MP-9

FINAL REPORT - PHASE 1

ARA CONTRACT - Cc - 6098

CORE DRILLING PROJECT
PEYTON CREEK PHOSPHATE AREA
ARKANSAS

ARKANSAS GEOLOGICAL COMMISSION
LITTLE ROCK, ARK.
1964

FINAL REPORT - PHASE I

ARA CONTRACT - Cc - 6098

CORE DRILLING PROJECT
PEYTON CREEK PHOSPHATE AREA
ARKANSAS

FINAL REPORT - PHASE I

CORE DRILLING PROJECT - PEYTON CREEK PHOSPHATE AREA

SEARCY-VAN BUREN COUNTIES, ARKANSAS

INTRODUCTION:

The contract for the core drilling at Peyton Creek was signed by the Joy Manufacturing Company on October 14, 1963. Drilling was begun on November 4, 1963 and was terminated January 9, 1964 with the completion of Hole S-6.

DRILLING OPERATIONS:

Two core drills were utilized on the project and were operated on an eight-hour day, five-day work week basis. The drillers retained either core or cuttings for the full depth of each hole drilled. Core recovery in the phosphate zones was well within the specified 85% in all drill holes. A geologist from the Arkansas Geological Commission was present at any time during drilling operations when coring was to be initiated, when the ore zone was being drilled or when a hole was to be terminated.

SAMPLING AND ASSAYING:

Phosphate layers as narrow as 0.2' were sampled and analyzed in order to provide as complete a picture as possible of the deposits. Where a number of closely spaced phosphate layers separated by relatively barren sandstone were encountered, the sandstone was included in the

total sample since selective underground mining of thin phosphate beds would not be economically feasible. In the sampling process the cores were split, one half being sent to the laboratory for chemical analysis, and the remaining half returned to its proper sequence in the core box for a permanent reference. In addition, adequate footages of core above and below the phosphate layers in each hole were retained to provide information on floor and roof conditions. All these cores are currently in storage at the office of the Peyton Creek Phosphate Mining Company at Leslie, Arkansas.

All chemical analyses of the cores were made in the Arkansas Geological Commission laboratory at Little Rock. Pulps of all the samples have been retained in the event check analyses are desired. Only the P_2O_5 content of the core samples was run to permit the laboratory to keep up with the drilling. Assays of core samples are shown both in the table of analyses for each deposit and on the stratigraphic logs of the individual drill holes.

RADIOACTIVE LOGGING:

It was decided to run gamma ray logs in as many of the drill holes as possible to make certain that no important phosphate beds were overlooked, particularly in the section of the drill holes that was not core-drilled. Arrangements were made with the Water Resources Branch of the U.S. Geological Survey to use their truck-mounted logging equipment on a rental basis. Considerable difficulty was encountered in

re-entering the early drill holes as the surface casing had been removed and caving had begun. The drilling contractor agreed to clean the holes out on an hourly pay basis, but the clean up effort met with limited success and was abandoned.

Despite these problems during the period December 18, 1963 through January 9, 1964, six holes N-6,7,8, and 9, and S-5 and 6 were successfully logged. The gamma ray logs of these holes accurately verified the phosphate layers that had previously been visually logged in the core and they also verified that no phosphate layers were present in the uncored section of the drill holes. Copies of all the gamma ray logs that were run are included in this report.

The effectiveness of this logging method is due to the fact that the phosphate beds are relatively higher in radioactivity than the surrounding sandstones and shales. Since radioactivity on the graph of the gamma ray log increases from left to right, the phosphate layers are represented by the peaks to the right of the graph.

Posted opposite each of these peaks on all the gamma ray logs (see Appendix A) is the thickness of phosphate rock that the peak represents. The grade of the phosphate bed is also indicated on the log in those instances where it was sampled and analyzed.

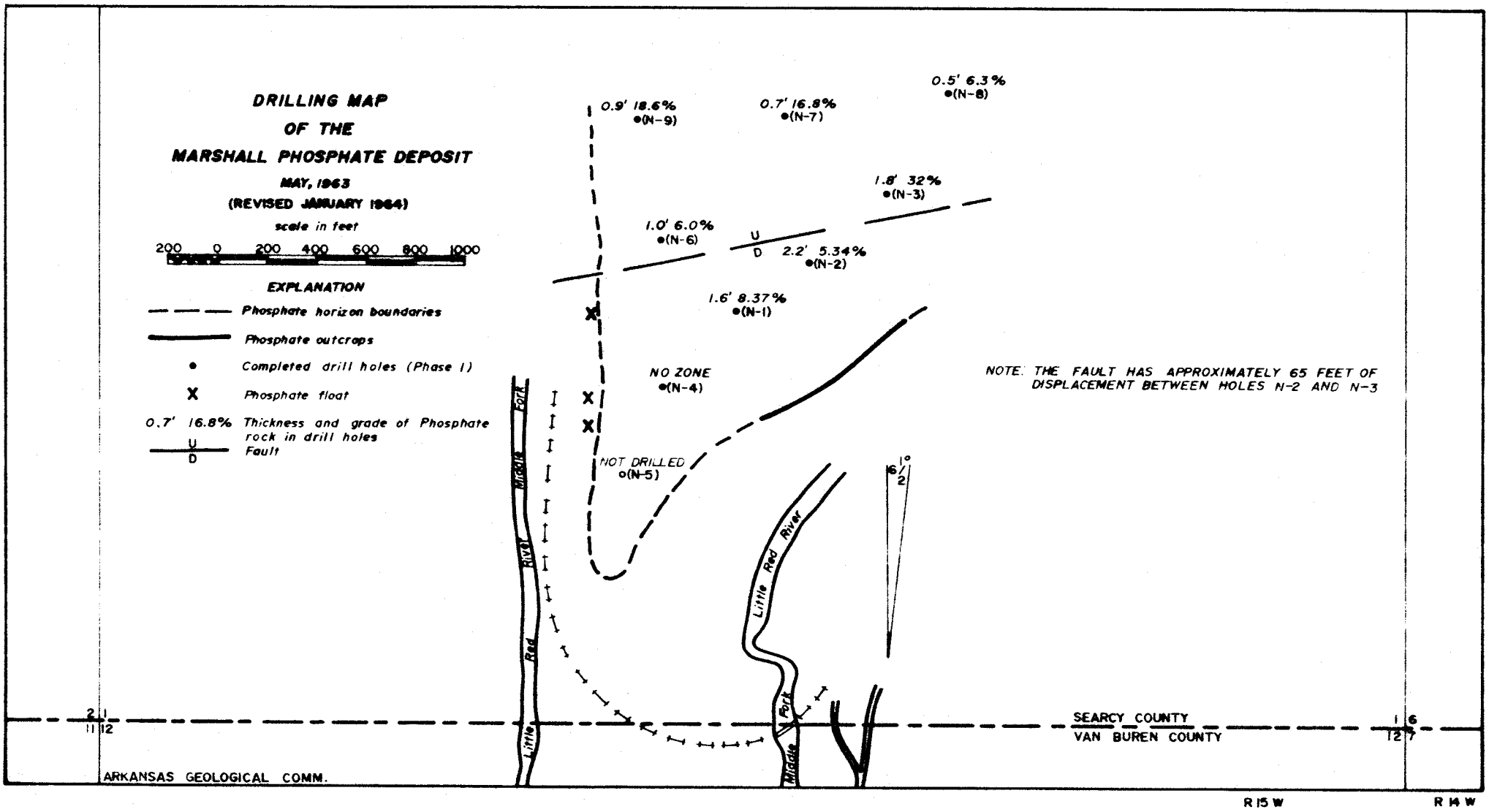
It should be noted that in all of the "N" series holes that were logged,

the peak at or nearest the bottom of the hole was not analyzed. In each of these holes this bottom peak represents the phosphatic limestone conglomerate that marks the base of the Cane Hill formation, the formation in which the phosphate beds occur. Analyses made of this conglomerate in Hole S-2 (Sample #5) and N-1 (Sample #3) indicated that it contained only 3 to 5 percent P_2O_5 and therefore did not justify further testing.

In drill hole N-8 coring was begun at 87 feet. Examination of the cuttings from the upper portion of the hole revealed that a phosphate layer had been penetrated in the 78'-83' depth interval. Chemical analysis of the cuttings from this interval showed a P_2O_5 content of 3.0 percent (Sample N-8-3). The gamma ray log of this hole pinpointed the mineralization in this interval as a phosphate layer at the 82 foot depth. It is estimated to be a foot or less in thickness but would probably assay much higher than 3.0 percent P_2O_5.

THE MARSHALL DEPOSIT:

Prior to the ARA project no core drilling had been accomplished at the Marshall deposit. Information on the deposit was limited to the outcrops and float shown on the accompanying map. Of the nine Phase I holes programmed for the Marshall deposit, all but N-5 were drilled. N-5 was dropped because two adjacent holes, N-6 and N-4, that were drilled early in the project were essentially barren. The pertinent features of the drilling at the Marshall deposit are shown on the attached map of the deposit and described in the accompanying strati-


DRILLING MAP
OF THE
MARSHALL PHOSPHATE DEPOSIT
MAY, 1963
(REVISED JANUARY 1964)
scale in feet
200 0 200 400 600 800 1000
EXPLANATION
Phosphate horizon boundaries
Phosphate outcrops
Completed drill holes (Phase I)
Phosphate float
0.7' 16.8% Thickness and grade of Phosphate rock in drill holes
U D Fault
0.9' 18.6% (N-9)
0.7' 16.8% (N-7)
0.5' 6.3% (N-8)
1.8' 32% (N-3)
1.0' 6.0% (N-6)
U D
2.2' 5.34% (N-2)
1.6' 8.37% (N-1)
NO ZONE (N-4)
NOT DRILLED (N-5)
NOTE: THE FAULT HAS APPROXIMATELY 65 FEET OF DISPLACEMENT BETWEEN HOLES N-2 AND N-3
Little Red River
Middle Fork
Little Red River
Middle Fork
1°
6 1/2
SEARCY COUNTY
VAN BUREN COUNTY
2 1
11 12
1 6
12 7
ARKANSAS GEOLOGICAL COMM.
R 15 W
R 14 W

graphic logs of the holes, (see Appendix B).

Examination of cores showed that the sedimentation in the Marshall deposit is very erratic. With few exceptions it was impossible to correlate either the phosphate layers or the enclosing sediments from one hole to the next. However, some generalizations can be made regarding the deposit:

(1) In every hole a black, oolitic, limestone conglomerate marked the base of the Cane Hill formation, the formation which carries the phosphate beds in this area. This conglomerate was slightly phosphatic, ranging from 3 to 5 percent in P_2O_5 content.

(2) The phosphatic beds occur in a crossbedded brownish sandstone. The number and position of these beds in the sandstone, and their thickness and grade varied from hole to hole. (The analyses are shown on the accompanying table).

(3) The phosphatic layers were characteristically thin (less than two feet), and with the exception of Hole N-3, low in P_2O_5 content.

(4) The presence of a fault was established by the drilling. (See map). Due to this faulting, the total depth of all holes drilled on the upthrown side of the fault were considerably less than estimated.

MARSHALL DEPOSIT

Chemical Analysis Of Core Samples

Drill Hole Number	Sample Number	Depth From	Interval To	Thickness	Percent P_2O_5
N-1	1	79.7	84.0	4.3	1.04
	2	66.8	68.4	1.6	8.37
	3	83.8	85.0	1.2	3.13
	4	70.6	70.7	0.1	4.58
N-2	1	77.5	79.7	2.2	5.34
N-3	1	39.5	41.3	1.8	32.0
N-4	1	60.7	64.3	5.6	1.93
	2	64.5	69.8	5.3	2.80
	3	69.8	83.5	13.7	1.29
N-5	-	-	Not Drilled	-	-
N-6	1	49.5	50.5	1.0	6.0
N-7	1	96.3	97.0	0.7	16.8
N-8	1	102.5	103.0	0.5	6.3
	2	110.8	112.5	1.7	4.8
	3	78	83	5.0	3.1*
N-9	1	57.4	58.3	0.9	18.6

* Analysis was made on cuttings from this five foot interval.

(5) The only drill hole containing significant phosphate rock was N-3 which had a 1.8' layer assaying 32% P_2O_5. This was the highest grade rock ever encountered by personnel of this office either in cores or in outcrops. Adjacent drill holes, however, failed to disclose similar material, so the N-3 occurrence was apparently very local.

The drilling results indicate that the Marshall deposit consists of an outcrop of a single continous bed of phosphate that dissipates rather rapidly underground into a series of thin, discontinous, phosphate layers.

ORE RESERVES - MARSHALL DEPOSIT:

The potential tonnage of phosphate rock in this deposit is so small that no reserve estimate was made.

THE FERGUSON DEPOSIT:

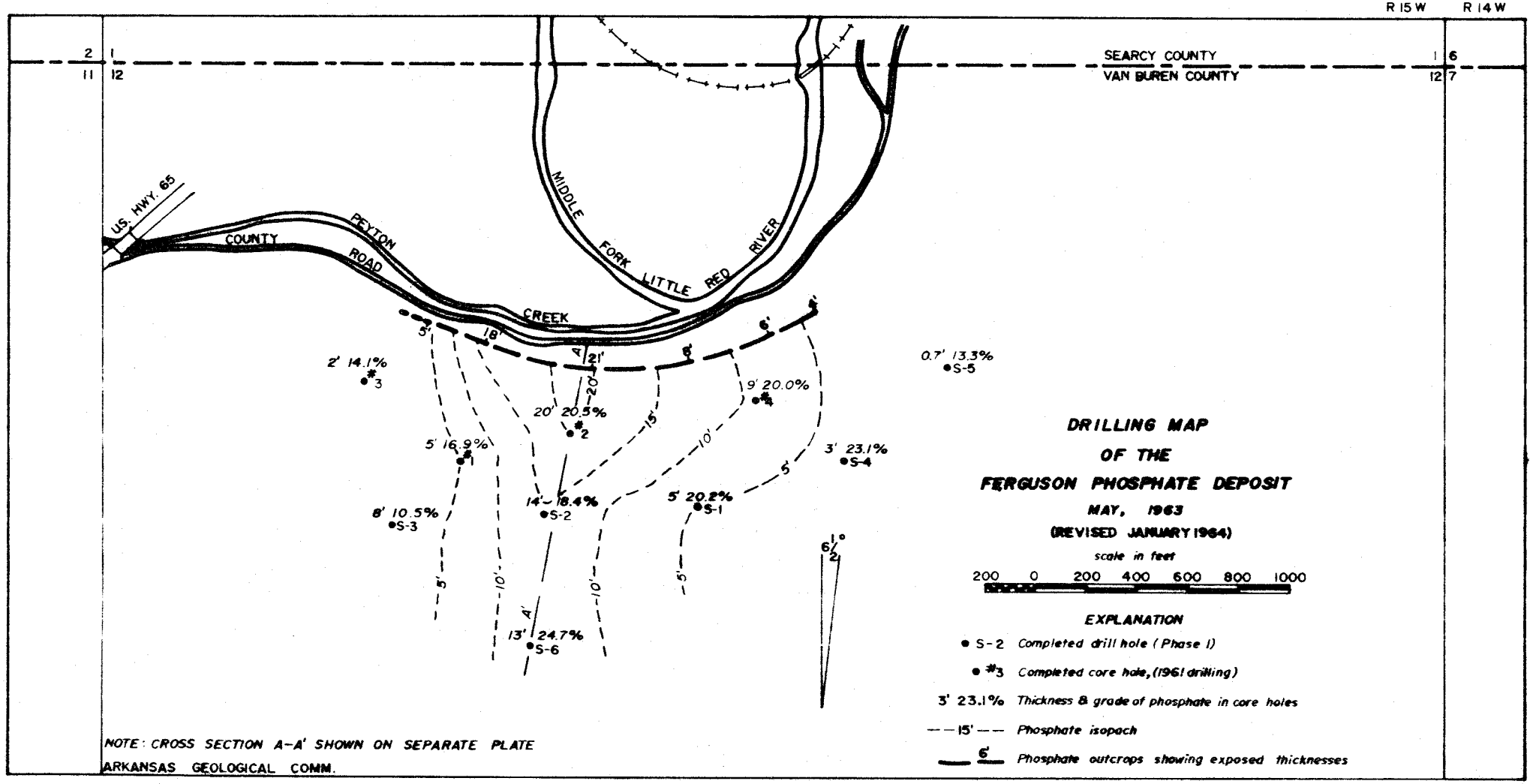
All five of the Phase I drill holes originally scheduled for the Ferguson deposit were drilled. Although all of these encountered some phosphate, Hole S-2 was the only hole that showed a significant thickness (14 feet) from the standpoint of underground mining operations. At the close of the project it was decided to use the funds remaining in the Phase I program in an attempt to extend the apparent trend of the Ferguson ore body southward from Hole S-2. An additional hole (S-6) was spotted about 520 feet south of S-2. S-6 was drilled

and a bed of phosphate 13 feet thick assaying 24.7% P_2O_5 was encountered at 373 feet. This was undoubtedly the most significant hole drilled during the project from the standpoint of thickness and grade combined, and it did verify the southward trend of the ore body. The pertinent features of the drilling at the Ferguson deposit are shown on the enclosed map and cross-section of the deposit, and described in the accompanying stratigraphic logs of the holes. (See Appendix B).

Unlike the Marshall deposit the phosphate beds, as well as the enclosing sediments at the Ferguson deposit, can be readily correlated throughout the deposit.

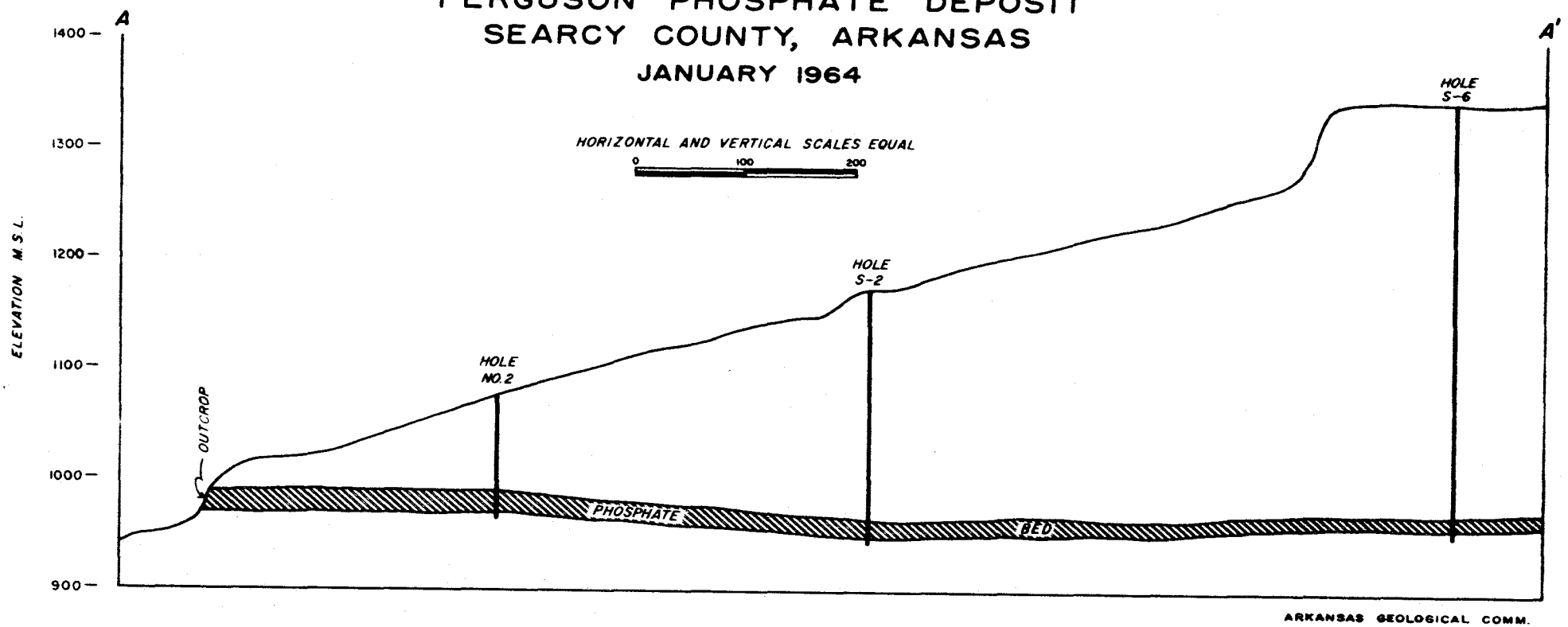
The Ferguson deposit at the outcrop has a cross-section similar to that of a broad, slightly asymmetrical bowl; the top being relatively flat, and the base tapering upward to the east and west from a point of maximum thickness at the center. Southward from the outcrop the deposit constricts and is more channel-like in cross-section.

From a study of the drill cores it is believed that the phosphate was deposited in Cane Hill time along with the enclosing sandstone in topographic lows; i.e., basins and channels in the Pitkin land surface. The limestone conglomerate noted in the discussion of the Marshall deposit was encountered in Hole S-2 and is presumed to mark the base of the Cane Hill formation in this hole.


R 15 W
R 14 W
SEARCY COUNTY
VAN BUREN COUNTY
US. HWY. 65
PEYTON
COUNTY
ROAD
CREEK
MIDDLE FORK LITTLE RED RIVER
2' 14.1%
#3
20' 20.5%
#2
5' 16.9%
#1
8' 10.5%
S-3
14'- 18.4%
S-2
13' 24.7%
S-6
5' 20.2%
S-1
3' 23.1%
S-4
9' 20.0%
#4
0.7' 13.3%
S-5
A
A'
21'
18'
5'
6'
20'
15'
10'
5'
6½°
DRILLING MAP
OF THE
FERGUSON PHOSPHATE DEPOSIT
MAY, 1963
(REVISED JANUARY 1964)
scale in feet
200 0 200 400 600 800 1000
EXPLANATION
S-2 Completed drill hole (Phase I)
#3 Completed core hole, (1961 drilling)
3' 23.1% Thickness & grade of phosphate in core holes
15' Phosphate isopach
6' Phosphate outcrops showing exposed thicknesses
NOTE: CROSS SECTION A-A' SHOWN ON SEPARATE PLATE
ARKANSAS GEOLOGICAL COMM.

CROSS SECTION A-A'

FERGUSON PHOSPHATE DEPOSIT
SEARCY COUNTY, ARKANSAS
JANUARY 1964



The phosphatic rock encountered in the Phase I core holes was essentially the same in composition and texture as that cored in the 1961 drilling. It has the characteristic oolitic texture, calcite cement, carbonized wood fragments and variable amounts of quartz sand. The variations in grade are due primarily to the degree of dilution of the rock with sand grains. The accompanying table shows the analyses of all cores tested from the Ferguson deposit.

ORE RESERVES - FERGUSON DEPOSIT:

Reserve estimates were made using the phosphate isopachs shown on the map and the average-end-area method of computation. A minimum thickness of 5 feet and an average grade of 20% was established for the estimate. A unit weight of 192#/cu. ft. was determined for the phosphate rock by measuring the specific gravity of core from Hole S-6. Limited to present drilling and utilizing the above factors the Ferguson deposit contains 1,502,000 short dry tons of phosphate rock averaging 20 percent P_2O_5 and occurring in a bed 5 feet or greater in thickness. It should be noted that this is a gross tonnage figure and makes no allowance for mining losses.

FERGUSON DEPOSIT

Chemical Analysis of Core Samples

Drill Hole Number	Sample Number	Depth From	Interval To	Thickness	Percent P_2O_5
S-1	1	208.8	209.3	0.5	27.6
	2	210.2	211.4	1.2	22.2
	3	213.5	218.4	4.9	20.2
S-2	1	204.9	205.4	0.5	26.3
	2	205.9	207.1	1.2	26.9
	3	208.9	215.3	6.4	18.4
	4	215.3	223.3	8.0	18.3
	5	232.3	236.7	4.4	5.42
S-3	1	257.2	265.2	8.0	10.5
S-4	1	198.5	201.5	3.0	23.1
S-5	1	206.0	206.7	0.7	13.3
S-6	1	373	386.1	13.1	24.7

RECOMMENDATIONS:

In view of the unfavorable results of the drilling at the Marshall deposit, no further drilling is recommended for this deposit.

At the Ferguson deposit a southward trend has definitely been established for the ore body, and although considerably less than the six million tons have been indicated by the Phase I drilling, it is felt that the possible extension of the deposit beyond Hole S-6 should be investigated by further drilling. Inasmuch as it is impossible to predict the trend the ore may follow, it is recommended that initially a group of three holes be drilled 500 feet south, east, and west, respectively of Hole S-6.

It is recommended that additional holes should be laid out and drilled as long as the grade and thickness of the phosphate rock justified such continuation, and, of course as long as expenditures for drilling did not exceed funds allocated for Phase II.

Based on charges for Phase I drilling, it is estimated that the three initial holes could be drilled for $4,700. Subsequent holes would probably average $2,000 per hole.

If the entire $50,000 were expended, 22 additional holes could be drilled. Assuming each hole was drilled on 500 foot centers and

penetrated 10 feet of phosphate, the hole would indicate approximately 250,000 tons of ore.

Using these assumptions, 25 such holes would add approximately 6,250,000 tons of ore to the 1.5 million developed in Phase I.

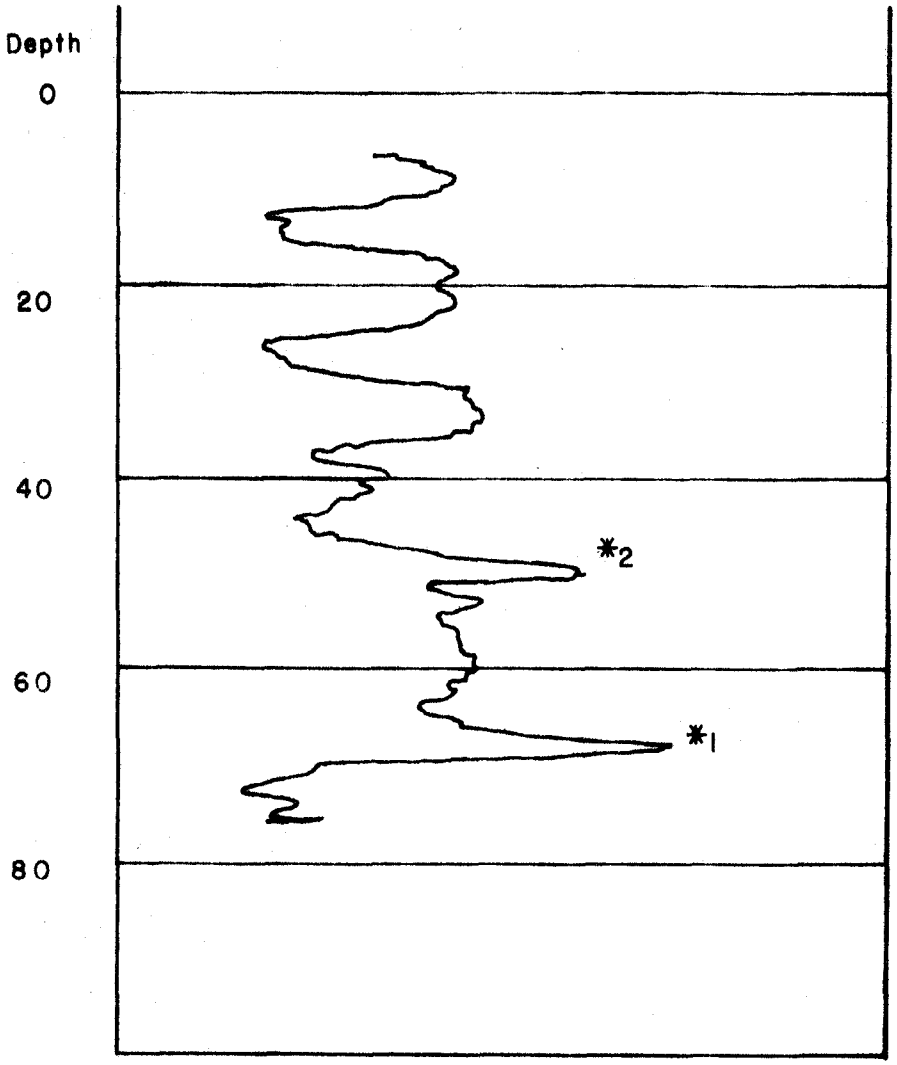
APPENDIX A

GAMMA RAY LOGS OF SELECTED DRILL HOLES

A.R.A. PHOSPHATE DRILLING PROJECT
SEARCY-VAN BUREN COUNTY, ARKANSAS

GAMMA RAY LOG

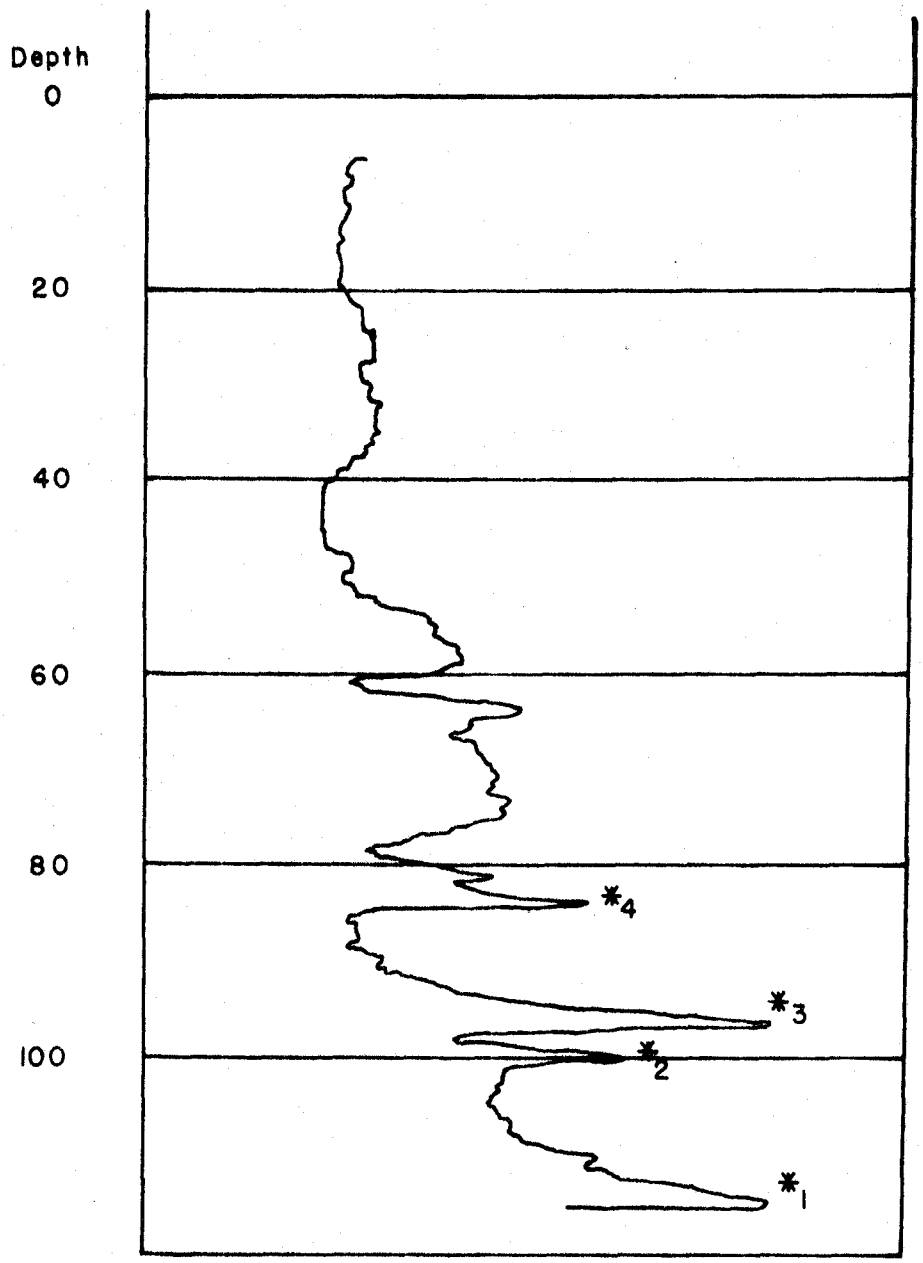
Hole No.	N-6
T. D.	76 ft.
Surface Elev. (msl)	1,099 ft.
G. R. Scale	.025
Peak Reading (*1)	2.9 MR/H
(*2)	1.7 MR/H
Logging Speed	12 ft./min.
Date Logged	12/18/63



Phosphate Thickness In Feet	Percent P_2O_5
1.0	6.0
1.2	Not Assayed

A.R.A. PHOSPHATE DRILLING PROJECT
SEARCY-VAN BUREN COUNTY, ARKANSAS

Hole No.		N-7
T.D.		115 ft.
Surface Elev.	(msl)	1,150 ft.
G.R. Scale		.025
Peak Reading	(*1)	1.2 MR/H
	(*2)	2.0 MR/H
	(*3)	2.5 MR/H
	(*4)	2.0 MR/H
Logging Speed		15 ft./ min.
Date Logged		12/28/63

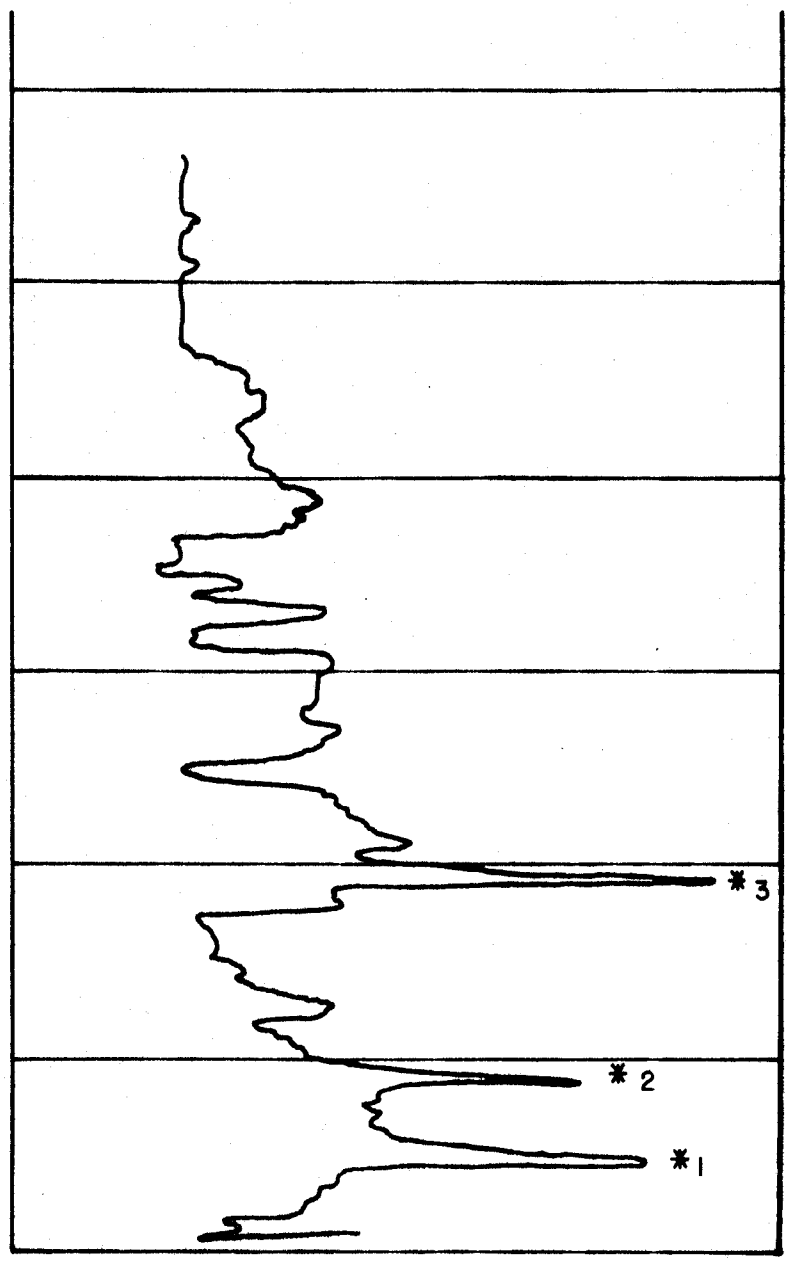


Phosphate In Feet	Thickness	Percent P_2O_5
	0.2	Not Assayed
	0.7	16.8
	0.1	Not Assayed
	1.0	Not Assayed

A.R.A. PHOSPHATE DRILLING PROJECT
SEARCY-VAN BUREN COUNTY, ARKANSAS

GAMMA RAY LOG

Hole No.		N-8
T. D.		119 ft.
Surface Elev.	(msl.)	1,158 ft.
G. R. Scale		.025
Peak Reading	(*1)	2.0 MR/H
	(*2)	2.0 MR/H
	(*3)	2.5 MR/H
Logging Speed		12'/min.
Date Logged		12/26/63

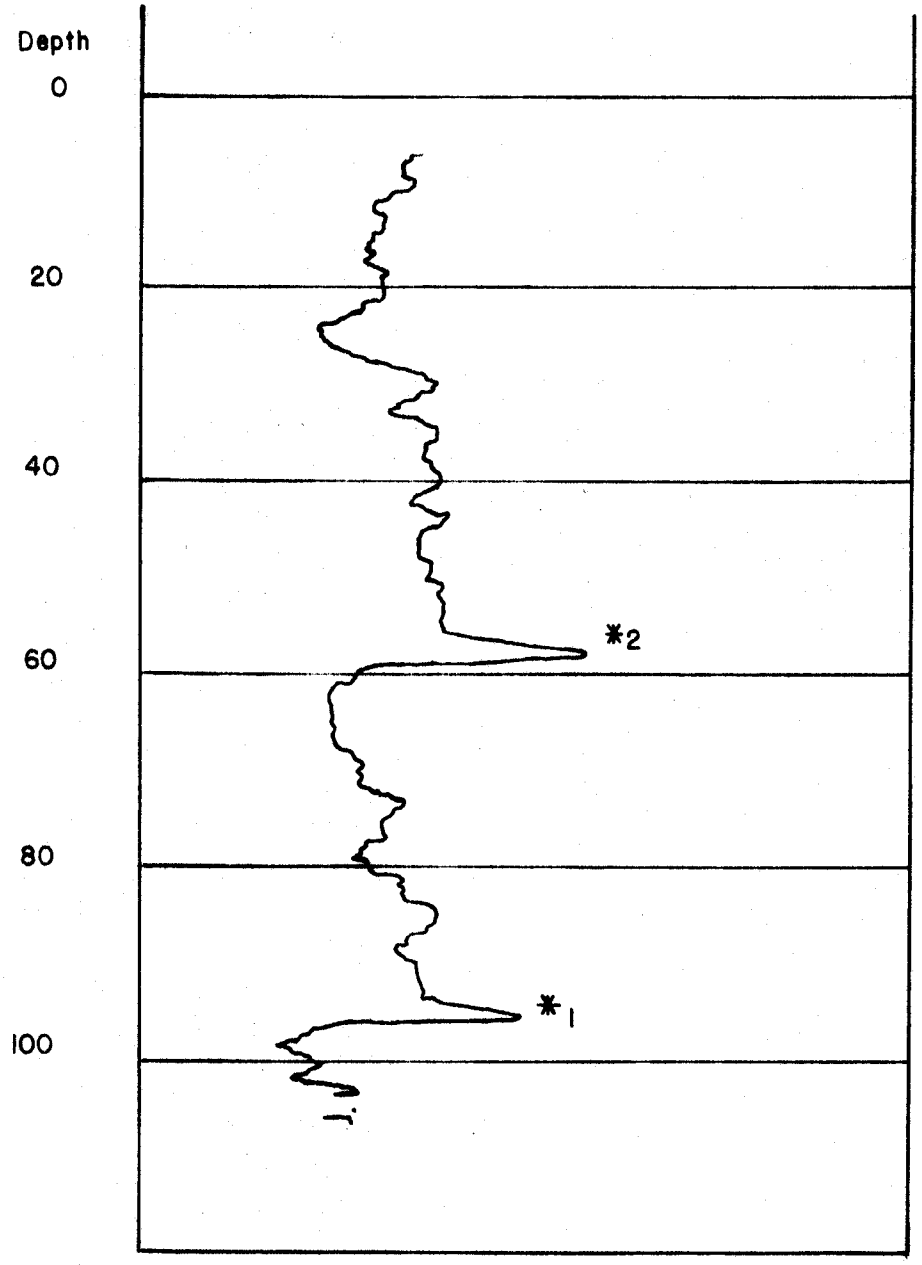


	Phosphate Thickness In Feet	Percent P_2O_5
*3	See Text	
*2	.5	6.3
*1	1.7	4.8

A.R.A. PHOSPHATE DRILLING PROJECT
SEARCY-VAN BUREN COUNTY, ARKANSAS

GAMMA RAY LOG

Hole No.		N-9
T. D.		103 ft.
Surface Elev.	(msl)	1,110 ft.
G. R. Scale		.025
Peak Reading	(*1)	2.5 MR/H
	(*2)	3.0 MR/H
Logging Speed		15 ft./min.
Date Logged		12/20/63



Phosphate Thickness In Feet	Percent P_2O_5
0.9	18.6
1.6	Not Assayed

APPENDIX B

GAMMA RAY LOGS OF SELECTED DRILL HOLES

STRATIGRAPHIC LOG

HOLE NO. N-1 LOCATION NE¼, SW¼, SEC. 1, T13N, R15W, Searcy County

PAGE 1 OF 1 DATE 11-4-63 11-6-63 COLLAR ELEV. 1072 NOTES BY DFH, PJS

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-23.5'		Weathered sandstone boulders and clay
23.5'-27.7'		Sandstone; gray, fine grained with a few 3-6"
		layers of fossiliferous limestone and limestone
		conglomerate
27.7'-31.0'		Sandstone; finely-laminated cross bedded
31.0'-37.8'		Sandstone; medium grained dark gray, calcareous
		with few black shale partings and carbonized wood
		fragments
37.8'-44.0'		Black clay shale- locally contains 1-3" siderite
		concretions
44.0'-49.0'		Sandstone; medium-grained dark gray calcareous
		with few thin shale seams and partings
49.0'-49.6'		Sandstone; dark gray, fine grained with pyrite
		in fractures
49.6'-57.2'		Black clay shale with some thin siderite concretions
57.2'-58.2'		Sandstone; gray, medium grained, finely laminated
58.2'-61.4'		Black clay shale
61.4'-66.8'		Shale; dark gray sandy slightly oolitic
66.8'-68.4'		Limestone conglomerate; coarsely crystalline,
		oolitic fossiliferous
68.4'-75.9'		Alternating layers of fine grained sandstone and
		black shale
75.9'-77.2'		Sandstone; gray fine grained
77.2'-79.7'		Black clay shale with scattered black carbonaceous
		sand seams
79.7'-83.8'		Alternating layers of black fine grained carbona-
		ceous sandstone and black clay shale
83.8'-85.0'		Limestone conglomerate; dark coarse-grained
		fossiliferous and oolitic
85.0'-87.6'		Limestone conglomerate with large limestone pebbles
87.6'-88.4'		Limestone; gray green dense
88.4'-89.9'		Limy shale; gray green
89.9'-91.5'		Limestone; gray dense crinoidal
91.5'-91.9'		Gray clay shale
91.9'-93.2'		Limestone; black fossiliferous
93.2'-96.0'		Limestone; dark gray oolitic

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	23.5	23.5		
23.5	25.5	2.0		
25.5	27.7	2.2		
27.7	29.3	1.6		
29.3	35.6	6.3		
35.6	38.9	3.3		
38.9	43.6	4.7		
43.6	49.6	6.0		
49.6	55.9	6.3		
55.9	65.8	9.9	9.8	99
65.8	69.8	4.0	3.6	90
69.8	75.9	6.1	6.0	98
75.9	85.8	9.8	9.8	100
85.8	96.0	10.2	9.8	96

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O
79.7	84.0	4.3	N-1-1	1.0
66.8	68.4	1.6	N-1-2	8.3
83.8	85.0	1.2	N-1-3	3.1
70.6	70.7	0.1	N-1-4	4.5

STRATIGRAPHIC LOG

HOLE NO. N-2 LOCATION NW¼, SE¼, Sec 1, T13N, R15W, Searcy County

PAGE 1 OF 1 DATE 11-13-63 (11-7-63) COLLAR ELEV. 1075 NOTES BY DFH, RVB

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-30'		Weathered sandstone and clay
30'-37'		Black clay shale
37'-42.6'		Sandstone; gray, fine grained with some interbedded shale layers
42.6'-43.8'		Shale; brown to gray sandy in part scattered siderite pebbles
43.8'-45.9'		Sandstone; light to dark gray, pyrite, medium grained
45.9'-53.7'		Clay shale with carbonaceous plant fragments
53.7'-61.5'		Sandstone - medium grained gray
61.5'-66.4'		Black clay shale-thin white calcite partings
66.4'-71.4'		Interbedded sandstone and shale
71.4'-75.0'		Siltstone; soft gray to brown Argillaceous
75.0'-77.5'		Black clay shale
77.5'-79.7'		Sandstone; gray, oolitic
79.7'-83.3'		Sandstone; fine grained, gray calcareous with some shale partings
83.3'-89.6'		Interbedded gray calcareous sandstone and black gray shale
89.6'-99.9'		Black clay shale with interbedded black carbonaceous sandstone
99.9'-100.9'		Limestone conglomerate; coarse grained, fossiliferous, oolitic
100.9'-102.0'		Limestone; medium grained, black, fossiliferous, oolitic
102'-103'		Limestone; dense, earthy, gray-green

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	23	23		
23	37	14		
37	41	4		
41	42.8	1.7		
42.8	46.8	4.0		
46.8	49.5	2.7		
49.5	53.7	4.2		
53.7	62.9	9.2		
62.9	72.7	9.8	9.0	92
72.7	81.1	8.4	7.5	89
81.1	84.2	3.1	3.1	100
84.2	89.6	5.4	5.0	93
89.6	96.6	7.0	6.8	97
96.6	103	6.4	6.0	94

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
77.5	79.7	2.2	N-2-1	5.34

STRATIGRAPHIC LOG

HOLE NO. N-3 LOCATION NW¼ SE¼ SEC 1 T13N R15W, Searcy County

PAGE 1 OF 1 DATE 11-11-63 11-13-63 COLLAR ELEV. 1103 NOTES BY RVB-DFH

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-15'		Weathered sandstone and clay
15'-18.7'		Sandstone; fine to medium grained
		cross bedded gray to brown
18.7'-19'		Interbedded gray siltstone and black shale
		(mostly siltstone)
19.0'-33.0'		Black clay shale
33.0'-37.2'		Sandstone; medium grained brown
37.2'-38.6'		Sandstone; medium grained gray calcareous
38.6'-39.5'		Sandstone; medium grained brown
39.5'-41.3'		Phosphorite
41.3'-42.7'		Sandstone; brown medium grained
42.7'-46.1'		Sandstone; fine grained gray calcareous
		massive
46.1'-46.2'		Sandstone; oolitic
46.2'-52.6'		Sandstone; fine grained, gray, cross bedded,
		thin shale partings
52.6'-65.0'		Black clay shale
65.0'-67.1'		Limestone; black, oolitic, massive, top 2"
		fossiliferous
67.1'-68.2'		Limestone; gray, earthy, dense
68.2'-71.7'		Limestone; massive gray fossiliferous
71.7'-73.1'		Limestone; gray shaly
73.1'-73.4'		Black clay shale
73.4'-74.1'		Limestone; black shaly
74.1'-74.9'		Limestone; fossiliferous, black oolitic
74.9'-75.3'		Shale; gray fossiliferous calcareous

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	15	15		
15	26	11		
26	33	7		
33	42.7	9.7	8.3	86
42.7	52.7	10.0	9.5	95
52.7	57.4	4.7	3.6	77
57.4	65.0	7.6	rock	bit
65.0	75.3	10.3	10.3	100

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
39.5	41.3	1.8	N-3-1	32.

STRATIGRAPHIC LOG

HOLE NO. N-4 LOCATION NE¼, SW¼ SEC. 1 T13N, R15W, Searcy County

11-7-63

PAGE 1 OF 1 DATE 11-9-63 COLLAR ELEV. 1064 NOTES BY P.J.S, D.E.H.

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-23'		Weathered sandstone boulders
		and clay
23'-25'		Black clay shale
25'-28.7'		Sandstone; gray, fine grained with black
		shale partings
28.7'-30.8'		Sandstone; very fine grained, pyritic,
		calcareous - interbedded, black shale
30.8'-42.0'		Black shale - some thin beds of fine grained
		dark sandstone
42.0'-49.5'		Sandstone; gray, calcareous with interbedded
		black shale
49.5'-54.6'		Sandstone; gray fine grained some bitumenous
		and pyritic material
54.6'-59.9'		Black clay shale
59.9'-60.7'		Dark gray clay shale with carbonized
		plant fragments
60.7'-64.3'		Sandstone; dark gray fine grained pyritic
		oolitic, carbonaceous
64.3'-64.5'		Black clay shale
64.5'-69.8'		Sandstone; fine grained gray banded - abun-
		dant plant fragments
69.8'-83.5'		Alternating layers of gray sandstone and
		black clay shale
83.5'-83.7'		Limestone conglomerate; black coarsely
		crystalline, oolitic, fossiliferous
83.7'-85.1'		Shale; gray, green, hard, calcareous

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	27	27		
27	30.2	3.2		
30.2	31	0.8		
31	49.5	18.5		
49.5	54.6	5.1	5.1	100
54.6	59.9	5.3	4.8	91
59.9	65.1	5.2	5.0	96
65.1	69.1	4.0	4.0	100
69.1	75.9	6.8	5.8	89
75.9	80.4	4.5	4.5	100
80.4	85.1	4.7	4.7	100

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
60.7	64.3	5.6	N-4-1	1.93
64.5	69.8	5.3	N-4-2	2.80
69.8	83.5	13.7	N-4-3	1.29

STRATIGRAPHIC LOG

HOLE NO. N-6 LOCATION NE¼, SW¼, SEC. 1 T13N, R15W, Searcy County

PAGE 1 OF 1 DATE 12-17-63 12-18-63 COLLAR ELEV. 1099 NOTES BY DFH

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-20.5'		Weathered sandstone and clay
20.5'-25.2'		Black clay shale striped with brown weathered streaks
25.2'-28.5'		Sandstone; brown, weathered locally to honeycomb texture; 0.3' conglomerate at 26.4', sand matrix, shale pebbles
28.5'-35.4'		Black clay shale
35.4'-35.9'		Siltstone; gray with thin shale seams
35.9'-51.5'		Sandstone; brownish, cross bedded locally thin phosphatic streaks (49.5-50.5') and thin limonitic zones
51.5'-54.6'		Sandstone; gray, fine-grained scattered oolites
54.6'-55.9'		Interbedded gray siltstone and black shale
55.9'-68.1'		Black clay shale
68.1'-69.3'		Limestone conglomerate; black, fossiliferous oolitic
69.3'-80.0'		Alternating layers of gray fossiliferous limestone black shale and black oolitic limestone

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	20.5	20.5	Rock	Bit
20.5	26.0	5.5		
26.0	36.0	10.0	7.5	75
36.0	46.0	10.0	10.0	100
46.0	53.4	7.4	6.0	81
53.4	61.6	8.2	7.3	90
61.6	71.0	9.4	9.3	99
71.0	80.0	9.0	9.0	100

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	P_2O_5
49.5	50.5	1.0	N-6-1	6.0

STRATIGRAPHIC LOG

HOLE NO. N-7 LOCATION NW¼,SE¼, SEC. 1 T13N, R15W, Searcy County

12-11-63

PAGE 1 OF 1 DATE 12-17-63 COLLAR ELEV. 1150 NOTES BY DEH, RVB

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-60'		Sandstone boulders and clay
60'-60.7'		Black clay shale
60.7'-61.8'		Sandstone; dark gray dark brown, medium
		grained, honeycomb texture due to leaching,
		coarse conglomerate at 60.9'-61.3'.
61.8'-65.1'		Sandstone; gray, fossil plant remains, a
		few inches of cross bedded shaly
		siltstone
65.1'-65.4'		Shale and shaly sandstone, conglomerate with
		calcareous pebbles
65.4'-71.1'		Shale
71.1'-71.8'		Sandstone; gray, with irregular shale partings
71.8'-72.7'		Black clay shale - with interbedded shaly
		sandstone
72.7'-75.5'		Black clay shale; weathered greenish at the
		top
75.5'-76.0'		Sandstone; finely cross laminated with shale
		partings
76.0'-85'		Sandstone; medium grained orange, with two
		thin phosphate layers (84.1'-84.3') and
		(84.6'-84.65')
85.0'-91.5'		Sandstone; medium grained, gray to brown
91.5'-96.3'		Sandstone; medium grained, gray to red, thin
		oolitic partings
96.3'-97.0'		Phosphorite
97.0'-99.8'		Sandstone; gray, medium-grained, hard and
		dense
99.8'-109'		Shale; black carbonaceous, fissile-conglomeratic
		hard black phosphorite (?) from 108.9'-109'
109'-114'		Black clay shale with gray siltstone pods and
		siderite lenses
114'-115'		Limestone conglomerate; oolitic fossiliferous.
115'-115.7'		Coarse pebble limestone conglomerate
115.7'-116.0'		Limestone; dense, black
116.0'-116.5'		Limestone; gray, fossiliferous

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	60	60	Rock	Bit
60	60.7	0.7	0.7	100
60.7	64.7	4.7	4.0	85
64.7	72.7	8.0	2.2	27
72.7	77.7	5.0	4.5	90
77.7	85.5	7.8	7.4	95
85.5	91.5	6.0	6.0	100
91.5	98.0	6.5	6.5	100
98.0	107	9.0	9.0	100
107	116.5	9.5	9.0	94

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
96.3	97.0	0.7	N-7-1	16.8
108.6	109.0	0.4	N-7-2	2.35

STRATIGRAPHIC LOG

HOLE NO. N-8 LOCATION NW¼, SE¼, SEC. 1, T13N, R15W, Searcy County
12-6-63

PAGE 1 OF 1 DATE 12-10-63 COLLAR ELEV. 1158 NOTES BY DEH, OAW

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-30'		Weathered sandstone and clay
30'-47'		Sandstone; buff to gray
47'-49.5'		Conglomerate; red to maroon, calcareous,
		claystone pebbles fossiliferous limestone matrix
49.5'-50.5'		Sandstone; light gray and brown, fine grained,
		calcareous, crossbedded
50.5'-50.8'		Sandstone; gray, very fine grained thinly
		laminated with shale partings
50.8'-52.8'		Sandstone; dark gray, finely crossbedded with
		scattered shale clasts
52.8'-55.5'		Shale; dark gray
55.5'-58.0'		Sandstone; gray, calcareous, stylolitic cross-
		bedded
58.0'-71.0'		Shale; dark gray
71.0'-74.0'		Sandstone; gray, calcareous, finely crossbedded
		0.2' shale at 73.5'
74.0-78.0'		Sandstone; brown to gray, few interbedded
		shale layers
78-83'		Sandstone; gray with limonitic spots, oolitic,
		few interbedded shale layers
83'-87.5'		Sandstone; gray with limonitic patches
87.5'-102.5'		Sandstone; gray and brown fine to medium
		grained, calcareous in part, numerous shale
		partings in bottom three feet
102.5'-103.0'		Sandstone; dark gray and black, medium
		grained, oolitic, shale partings
103.0'-110.5'		Black clay shale
110.5'-112.5'		Shale; black, pebbly, oolitic, fossiliferous
112.5'-115.6'		Shale; black, carbonaceous with siderite lenses
115.6'-117.1'		Limestone; dark gray dense narrow brecciated
		zone at top
117.1'-117.7'		Shale; black, carbonaceous with thin sand
		streaks
117.7'-118.4'		Limestone breccia: dark gray with white cal-
		cite vein
118.4'-120.0'		Limestone; gray, fossiliferous with interbedded
		thin shale streaks

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	47	47		
47	55	8		
55	61	6		
61	71	10		
71	74	3		
74	87.5	13.5		
87.5	90.0	2.5	0.5	20
90.0	103	13	13	100
103	108	5.0	4.9	98
108	112.5	4.5	4.3	95
112.5	120.0	7.5	7.5	100

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
102.5	103	0.5	N-8-1	6.3
110.8	12.5	1.7	N-8-2	4.8
78	83	5.0	N-8-3	3.1

STRATIGRAPHIC LOG

HOLE NO. N-9 LOCATION NE¼,SW¼,SEC. 1, T13N, R15W, Searcy County

PAGE 1 OF 1 DATE 12-20-63 COLLAR ELEV. 1110 NOTES BY DFH

12-18-63

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-30'		Boulders and clay
30-33'		Sandstone; brown, locally honeycombed by weathering, 0.1' conglomerate seam at 33'
33-43'		Black clay shale with scattered siderite lenses
43-44'		Siltstone; gray, with black shale partings
44-55'		Black clay shale; stained brown 51'-52'
55'-55.3'		Siltstone; gray and brown
55.3'-57.4'		Sandstone; orange, fine-grained, slightly oolitic at bottom
57.4'-58.3'		Phosphorite; with some interbedded orange sand streaks
58.3'-65.2'		Sandstone; orange, crossbedded
65.2'-65.9'		Siltstone; gray, massive with scattered oolites
65.9'-67.7'		Siltstone; buff, massive
67.7'-83.7'		Siltstone; gray, with thin shale partings (80.7'-82.1')
83.7'-85.0'		Interbedded black shale and gray siltstone (mostly shale)
85.0'-94.0'		Black clay shale with thin black silt seams
94.0'-95.6'		Limestone conglomerate; oolitic, black, very coarse at top, medium to fine grained at bottom
95.6'-97.0'		Interbedded gray limestone and black shale
97.0'-97.4'		Limestone; black, fossiliferous
97.4'-99.8'		Limestone; black, oolitic, with fossiliferous zones
99.8'-101.1'		Limestone; black, shaly
101.1'-101.9'		Limestone; gray, fossiliferous
101.9'-103.0'		Interbedded gray limestone and black shale

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	30	30	Rock	Bit
30	35.5	5.5	2.3	41
35.5	40.0	4.5	3.7	82
40.0	44.0	4.0	2.3	57
44.0	52.0	8.0	2.7	34
52.0	57.0	5.0	4.4	88
57.0	67.0	10.0	9.7	97
67.0	83.7	16.7	16.7	100
83.7	85.0	1.3	1.3	100
85.0	103	18	16	90

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
57.4	58.3	0.9	N-9-1	18.6

STRATIGRAPHIC LOG

HOLE NO. S-1 LOCATION SE¼,NW¼, SEC. 12, T13N, R15W, Van Buren, County.
11-29-63

PAGE 1 OF 2 DATE 12-4-63 COLLAR ELEV. 1150 NOTES BY DEH,TF,OAW

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-55'		Weathered sandstone, clay, sandstone boulders
55'-60'		Siltstone; gray
60'-113.4'		Black clay shale with some siderite fragments
113.4'-115.8'		Siltstone; gray with a few thin black shale layers
115.8'-125'		Black clay shale
125.0'-126.6'		Interbedded sandstone and shale
126.6'-127.3'		Limestone conglomerate fossil debris
127.3'-178.0'		Black shale
178.0'-182.8'		Sandstone; light gray with shale partings
182.8'-186.5'		Black shale with scattered sand streaks
186.5'-189.5'		Sandstone; gray fine grained
189.5'-190.8'		Siltstone; some interbedded black shale
190.8'-194.1'		Black clay shale with narrow siderite lenses
194.1'-195.2'		Siltstone; hard, gray
195.2'-196.0'		Black clay shale with two narrow siltstone bands
196.0'-200.2'		Sandstone; gray calcareous
200.2'-205.1'		Banded layers of gray to black siltstone and black shale siltstone predominates
205.1'-207.8'		Black clay shale with thin black sand seams
207.8'-208.8'		Siltstone; gray, finely banded at top conglomeratic at base
208.8'-209.3'		Phosphorite
209.3'-210.2'		Siltstone; gray, cross bedded
210.2'-211.4'		Phosphorite; conglomeratic cross bedded

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	55	55		
55	71.4	16.4		
71.4	87.0	15.6		
87.0	113.4	26.4		
113.4	116	2.6		
116	125	9.0		
125	133	8.0		
133	170	37.0		
170	185.4	15.4		
185.4	205.4	20.0		
205.4	225.9	20.4	20.0	
225.9	233.0	7.1	6.5	

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P 0 2 5
208.8	209.3	0.5	S-1-1	27.6
210.2	211.4	1.2	S-1-2	22.2
213.5	218.4	4.9	S-1-3	20.2

STRATIGRAPHIC LOG

HOLE NO. S-1 LOCATION SE¼, NW¼ SEC. 12, T13N, R15W, Van Buren, County

11-29-63

PAGE 2 OF 2 DATE 11-4-63 COLLAR ELEV. 1150 NOTES BY DFH, TF, OAW

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
211.4'-213.5'		Sandstone; gray, fine grained
213.5'-218.4'		Phosphorite; conglomeratic in part contains few thin barren sand seams
218.4'-226.3'		Siltstone; gray, wrinkled appearance to the core surface
226.3'-227.4'		Interbedded gray siltstone and black shale with siderite concretions
227.4'-229.2'		Black clay shale
229.2'-233.0'		Brown clay shale slightly waxy

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER

STRATIGRAPHIC LOG

HOLE NO. S-2 LOCATION SE¼, NW¼, SEC. 12, T13N, R15W, Van Buren County
11-16-63

PAGE 1 OF 2 DATE 11-23-63 COLLAR ELEV. 1172 NOTES BY OAW, DEH, RVE

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-22'		Weathered sandstone, clay and sandstone boulders
22'-58'		Sandstone; very fine grained varying from gray to blue gray to brown in color
58'-59'		Interbedded sandstone and shale
59'-59.2'		Conglomerate
59.2'-109.3'		Black clay shale; 3" fossil debris at 67.6', 6" fossil debris zone at 83.3', A few ½" siderite lenses 3" pyritic zone at 104.4', interbedded sand seams 106.4'-107.4'.
109.3'-113.2'		Sandstone; gray fine-grained cross bedded with 2-2" black shale layers
113.2'-175'		Black shale with scattered siderite lenses
175'-176.3'		Sandstone; fine grained some shale partings
176.3'-179.1'		Sandstone; fine grained light and dark gray, shale partings
179.1'-180.8'		Alternating layers of crossbedded brownish fine grained sandstone and black pyritic shale
180.8'-181.9'		Black shale-conglomeratic with siderite pebbles
181.9'-182.9'		Alternating black shale and gray fine-grained sandstone
182.9'-184.6'		Sandstone-fine grained gray, shale partings, carbonized plant fragments
184.6'-186.4'		Alternating gray sandstone and shale-plant imprints in sandstone
186.4'-188.9'		Black shale scattered siderite concretions

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	22	22		
22	34.5	12.5		
34.5	42.6	8.1		
42.6	52.6	10.0		
52.6	61.4	8.8		
61.4	68.2	6.8		
68.2	86.1	17.9		
86.1	94.5	8.4		
94.5	104.9	10.4		
104.9	116.0	11.1		
116.0	158.0	42.0		
158.0	175	17.0		
175	186.7	11.7		
186.7	197.0	10.3		
197.0	216.8	19.8	19.4	98
216.8	227.3	10.5	10.4	99
227.3	237.3	10.0	9.7	97

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
204.9	205.4	0.5	S-2-1	26.3
205.9	207.1	1.2	S-2-2	26.9
208.9	215.3	6.4	S-2-3	18.4
215.3	223.3	8.0	S-2-4	18.3
232.3	236.7	4.4	S-2-5	5.42

STRATIGRAPHIC LOG

HOLE NO. S-2 LOCATION SE¼, NW¼, SEC. 12, T13N, R15W, Van Buren County

PAGE 2 OF 2 DATE 11-16-63 11-23-63 COLLAR ELEV. 1172 NOTES BY OAW, DFH, RVB

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
188.9'-190.2'		Alternating layers of shale and sandstone
190.2'-196.7'		Sandstone; gray, fine grained shale partings
196.7'-197.4'		Black clay shale
197.4'-198.5'		Siltstone; gray, finely laminated
198.5'-200'		Interbedded black clay shale and gray siltstone
200'-203.7'		Black clay shale
203.7'-204.9'		Siltstone; gray, calcareous
204.9'-205.4'		Phosphorite
205.4'-205.9'		Sandstone; gray, calcareous
205.9'-207.1'		Phosphorite
207.1'-207.6'		Sandstone; gray, calcareous
207.6'-207.8'		Phosphorite
207.8'-208.9'		Sandstone; gray, calcareous
208.9'-214.4'		Phosphorite
214.4'-215.3'		Sandstone; gray, calcareous
215.3'-223.3'		Phosphorite
223.3'-226.3'		Sandstone; gray, calcareous with shale partings
226.3'-232.3'		Interbedded black shale and gray calcareous sandstone upper 3 feet mainly sandstone lower 3 feet mainly shale
232.3'-236.7'		Limestone conglomerate; black, coarsely crystalline, bituminous streaks, oolitic fossiliferous
236.7'-237.3'		Black clay shale

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER

STRATIGRAPHIC LOG

HOLE NO. S-3 LOCATION SW¼ NW¼ SEC. 12 T13N R15W, Van Buren, County

PAGE 1 OF 2 DATE 11-15-63 11-26-63 COLLAR ELEV. 1247 NOTES BY RVB, OAW, DEH

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0'-35'		Weathered sandstone and clay
35'-40'		Gray shale
40'-45'		Gray slightly sandy shale
45'-55'		Gray shale
55'-60'		Gray silty shale
60'-64'		Sandstone; light gray fine grained
64'-85.7'		Sandstone; fine to medium-grained scattered
		shale partings - bituminous material in partings
85.7'-114.1'		Sandstone; very fine grained stylolitic shale
		partings
114.1'-116.1'		Black shale - with some interbedded sandstone
116.1'-116.9'		Sandstone - argillaceous - crossbedded with
		fossil fragments
116.9'-117.9'		Conglomerate; siderite pebbles, silicified fossils,
		honeycomb texture, non-calcareous
117.9'-158'		Black shale - carbonaceous and sandy
158'-159.8'		Black shale and crossbedded sandstone
159.8'-163.4'		Sandstone; gray, crossbedded, 0.5' zone fossil
		debris
163.4'-164.5'		Black shale and crossbedded sandstone
164.5'-228.0'		Black shale
228.0'-230.8'		Sandstone; gray to dark gray, medium grained
230.8'-231'		Siltstone; gray
231'-234'		Black shale with siltstone and sandstone streaks
234'-238'		Sandstone; gray, with thin shale partings and
		layers, ½" zone siderite fragments at 238'
238'-243'		Black shale with scattered siderite concretions
243'-243.4'		Siltstone; finely laminated
243.4'-250.4'		Siltstone; massive, gray, calcareous with
		stylolitic shale partings
250.4'-253.7'		Interbedded grey calcareous siltstone and
		black clay shale
253.7'-257.2'		Black clay shale

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	64	64		
64	104.4	40.4		
104.4	119	14.6		
119	158	39		
158	165	7		
165	228	63		
228	241	13		
241	250	9		
250	253.7	3.7	3.7	100
253.7	265.2	11.5	11.5	100
265.2	270.7	5.5	5.5	100
270.7	278.8	8.1	8.1	100

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
257.2	265.2	8.0	S-3-1	10.5

STRATIGRAPHIC LOG

HOLE NO. S-3 LOCATION SW¼,NW¼,SEC.12, T13N, R15W, Van Buren County

PAGE 2 OF 2 DATE 11-15-63 11-26-63 COLLAR ELEV. 1247 NOTES BY OAW, DFH, RVB

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
257.2-265.2'		Oolitic sandstone (phosphorite?) (oolitic streaks throughout the interval in varying concentrations) conglomeratic at 259.2'-259.3', two narrow shale seams
265.2'-266.5'		Dark gray waxy shale
266.5'-266.6'		Conglomerate; coarse limestone pebbles, shale matrix
266.6'-277.7'		Shale; hard dense black calcareous, a few fossiliferous zones and calcite veinlets
277.7'-278.8'		Black clay shale

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER

STRATIGRAPHIC LOG

HOLE NO. S-4 LOCATION SW¼, NE¼ SEC. 12, T13N, R15W, Van Buren, County

PAGE 1 OF 1 DATE 11-29-63 12-4-63 COLLAR ELEV. 1152 NOTES BY TF, DFH, QAW

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0'-37'		Weathered sandstone boulders and clay
37'-51'		Siltstone; gray, with very thin shale partings
51'-102'		Black shale
102'-104.5'		Siltstone; gray with carbonized wood fragments
104.5'-167.0'		Black clay shale
167.0'-169.5'		Sandstone; light gray with interbedded shale, black carbonaceous
169.5'-172.6'		Sandstone; light gray with limy streaks (72'-72.6' fossiliferous fragmental conglomerate)
172.6'-176.2'		Black shale with scattered siderite lenses
176.2'-178.4'		Sandstone; light gray slightly argillaceous
178.4'-183.7'		Black shale with few sand stringers, siderite lenses, conglomerate
183.7'-190.4'		Sandstone; white calcareous streak of fossiliferous debris
190.4'-197.3'		Interbedded sandstone and black shale
197.3'-197.9'		Sandstone; light gray conglomeratic
197.9'-198.5'		Sandstone; gray crossbedded contains narrow oolitic zones
198.5'-199.6'		Phosphorite
199.6'-200.0		Sandstone; gray, cross bedded few oolitic seams
200.0'-201.5'		Phosphorite
201.5'-203.1'		Sandstone; gray, carbonaceous calcareous
203.1'-204.3'		Black clay shale (1" brown waxy clay)
204.3'-214.8'		Hard black calcareous shale 6" fossiliferous zone at 213.3'

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	37	37		
37	52	14		
52	102	50		
102	105	3		
105	167	62		
167	173.8	6.8		
173.8	181.0	7.1		
181.0	190.4	9.4		
190.4	198.3	7.9	7.8	98
198.3	205.2	6.9	6.9	100
205.2	214.8	9.6	9.3	97

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
198.5	201.5	3.0	S-4-1	23.1

STRATIGRAPHIC LOG

HOLE NO. S-5 LOCATION NW¼, NE¼ SEC. 12 T13N, R15W, Van Buren, County

PAGE 1 OF 2 DATE 12-6-63 12-17-63 COLLAR ELEV. 1134 NOTES BY DFH, TF, OAW

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-10'		Clay and sandstone boulders
10-54.3'		Sandstone; light gray to brown medium grained
		stylolitic and shale partings
54.3'-54.9'		Shale; black fossiliferous, pyritic streaks,
		siderite pebbles
54.9'-102'		Black shale
102'-105'		Shale; black, clay fissile 0.5' pebbly zone
105'-107'		Shale; black with interbedded thin sand streaks
107'-112.3'		Sandstone; light gray medium grained, thinly
		laminated (111.4'-112.0'), two 1" shale
		breaks with plant fragments
112.3'-177'		Black clay shale
177'-178.4'		Interbedded and banded gray siltstone and
		black shale (mostly siltstone)
178.4'-180.7'		Siltstone; gray with carbonized wood fragment
		partings
180.7'-181.2'		Black shale
181.2'-182.7'		Conglomerate; very coarse pebbles mostly
		siderite, sand and limestone matrix
182.7'-183.8'		Interbedded gray siltstone and black shale
183.8'-187.5'		Siltstone; massive, gray
187.5'-188.4'		Interbedded gray siltstone and black shale,
		1" brecciated zone at 188.1'
188.4'-191.9'		Black shale with many siderite concretions
191.9'-192.2'		Siltstone; dark, gray, dense, argillaceous
192.2'-192.7'		Siltstone; mottled, gray to dark gray, banded
192.7'-193.5'		Interbedded dark gray siltstone and black shale
193.5'-194.6'		Siltstone; light gray, 2" conglomerate layer
		at base
194.6'-195.2'		Siltstone; gray, finely banded, few narrow
		shale partings
195.2'-199.6'		Sandstone; massive, gray scattered pyrite seams
199.6'-200.0'		Black clay shale
200.0'-202.8'		Siltstone; gray, banded in part 2 thin shale
		seams

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV
0	10	10		
10	21	11		
21	31	10		
31	51	20		
51	54.9	3.9		
54.9	102	47.1		
102	112	10		
112	177	65		
177	187.5	10.5	10.2	97
187.5	190.8	3.3	3.1	94
190.8	207.0	16.2	16.2	100
207.0	217.0	10.0	10.0	100

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
206.0	206.7	0.7	S-5-1	13.3

STRATIGRAPHIC LOG

HOLE NO. S-5 LOCATION NW¼, NE¼, SEC. 12 T13N, R15W, Van Buren County

PAGE 2 OF 2 DATE 12-6-63 12-17-63 COLLAR ELEV. 1134 NOTES BY DFH, TF, OAW

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
202.8'-205.3'		Black clay shale
205.3'-206.0'		Siltstone; gray, banded, crossbedded
206.0'-206.7'		Phosphorite; conglomeratic
206.7'-207.1'		Black clay shale
207.1'-217.0'		Shale; hard black calcareous with scattered fossil zones

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER

STRATIGRAPHIC LOG

HOLE NO. S-6 LOCATION SE¼, NW¼ SEC. 12, T13N, R15W, Van Buren, County

PAGE 1 OF 2 DATE 12-30-63 1-9-64 COLLAR ELEV. 1347 NOTES BY DEH

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
0-20'		Sand and clay
20-63'		Sandstone; buff to brown, medium-grained s slightly friable, massive
63'-81.3'		Sandstone; unweathered equivalent of above rock, light gray, some mica flakes
81.3'-84.0'		Interbedded black shale and gray sandstone
84.0'-184.0'		Black clay shale
184.0'-187.7'		Interbedded thinly laminated gray sandstone and shale, black micaceous shaly sandstone, and siderite nodules
187.7'-225'		Siltstone; gray, slightly micaceous with numerous thin black shale partings
225.0'-225.5'		Conglomeratic layer; large black phosphate or siderite pebbles
225.5'-337'		Black clay shale with occasional large siderite nodules
337'-340.4'		Siltstone; gray, corssbedded 0.2' black clay shale at 338.8'
340.4'-341.4'		Black shale, brown siltstone and siderite lenses
341.4'-342'		Gray siltstone
342.0'-343.7'		Black clay shale - 0.3' interbedded shale and siltstone at bottom
343.7'-346.1'		Gray siltstone
346.1'-351.9'		Black clay shale with large siderite concretions - bottom 0.5' silty
351.9'-357.4'		Siltstone; gray with thin black shale partings
357.4'-358.4'		Alternating black, gray and brown siltstone with some black shale
358.4'-359.7'		Siltstone; gray, with 2 0.1' conglomerates, siderite pebbles
359.7'-360.1'		Black clay shale
360.1'-360.4'		Siltstone; gray, conglomeratic
360.4'-360.8'		Siltstone; gray
360.8'-362.9'		Interbedded black shale and gray and black siltstone
362.9'-366.3'		Black clay shale with siderite nodules
366.3'-366.5'		Gray siltstone
366.5'-367.4'		Siltstone; dark gray, a few scattered oolites

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
0	20	20	Rock	Bit
20	40	20		
40	60	20		
60	70	10		
70	84.8	14.8		
84.8	137	52.2	Rock	Bit
137	140	3.0		
140	173	33	Rock	Bit
173	175	2		
175	184	9		
184	204	20		
204	224	20		
224	236	12		
236	270	34		
270	278	8		

(continued on Page 2)

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER	% P_2O_5
373	386.1	13.1	S-6-1	24.7

STRATIGRAPHIC LOG

HOLE NO. S-6 LOCATION SE¼, NW¼, SEC. 12, T13N, R15W, Van Buren, County

PAGE 2 OF 2 DATE 12-30-63 1-9-64 COLLAR ELEV. 1347 NOTES BY DFH

LITHOLOGIC NOTES

DEPTH	PROFILE	DESCRIPTION
367.4'-373'		Siltstone; gray, with scattered oolitic streaks
373'-386.1'		Phosphorite; black, with a few conglomeratic layers
386.1'-390.4'		Siltstone; gray
390.4'-391.0'		Black shale with thin gray siltstone seams

BORING NOTES

DEPTH FROM	DEPTH TO	INTERV.	CORE RECOV.	% RECOV.
278	337	59	Rock	Bit
337	347	10		
347	362	15	14.1	94
362	365	3	3	100
365	384.8	19.8	19.4	98
384.8	391.0	6.2	6.2	100

SAMPLING NOTES

DEPTH FROM	DEPTH TO	INTERV.	SAMPLE NUMBER