop, east side Rt. 4, 3 mi. N, Washington, Hempstead Co. AR.	Saratoga Chalk (Upper Cretaceous). Weathered buff chalk. Grey thin bedded chalk 10 to 16 ft. thick overlie the buff chalk beds sampled. Phosphatic and clayey chalk beds (1-2 ft.) and claystone beds of the Marbrook Marl underlie the beds sampled.
7229A	2	Limestone, chalky	Outcrop, east side Rt. 61 at Jct. with Bipass 61 on N edge Vicksburg, Warren Co. MS.	Byram Formation, Vicksburg ~~Group~~ Gp (Oligocene) sample A is from the uppermost bedrock strata, of the base of exposure.
7229B	1	~~Marine marl~~ siltstone		Glendon Limestone ~~Member~~ Mbr. of Byram Fm., Vicksburg ~~Group~~ Gp. Sample B underlies A, C underlies B, etc.
7229C	4	Limestone, chalky		
7229D	1	~~Marine marl~~ Limestone, chalky		
7229E	1	Limestone, chalky		
7229F	1.3	Limestone, chalky		
~~7229G~~	~~1~~	~~Marine marl~~		~~Marianna Limestone, Vicksburg Group~~. Vicksburg Group limestones and marls are used for cement raw materials at nearby Redwood, Ms (Miss. Valley Portland Cement Co.).
7230	15-18	Chalk	Mississippi Dept. Agriculture and Commerce, quarry located east side Rt. 47, 8 mi. S. Trebloc in Clay Co. MS.	Demopolis Chalk (Upper part), Selma Group (Upper Cretaceous). Quarried by ripping.

* The beds below are unaccessible but belong to the same geologic unit and are thought to have similar properties to those sampled.

MILESTONE CHART

Petrographic Characterization of Chalks and Marls Related to the Pore Structure of Their Calcined Products

Contract No. 68-02-0212

ILLINOIS STATE GEOLOGICAL SURVEY, URBANA, ILLINOIS

Progress to September 30, 1972

Geologic field examination and collection of samples ....

Laboratory characterization of samples of chalks and marls

Petrographic characterization including scanning electron microscopy .....

Mineralogical analyses ....

Chemical and pore size analyses ....

Pore structure of calcined samples

Pore-size distribution and surface area .....

Scanning electron microscopy of calcines ....

Reports ....