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Uranium and Phosphate in the Western Part of the Bonny Lake Mine, Polk County, Florida

Trace Elements Memorandum Report 231

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

URANIUM AND PHOSPHATE IN THE WESTERN PART OF THE BONNY LAKE MINE, POLK COUNTY, FLORIDA

by

Richard G. Petersen

February 1951

Trace Elements Memorandum Report 231

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URANIUM AND PHOSPHATE IN THE WESTERN PART OF THE BONNY LAKE MINE, POLK COUNTY, FLORIDA

by

Richard G. Petersen

ABSTRACT

During the month of May 1950, the Davison Chemical Corporation, under contract with the Atomic Energy Commission, drilled 24 phosphate prospecting holes in the western part of the Bonny Lake mine, in the SW¼NW¼ and the NW¼SW¼ sec. 32, T. 29 S., R. 24 E., Polk County, Fla.

The purpose of this drilling was to obtain a comparison between tonnage and grade of uranium in the phosphate as indicated by prospecting, and the tonnage and grade of uranium in the phosphate products recovered in the mill.

The phosphate deposits of the land-pebble phosphate field are in the Pliocene Bone Valley formation. The Bone Valley formation is underlain by the Miocene Hawthorn formation, and is overlain by Pleistocene sand.

The results presented in this paper are based upon a study of drill cores, drill logs, gamma-ray logs, and the chemical analyses of drill-core samples.

Metallurgical treatment and chemical analyses of prospect samples indicate a total of 262,000 long tons of merchantable phosphate products with an average grade of 0.020 percent uranium, or about 114,000 pounds of uranium. Waste products total 352,000 long tons with an average grade of 0.009 percent uranium, or about 71,000 pounds of uranium. Therefore, about 62 percent of the total uranium, calculated from prospect data, is in the merchantable products. At the present rate of mining at the Bonny Lake mine, approximately 630 pounds of uranium per day would be available for recovery.

A comparison of the maps of the Bonny Lake mine in this report shows a direct relationship between the P_2O_5 content and the uranium content in each size fraction of the matrix; that is, with an increase in the percentage of P_2O_5 of each fraction there is also an increase in the percentage of uranium.

INTRODUCTION

From May 2 to June 7, 1950, the Davison Chemical Corporation, under Atomic Energy Commission contract AT (30-1) 885, drilled 24 prospecting holes in the $SW\frac{1}{4}NW\frac{1}{4}$ and the $NW\frac{1}{4}SW\frac{1}{4}$ sec. 32, T. 29 S., R. 24 E.. This area is in the western part of the Davison Chemical Corporation's Bonny Lake phosphate mine in Polk County, Fla. (fig. 1). The 24 holes were evenly spaced along the center line of each of

three north-trending proposed mining cuts 250 feet wide and 1500 feet long. The area of the proposed cuts totals approximately 25.8 acres; thus each hole represents 1.075 acres.

The purpose of this drilling was to obtain a comparison between tonnage and grade as indicated by prospecting and the actual tonnage and grade of the products recovered in the mill. This comparison has been reported by the Davison Chemical Corporation _/, and the

_/ Davison Chemical Corporation, Prospecting and sampling program under contract No. AT (30-1) 885: Report No. 2, September 1950. Report No. 3, October 1950.

U. S. Geological Survey _/.

_/ Cathcart, J. B., Letter to F. W. McQuiston, Jr., Sept. 21, 1950.

Estimates of phosphate and uranium reserves in the eastern part of the Bonny Lake mine have been given previously _/.

_/ Wayland, Thomas E., Preliminary report on drilling in the eastern part of the Bonny Lake mine, Polk County, Florida: U. S. Geol. Survey Trace Elements Memorandum Rept. 230, December 1950.

Metallurgical treatment, screening into six fractions, analysis for P_2O_5 content, and the computation of tonnages were done by the Davison Chemical Corporation _/. Splits of the screened samples

_/ Davison Chemical Corporation, Prospecting and sampling program under contract No. AT (30-1) 885: Report No. 1, Sept. 1950.

were sent to the U. S. Geological Survey's laboratory in Washington, D. C., to be analyzed for uranium.

After completion of the drilling of each hole, the Geological Survey's gamma-ray logging unit measured the radioactivity of the rock exposed in the hole. The gamma-ray logs aided in determining the upper and lower contact of the leached zone.

The author is grateful for the cooperation of the Davison Chemical Corporation, and for the planning and supervision of J. B. Cathcart, Project Chief of the Geological Survey's Florida Phosphate Project.

GEOLOGY

General geology

The land-pebble phosphate field in Polk and Hillsborough Counties, Fla., is in the Gulf Coastal Plain, and is underlain by thin, nearly flat-lying rocks. The oldest exposed rock is the Hawthorn formation of lower middle Miocene age. The Pliocene Bone Valley formation overlies the Hawthorn formation, and is overlain by sands of Pleistocene age _/.

_/ MacNeil, F. S., Pleistocene shorelines in Georgia and Florida: U. S. Geol. Survey Prof. Paper 221-F (in press).

The Hawthorn formation is composed of hard buff-colored fossiliferous limestone containing phosphate pellets, interbedded with sand and clay. A long period of erosion followed the deposition of the Hawthorn formation leaving a karst topography upon which the Pliocene Bone Valley formation was deposited.

The Bone Valley formation is divided into two parts. The lower minable part consists of silt- to cobble-size phosphate pellets mixed with varying amounts of quartz sand and clay. It ranges in thickness from 3 feet to 50 feet. The phosphate pellets are composed largely of calcium phosphate and contain about 25 to 35 percent P_2O_5. The upper part of the Bone Valley formation is composed largely of a porous light-weight rock of aluminum phosphate (wavellite) and quartz. According to Altschuler and Boudreau _/ this upper part originally was similar to the lower

_/ Altschuler, Z. S. and Boudreau, C. E., Official communication, 1950.

part of the formation but subsequent leaching has removed much of the calcium and some phosphorus. This leached zone contains 12 to 15 percent P_2O_5 as aluminum phosphate.

The Bone Valley formation is overlain by terraced Pleistocene quartz sands. These sands are largely unconsolidated, but in some places iron-bearing ground water has cemented the sands to form a semi-indurated sandstone.

The mining companies of the phosphate district have developed a local terminology for distinguishing the various rock units of the area. The hard limestone of the Hawthorn formation is called "bedrock." The residual clay of the Hawthorn, overlying the limestone, is named the "bed clay." The economic phosphate deposit, whether in the Hawthorn or Bone Valley formation, is known as the

"matrix," and the leached upper part of the Bone Valley formation is called the "leached zone." All sediments, including the leached zone, overlying the matrix are classed as "overburden" and discarded. No process has yet been discovered for the economic extraction of phosphate or uranium from the leached zone.

All mining companies in the district analyze the phosphate samples for percent of P_2O_5, which is then multiplied by 2.18 to give the market term "B.P.L." (Bone Phosphate of Lime). All phosphate analyses are reported as percent B.P.L.

Bonny Lake mine

The Bonny Lake mine of the Davison Chemical Corporation is located in secs. 32 and 33, T. 29 S., R. 24 E., Polk County, Fla. (fig. 1). The Hawthorn formation, Bone Valley formation, and Pleistocene sands, discussed in the section on General Geology, are exposed at the Bonny Lake mine.

The bedrock at the Bonny Lake mine is a ridge of limestone of the Hawthorn formation (fig. 8). The Hawthorn residuum, or bed clay, covers the limestone. It ranges in thickness from 2 to 21 feet and averages 7 feet. There is a general increase in thickness toward the west (fig. 6). The bed clay at the Bonny Lake mine is gray to gray-green, calcareous and stiff, and contains some black phosphate pellets.

The economic lower part, or matrix, of the Bone Valley formation at the Bonny Lake mine contains a large percentage of coarse-size (+3 mesh) phosphate pellets and essentially no flotation-size (-48+150 mesh) phosphate (see tables 2 through 7). Two strata are present, (1) a top stratum of light-brown to white phosphate pebbles in quartz sand with a little clay and, (2) a bottom stratum of dark-brown to black phosphate pebbles in sandy clay. The matrix ranges in thickness from 7 to 19 feet and averages 13 feet. The thickness increases toward the east and northeast (fig. 5).

The upper or leached zone of the Bone Valley formation ranges in thickness from 1 to 8 feet, and is present over a large part of the mine; the thickest areas are isolated and have no general trend (fig. 4). It is composed of light-weight porous sand cemented by wavellitic clay and contains soft crumbly tan and white phosphate pellets.

Pleistocene deposits consist largely of unconsolidated quartz sand and are generally thicker than the Pleistocene deposits at the other mines in the district. The thickness ranges from 35 to 45 feet, increasing from west to east and northeast (fig. 3).

MEASURED RESERVES

The matrix samples from the 24 holes on the 25.8-acre tract at the Bonny Lake mine were separated into five screen fractions. The fractions consist of the following sizes:

(1) +3 mesh, coarse pebble.

(2) -3+20 mesh, fine pebble.

(3) -20+48 mesh, table feed.

(4) -48+150 mesh, washer sand.

(5) -150 mesh, slime.

The +3 mesh and the -3+20 mesh fractions consist essentially of phosphate pellets and are merchantable products. The -20+48 mesh fraction is treated with reagents to separate it into a merchantable concentrate of phosphate particles and a waste-sand tailing fraction. The -48+150 mesh fraction is ordinarily a flotation-cell feed, but at the Bonny Lake mine it contains such a small percentage of phosphate that it is considered a waste product and is discarded. The -150 mesh fraction contains appreciable amounts of phosphate, but the particle size is too small for economic treatment, and it is therefore a waste product.

The tonnages, B.P.L. content, and uranium content of each product are listed in tables 2 through 7. Table 1 is a summary of these tables.

Table 1

Summary of the measured reserves of phosphate and uranium calculated from prospect data of 25.8 acres in the SW¼NW¼ and NW¼SW¼ sec. 32, T. 29 S., R. 24 E., Polk County, Florida

Fraction	Total (long tons)	B.P.L. / (weighted average percent)	Uranium (weighted average percent)	Uranium (pounds)
Coarse pebble (+3 mesh)	56,000	69.9	0.022	27,000
Fine pebble (-3+20 mesh)	177,000	70.5	0.020	77,000
Table concentrate (-20+48 mesh)	29,000	70.0	0.016	10,000
Total merchantable products	262,000	70.2	0.020	114,000
Washer sands (-48+150 mesh)	151,000	19.2	0.005	16,000
Slime (-150 mesh)	143,000	41.4	0.016	50,000
Table tails (-20+48 mesh)	58,000	11.8	0.004	5,000
Total waste products	352,000	27.0	0.009	71,000

/ B.P.L. = percent P_2O_5 x 2.18

According to the figures in table 1, about 62 percent of the uranium in the matrix is in the merchantable phosphate products and therefore is available for recovery. At the present rate of mining of 1 acre in 7 days at the Bonny Lake mine, approximately 630 pounds of uranium per day would be available for recovery.

A comparison of the maps showing the phosphate (figs. 9, 10, 12, 13, 15, 16, 21) and uranium content (figs. 11, 14, 17, 18, 19, 22) of the various size fractions of the matrix shows that, in a general way, for each fraction, an increase in uranium content accompanies an increase in P_2O_5 content. Also, a comparison of the maps of P_2O_5 content of all the size fractions of the matrix (figs. 9, 10, 12, 13, 15, 16, 21) shows that, in a general way, all the maxima coincide and all the minima coincide. The same is true for the maps of uranium content (figs. 11, 14, 17, 18, 19, 22).

Table 2

Measured reserves of uranium in the coarse-pebble (+3 mesh) fraction of the matrix in the $SW\frac{1}{4}NW\frac{1}{4}$ and $NW\frac{1}{4}SW\frac{1}{4}$ sec. 32, T. 29 S., R. 24 E., Polk County, Florida

Hole number 1/	Tons 2/	B.P.L. 3/ (percent)	Uranium (percent)	Uranium (pounds)
1	2656	71.0	0.023	1368
2	2208	70.4	0.022	1088
3	1896	70.3	0.021	849
4	2242	70.8	0.024	1205
5	1881	71.1	0.021	884
6	1996	69.1	0.020	894
7	2030	70.0	0.022	1000
8	2251	70.0	0.023	1160
9	2154	70.7	0.023	1110
10	2766	69.9	0.021	1301
11	2916	68.9	0.025	1633
12	2855	69.5	0.020	1279
13	2221	69.7	0.022	1095
14	2513	70.4	0.023	1295
15	2081	69.5	0.024	1119
16	1829	71.7	0.027	1106
17	2908	68.0	0.020	1303
18	2356	69.2	0.020	1055
19	2850	69.4	0.019	1213
20	2258	69.5	0.020	1012
21	2604	67.8	0.019	1108
22	2981	69.2	0.021	1402
23	2571	66.9	0.019	1094
24	1234	69.2	0.023	636
Total	56,257			27,209
Weighted averages		69.6	0.022	

1/ Each hole represents 1.075 acres.

2/ Total long tons represented by each hole.

3/ B.P.L. (Bone Phosphate of Lime) = percent P_2O_5 x 2.18.

Table 3

Measured reserves of uranium in the fine-pebble (-3+20 mesh) fraction of the matrix in the SW¼NW¼ and NW¼SW¼ sec. 32, T. 29 S., R. 24 E., Polk County, Florida

Hole number 1/	Tons 2/	B.P.L. 3/ (percent)	Uranium (percent)	Uranium (pounds)
1	7077	71.0	0.021	3329
2	7442	71.0	0.022	3667
3	6333	70.5	0.023	3121
4	7607	70.9	0.021	3578
5	6977	72.1	0.017	2657
6	5825	69.6	0.018	2349
7	6748	71.7	0.023	3477
8	7463	70.5	0.023	3845
9	6440	70.8	0.021	3029
10	7836	71.5	0.006	3159
11	7625	69.7	0.020	3416
12	7606	69.7	0.018	3067
13	7126	70.5	0.021	3352
14	9031	71.7	0.020	4046
15	5589	70.2	0.021	2629
16	6069	70.1	0.023	3127
17	8233	68.4	0.017	3135
18	9488	71.5	0.016	3401
19	7627	70.5	0.019	3246
20	8149	71.5	0.017	3103
21	8236	70.4	0.017	3136
22	7539	69.3	0.020	3377
23	9962	69.6	0.017	3794
24	4730	69.1	0.020	2119
Total	176,758			77,159
Weighted averages		70.5	0.020	

1/ Each hole represents 1.075 acres.

2/ Total long tons represented by each hole.

3/ B.P.L. (Bone Phosphate of Lime) = percent P_2O_5 x 2.18.

Table 4

Measured reserves of uranium in the table-concentrate (-20/48 mesh) fraction of the matrix in the SW¼NW¼ and NW¼SW¼ sec. 32, T. 29 S., R. 24 E., Polk County, Florida

Hole number 1/	Tons 2/	B.P.L. 3/ (percent)	Uranium (percent)	Uranium (pounds)
1	865	69.9	0.016	310
2	1140	71.2	0.016	409
3	762	70.7	0.014	256
4	1539	69.8	0.017	586
5	1349	71.8	0.016	483
6	1288	68.3	0.015	433
7	976	73.0	0.017	372
8	1272	68.7	0.015	427
9	1043	70.9	0.013	304
10	1280	72.2	0.017	487
11	775	70.4	0.015	260
12	1173	68.8	0.014	368
13	1976	69.3	0.014	620
14	1406	70.3	0.018	567
15	1379	71.2	0.017	525
16	1091	69.5	0.016	391
17	1228	68.6	0.016	440
18	1425	70.8	0.016	511
19	1151	70.3	0.016	413
20	1106	69.7	0.014	347
21	1429	68.2	0.015	480
22	1012	68.4	0.014	318
23	1608	68.5	0.013	540
24	976	69.9	0.017	372
Total	29,250			10,219
Weighted averages		70.0	0.016	

1/ Each hole represents 1.075 acres.

2/ Total long tons represented by each hole.

3/ B.P.L. (Bone Phosphate of Lime) = percent P_2O_5 x 2.18.

Table 5

Measured reserves of uranium in the (-48/150 mesh) fraction 1/ of the matrix in the SW¼NW¼ and NW¼SW¼ sec. 32, T. 29 S., R. 24 E., Polk County, Florida

Hole number 2/	Tons 3/	B.P.L. 4/ (percent)	Uranium (percent)	Uranium (pounds)
1	3138	25.4	0.007	492
2	7907	16.9	0.006	1063
3	4236	22.7	0.004	474
4	7577	18.8	0.005	849
5	7473	19.7	0.004	670
6	4624	21.9	0.005	518
7	7128	20.6	0.007	1118
8	7433	21.4	0.006	999
9	5848	17.2	0.004	524
10	5659	20.8	0.005	634
11	6064	16.6	0.005	679
12	6805	15.7	0.003	457
13	5710	19.1	0.006	767
14	7569	19.8	0.005	848
15	4991	23.6	0.007	783
16	3858	25.3	0.007	569
17	5644	16.5	0.005	632
18	8326	16.6	0.003	560
19	6523	17.9	0.004	584
20	7654	16.7	0.003	514
21	8447	15.0	0.003	568
22	7194	19.9	0.006	967
23	7424	22.7	0.004	665
24	4141	21.0	0.004	371
Total	151,373			16,305
Weighted averages		19.2	0.005	

1/ The(-48/150 mesh) fraction is ordinarily flotation feed, but at the Bonny Lake mine, this fraction is too low in phosphate content to be treated, and is considered a waste product.

2/ Each hole represents 1.075 acres.

3/ Total long tons represented by each hole.

4/ B.P.L. (Bone Phosphate of Lime) = percent P_2O_5 x 2.18.

Table 6

Measured reserves of uranium in the slime (-150 mesh) fraction of the matrix in the SW¼NW¼ and NW¼SW¼ sec. 32, T. 29 S., R. 24 E., Polk County, Florida

Hole number 1/	Tons 2/	B.P.L. 3/ (percent)	Uranium (percent)	Uranium (pounds)
1	8154	38.7	0.014	2557
2	4771	39.1	0.016	1710
3	4901	43.2	0.019	1756
4	8243	45.7	0.020	3693
5	5487	45.7	0.014	1721
6	4949	44.7	0.011	1219
7	5429	54.9	0.024	2919
8	9120	25.3	0.022	4494
9	5328	41.5	0.014	1671
10	5455	41.2	0.014	1711
11	5681	39.4	0.015	1909
12	5764	37.0	0.012	1549
13	4515	44.4	0.015	1517
14	6605	41.7	0.015	2219
15	3411	44.0	0.019	1452
16	3957	42.4	0.018	1594
17	4275	43.3	0.015	1436
18	7290	33.1	0.010	1633
19	5136	40.9	0.011	1266
20	5947	40.3	0.012	1599
21	7055	35.6	0.009	1422
22	7022	47.3	0.016	2517
23	7970	50.4	0.014	2499
24	6059	45.4	0.030	4072
Total	142,524			50,135
Weighted averages		41.4	0.016	

1/ Each hole represents 1.075 acres.

2/ Total long tons represented by each hole.

3/ B.P.L. (Bone Phosphate of Lime) = percent P_2O_5 x 2.18.

Table 7

Uranium content of the table-tailings (-20/48 mesh) fraction of the matrix in the $SW\frac{1}{4}NW\frac{1}{4}$ and $NW\frac{1}{4}SW\frac{1}{4}$ sec. 32, T. 29 S., R. 24 E., Polk County, Florida

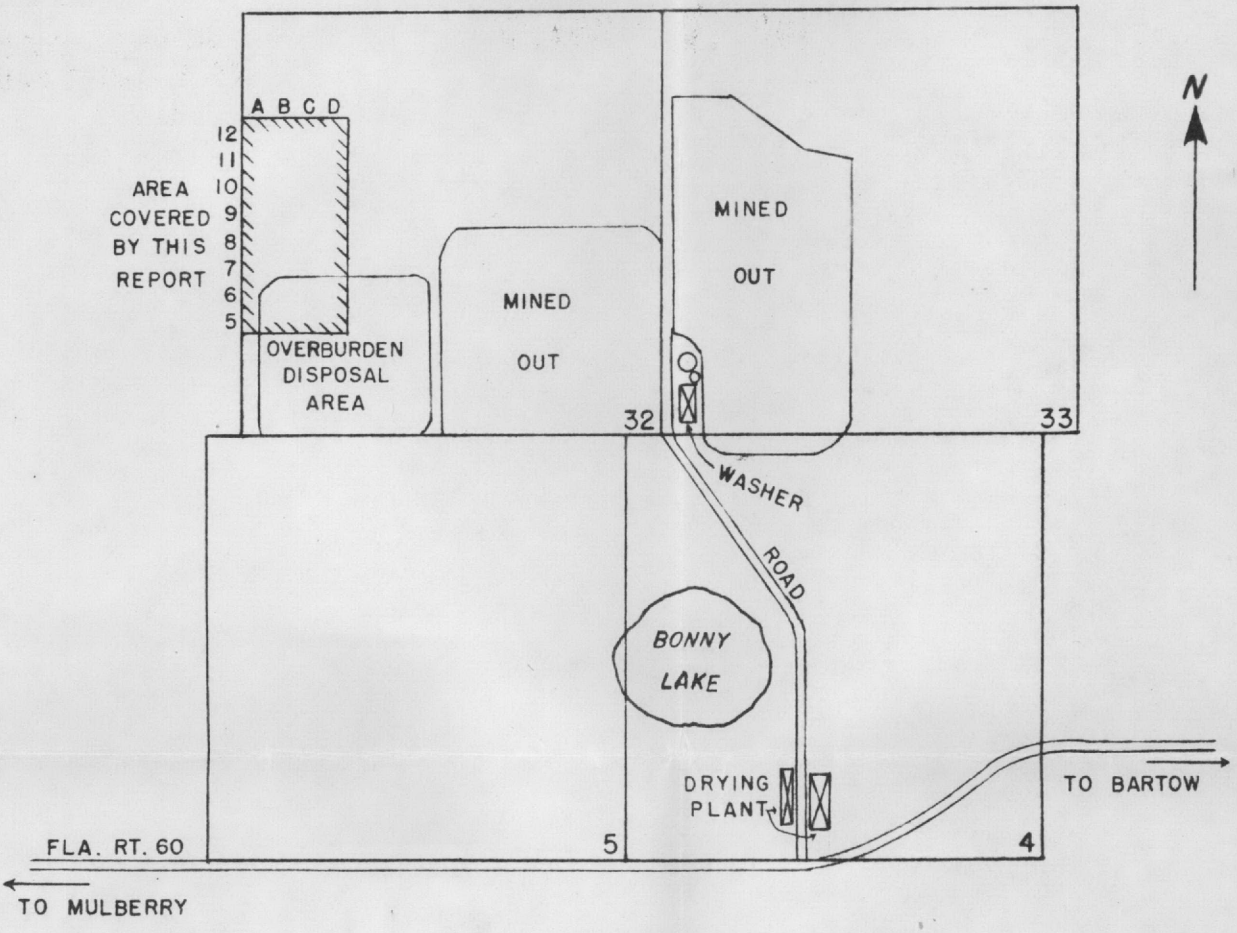
Hole number 1/	Tons 2/	B.P.L. 3/ (percent)	Uranium (percent)	Uranium (pounds)
1	1012	3.9	0.001	23
2	3796	10.3	0.003	255
3	2041	17.3	0.002	229
4	3096	10.2	0.005	347
5	2961	11.9	0.004	265
6	1687	3.7	0.001	38
7	3057	17.0	0.007	479
8	2075	10.1	0.003	139
9	2864	14.2	0.004	257
10	2611	14.6	0.018	351
11	2525	17.8	0.006	339
12	2481	10.5	0.002	111
13	3272	8.5	0.003	192
14	2087	8.1	0.004	188
15	1823	8.0	0.003	122
16	1716	13.3	0.005	192
17	2145	9.1	0.004	192
18	2534	10.3	0.003	170
19	2392	16.2	0.003	161
20	2418	12.7	0.004	217
21	2508	10.5	0.002	112
22	2915	14.4	0.004	261
23	2602	14.2	0.002	117
24	1854	5.2	0.002	83
Total	58,472			4,840
Weighted averages		11.8	0.004	

1/ Each hole represents 1.075 acres.

2/ Total long tons represented by each hole.

3/ B.P.L. (Bone Phosphate of Lime) = percent P_2O_5 x 2.18.

OFFICIAL USE ONLY



INDEX MAP SHOWING LOCATION OF SECTIONS 32, 33, T.29S., R.24E., AND SECTIONS 4, 5, T.30S., R.24E., POLK COUNTY, FLORIDA.

CAUTION

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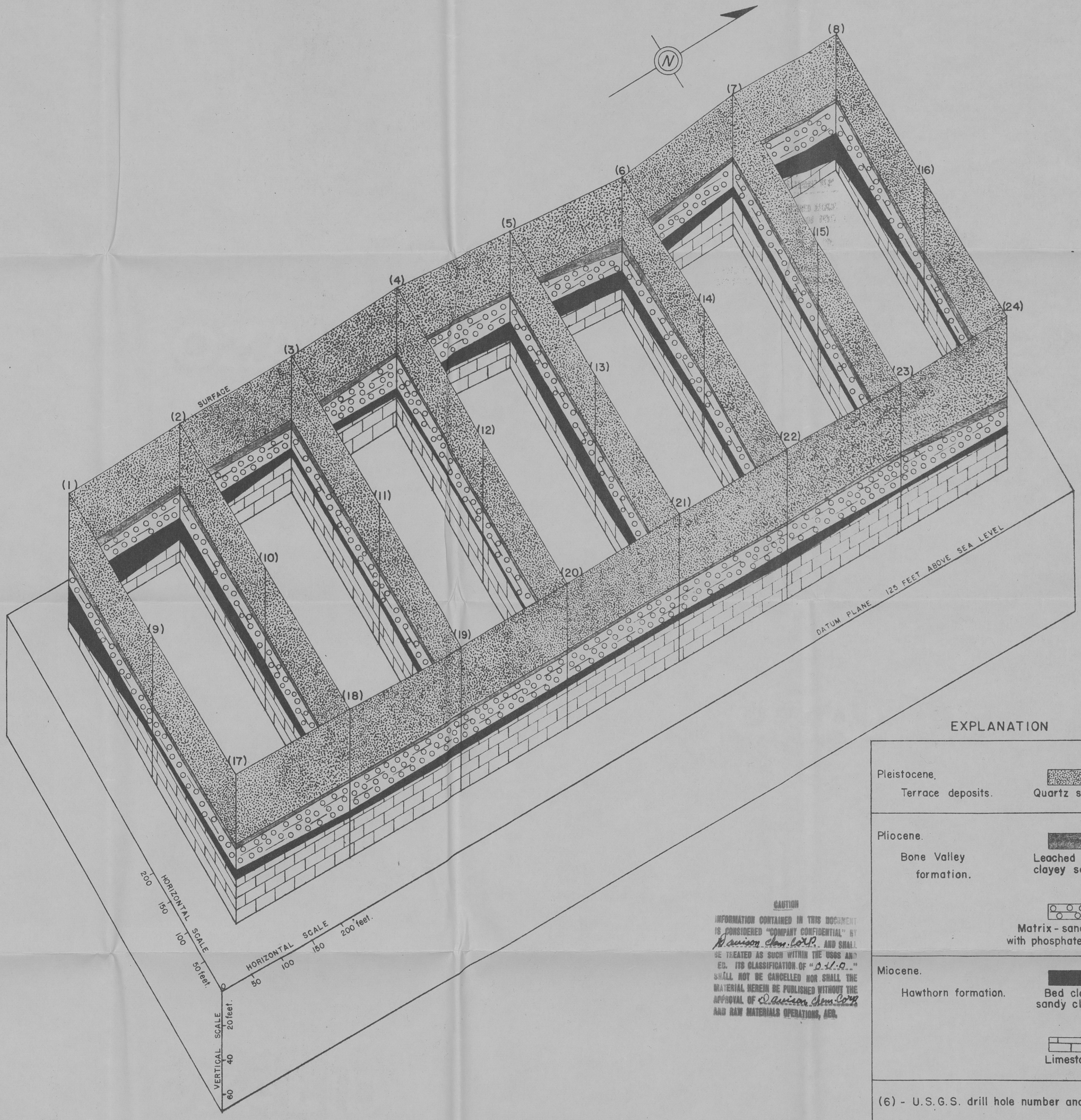
OFFICIAL USE ONLY

0 1/4 1/2 3/4 1 mile

OFFICIAL USE ONLY



EXPLANATION

Pleistocene. Terrace deposits.	Quartz sand.
Pliocene. Bone Valley formation.	Leached zone - clayey sand.
	Matrix - sand & clay with phosphate nodules.
Miocene. Hawthorn formation.	Bed clay - sandy clay.
	Limestone.
(6) - U.S.G.S. drill hole number and location.	

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ISOMETRIC BLOCK DIAGRAM OF MINING CUTS 27, 28, and 29, BONNY LAKE MINE.

OFFICIAL USE ONLY

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 Sec. 32, T. 29S., R. 24E.

Polk County, Florida.

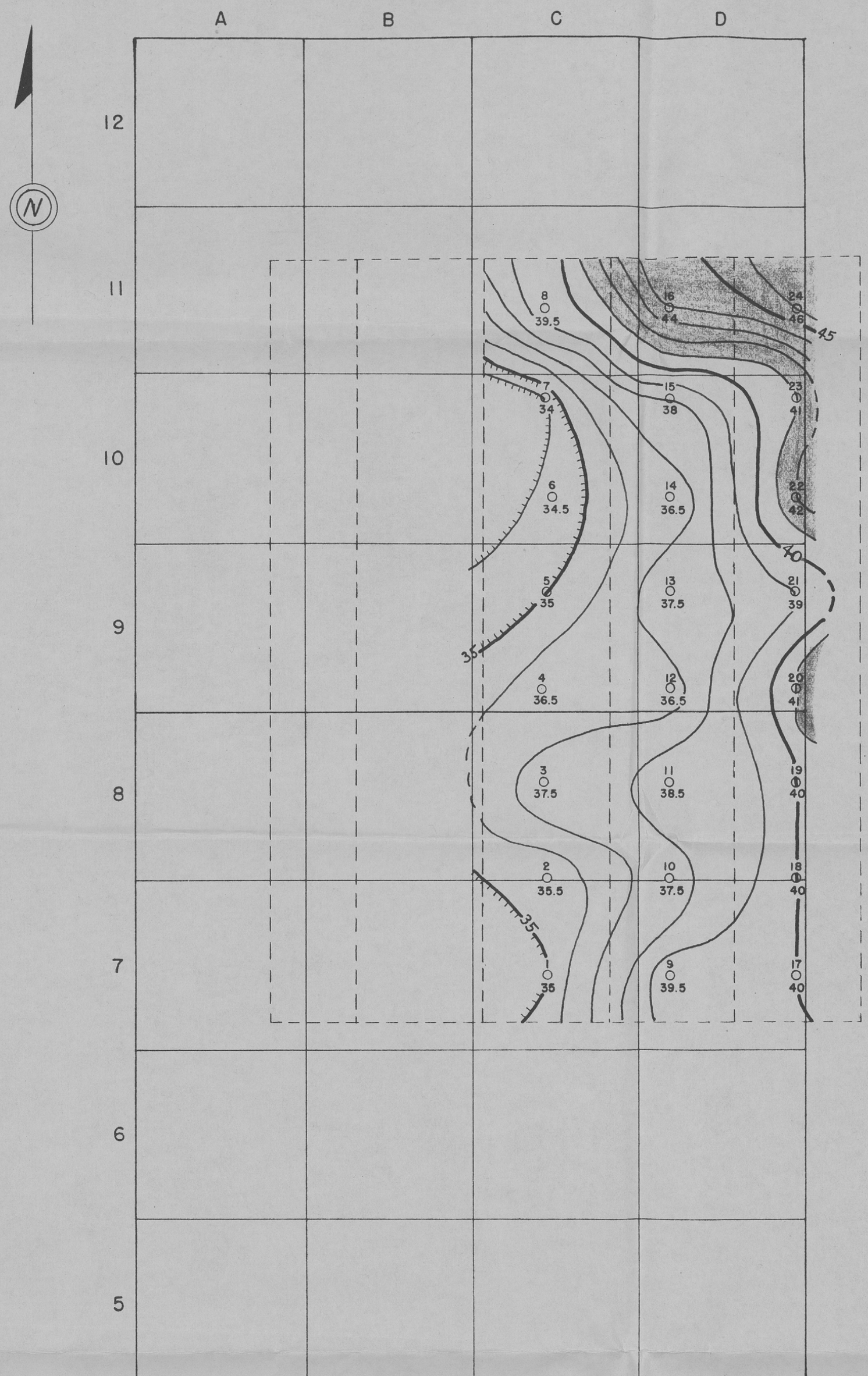
U.S. DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TRACE ELEMENTS MEMORANDUM REPORT 231

FIGURE 3

OFFICIAL USE ONLY



EXPLANATION

15 / 38 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is thickness, in feet, of overburden.

— — — Outline of mining cuts.

Thinner places.

Thicker places.

CAUTION

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ISOPACH MAP OF THE OVERBURDEN (PLEISTOCENE SAND)

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29S., R. 24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

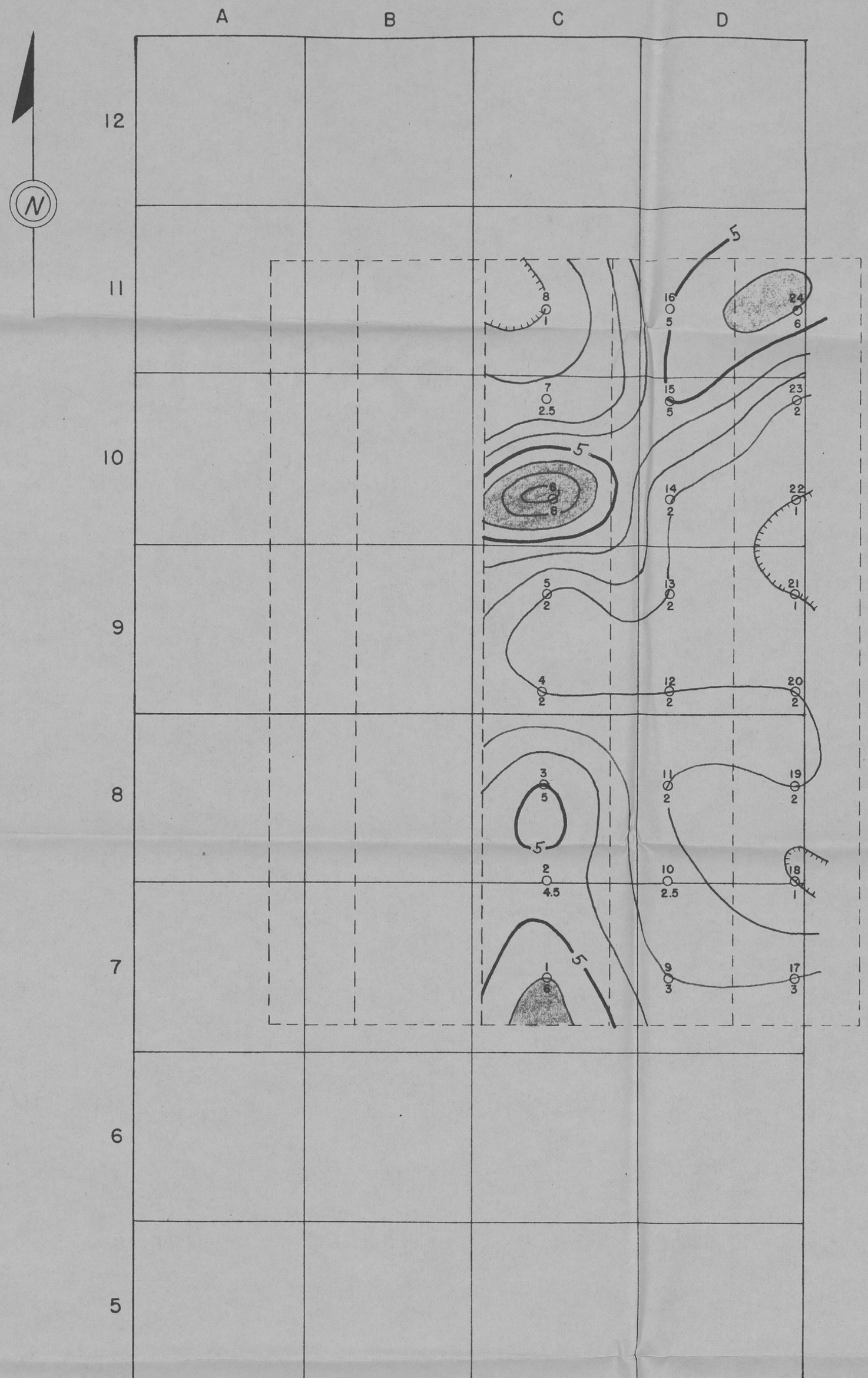
Contour interval 1 foot

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

TRACE ELEMENTS MEMORANDUM REPORT 231

FIGURE 4

OFFICIAL USE ONLY



EXPLANATION

15 / 5 — Location of prospect holes. Top figure is U.S. G.S. hole number; bottom figure is thickness, in feet, of leached zone.

---- Outline of mining cuts.

Thinner places.

Thicker places.

CAUTION

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ISOPACH MAP OF THE LEACHED ZONE (UPPER PART OF THE BONE VALLEY FORMATION)

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29 S., R. 24 E.

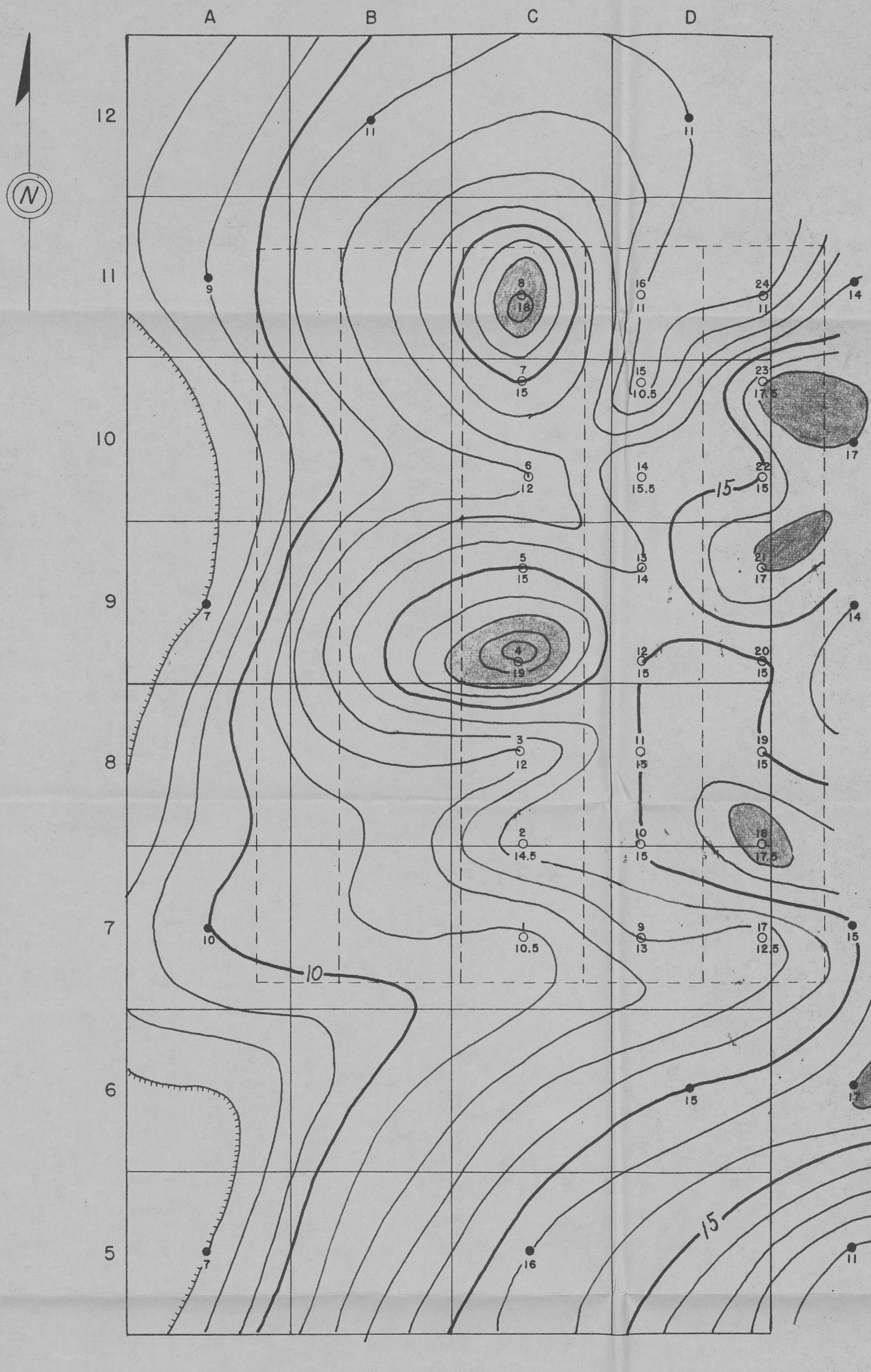
Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1 foot

OFFICIAL USE ONLY



EXPLANATION

15 / 10.5 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is thickness, in feet, of matrix.

A / 9 / 7 — Location of earlier company drilling. Hole number A-9. Figure below hole is thickness, in feet, of matrix.

Outline of mining cuts.

Thinner places.

Thicker places.

CAUTION

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ISOPACH MAP OF THE MATRIX (LOWER, UNLEACHED PART OF THE BONE VALLEY FORMATION)

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29 S., R. 24 E.

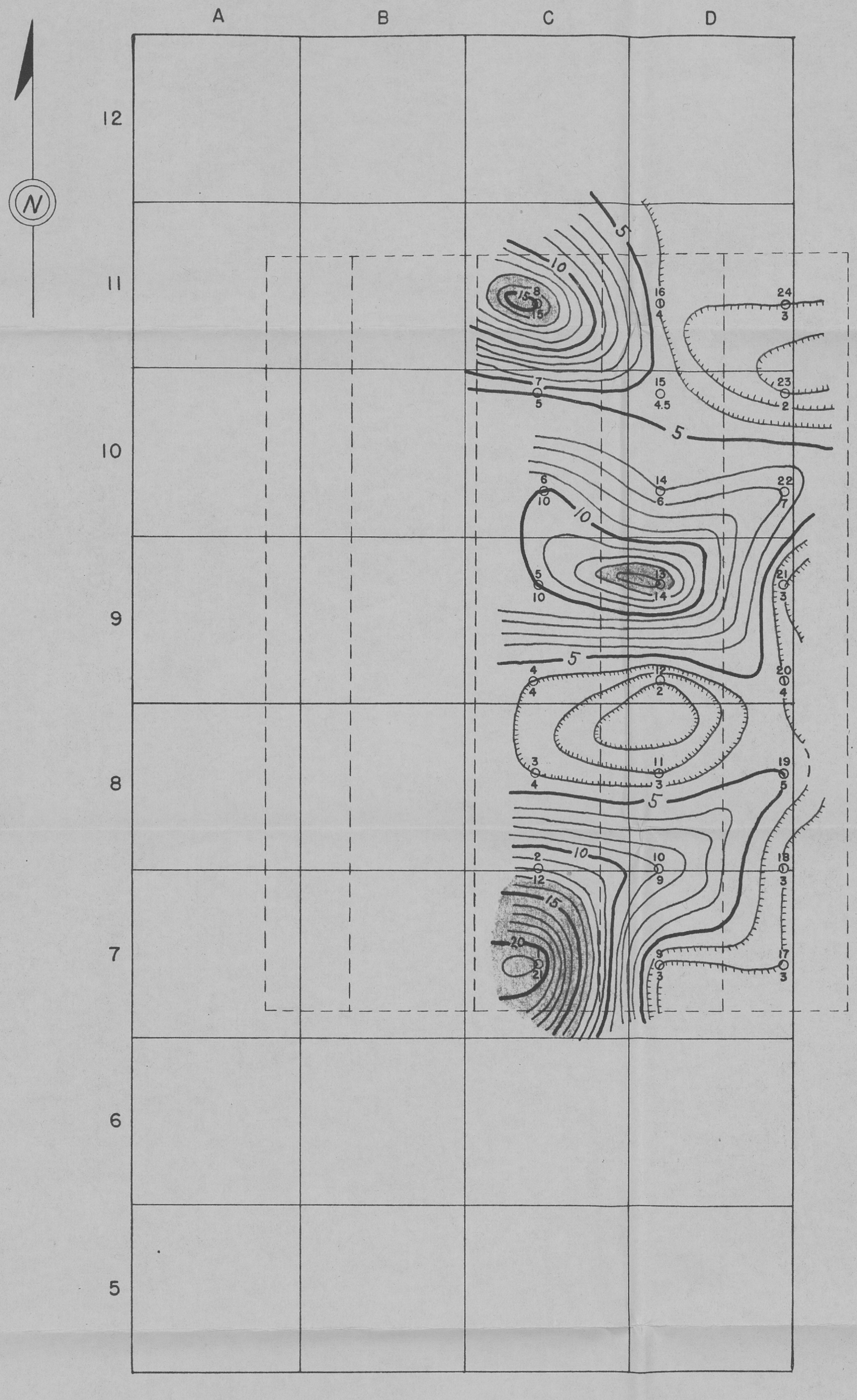
Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1 foot

OFFICIAL USE ONLY



EXPLANATION

15 / 4.5 — Location of prospect holes. Top figure is U.S.G.S. hole number, bottom figure is thickness, in feet, of bed clay.

---- Outline of mining cuts.

Thinner places.

Thicker places.

CAUTION

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ISOPACH MAP OF THE BED CLAY (UPPER PART OF THE HAWTHORN FORMATION)

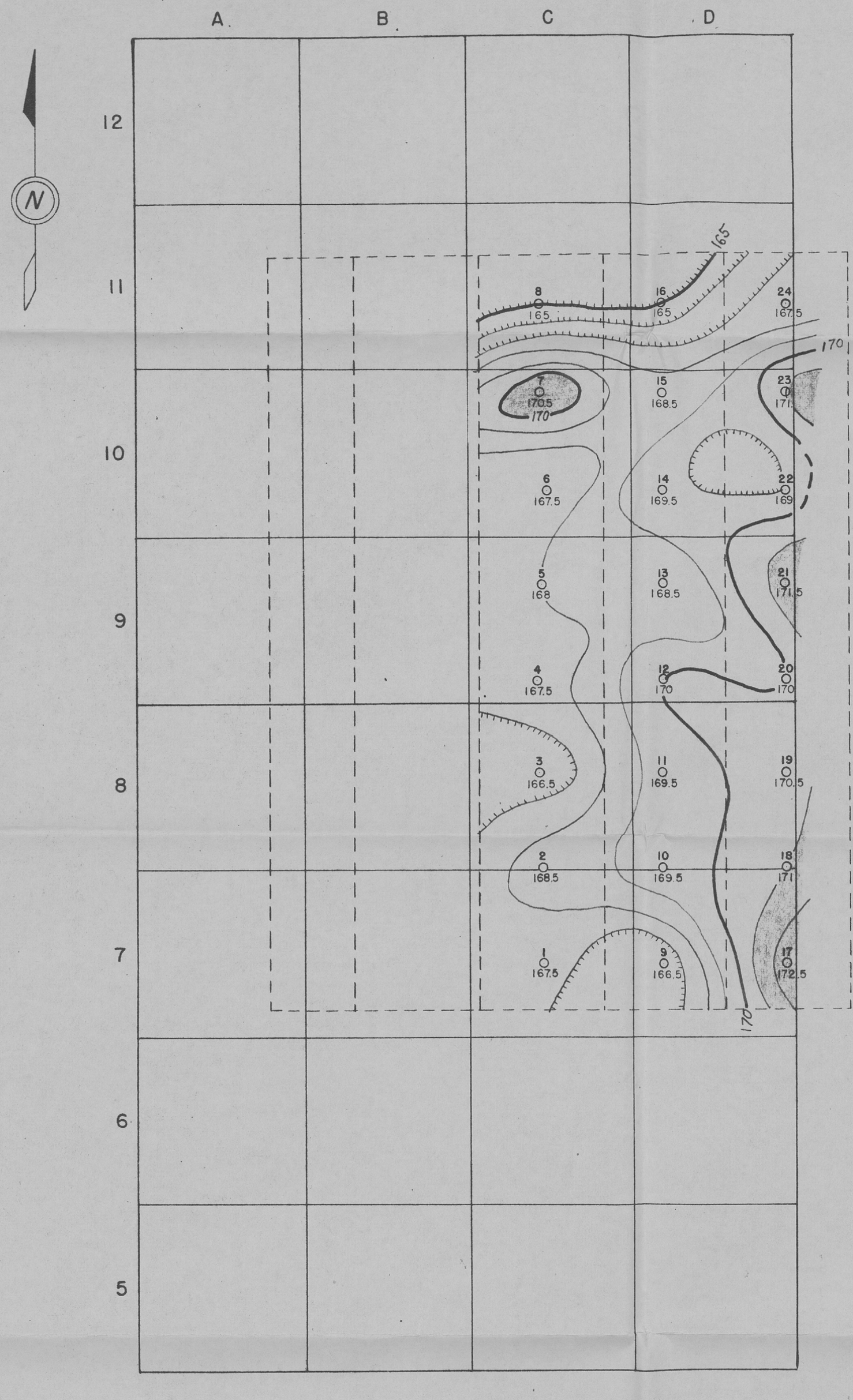
SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29S., R. 24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1 foot



EXPLANATION

15 / 168.5 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is elevation, in feet, above sea level.

Outline of mining cuts.

Troughs.

Peaks.

CAUTION

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SUBSURFACE CONTOUR MAP ON THE TOP OF THE LEACHED ZONE.

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

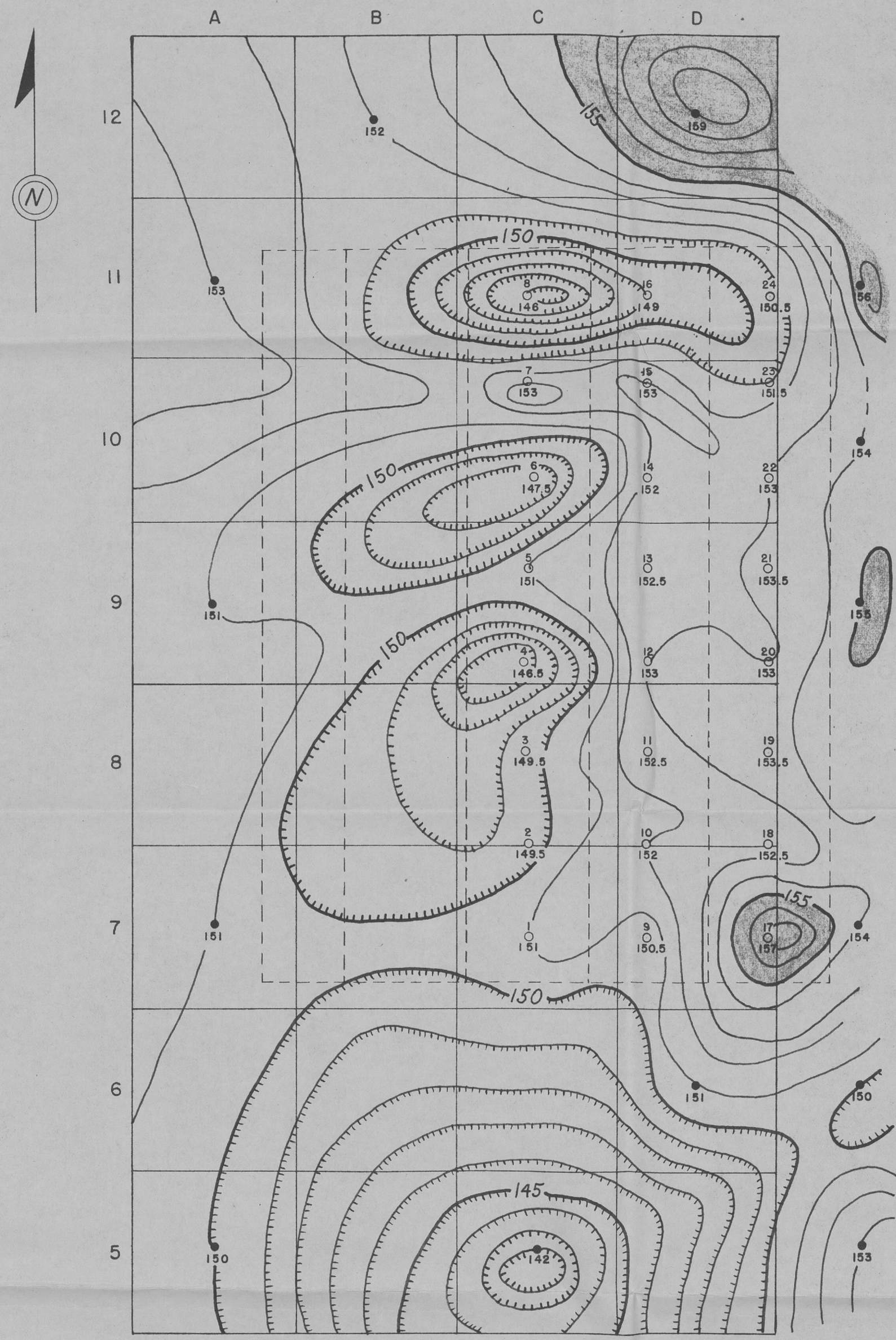
Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1 foot

Datum is mean sea level



EXPLANATION

15 / 153 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is elevation, in feet, above sea level.

A / 9 / 151 — Location of earlier company drilling. Hole number A-9. Figure below hole is elevation, in feet, above sea level.

Outline of mining cuts.

Troughs.

Peaks.

CAUTION

INFORMATION CONTAINED IN THIS DOCUMENT IS CONSIDERED "COMPANY CONFIDENTIAL" BY Dawson Chem. Corp AND SHALL BE TREATED AS SUCH WITHIN THE USGS AND AEC. ITS CLASSIFICATION OF "O.U.O." SHALL NOT BE CANCELLED NOR SHALL THE MATERIAL HEREIN BE PUBLISHED WITHOUT THE APPROVAL OF Dawson Chem. Corp. AND RAW MATERIALS OPERATIONS, AEC.

SUBSURFACE CONTOUR MAP OF THE TOP OF THE HAWTHORN FORMATION.

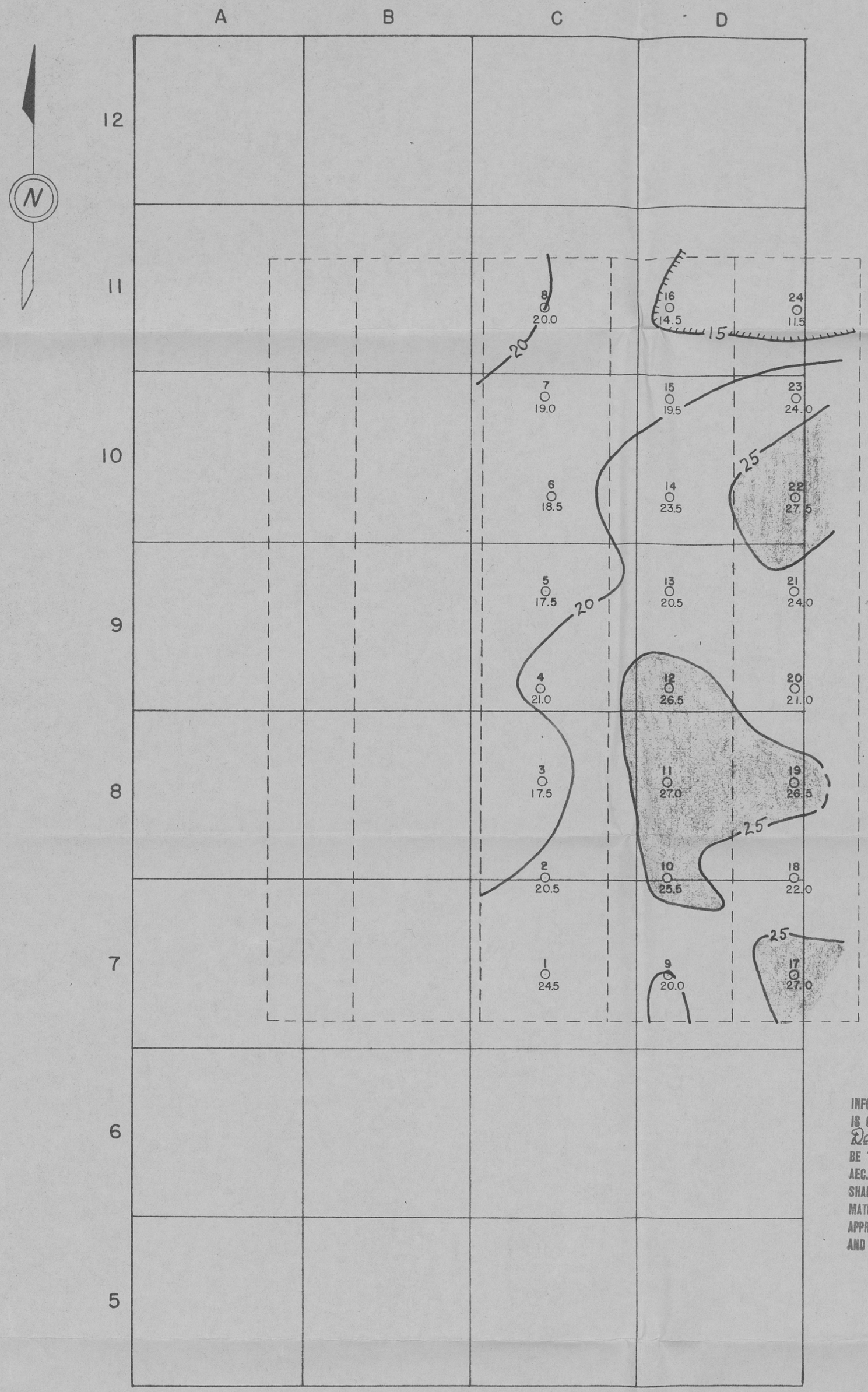
SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29 S., R. 24 E.
Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1 foot

Datum is mean sea level



EXPLANATION

15 / 19.5 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is long tons of phosphate per acre in hundreds.

——— Outline of mining cuts.

Minima.

Maxima.

20 — Isograde line of long tons of phosphate per acre in hundreds, i.e.- 20 = 2000 long tons.

CAUTION

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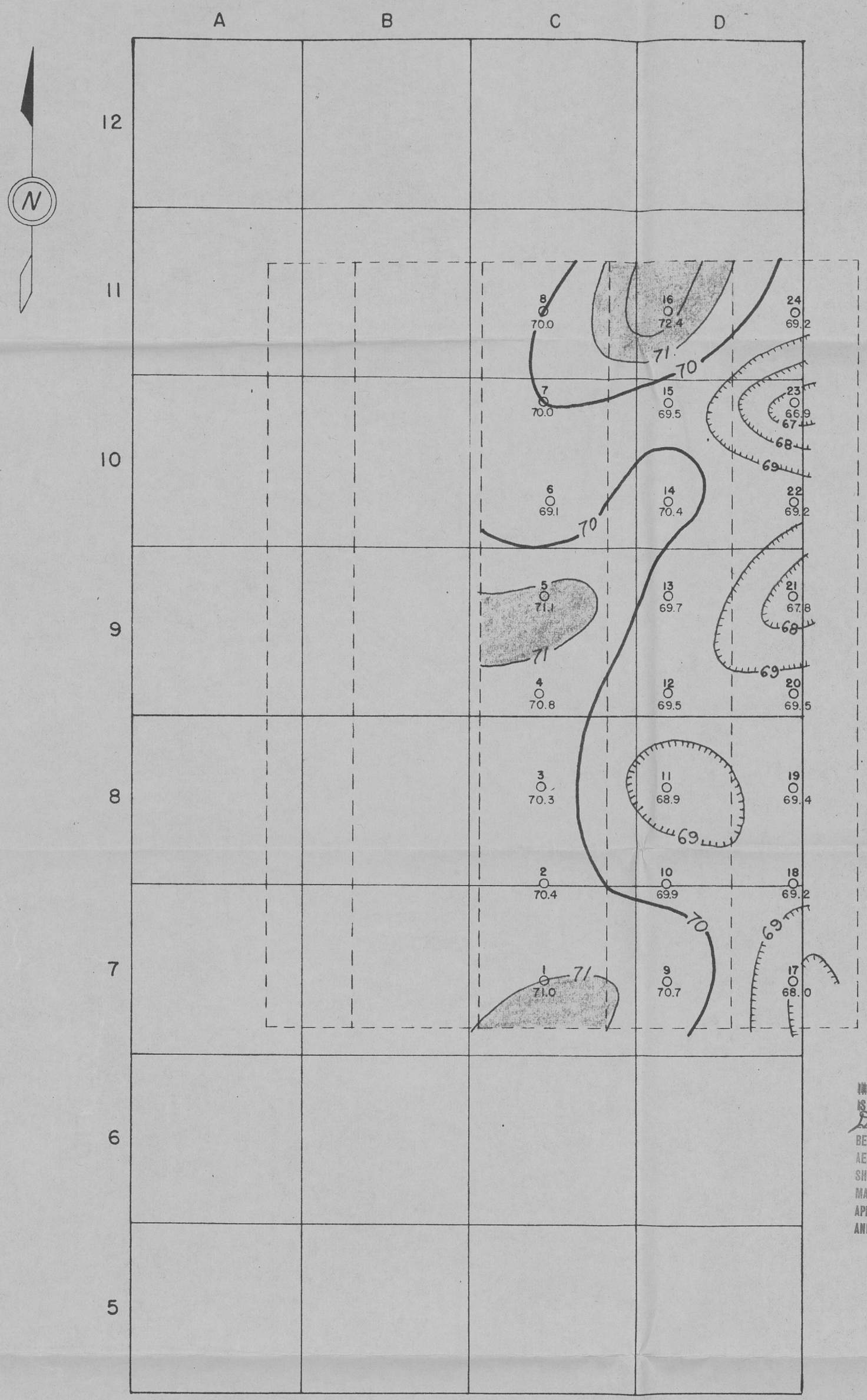
MAP OF TONS OF PHOSPHATE PER ACRE IN THE +3 MESH FRACTION OF THE MATRIX.

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.
Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 500 long tons per acre.



EXPLANATION

15 / 69.5 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent B.P.L. (B.P.L. is percent P_2O_5 X 2.18).

— — — Outline of mining cuts.

Minima.

Maxima.

CAUTION

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ISOGRADE MAP OF THE PHOSPHATE CONTENT (PERCENT B.P.L.) IN THE +3 MESH FRACTION OF THE MATRIX.

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1.0 percent B.P.L.

EXPLANATION

15 / 24 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent uranium in thousandths.

— — — Outline of mining cuts

Minima.

Maxima.

-20- Isograde line of percent uranium in thousandths, i.e.- 20 = 0.020 percent.

CAUTION

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ISOGRADE MAP OF THE URANIUM IN THE +3 MESH FRACTION OF THE MATRIX

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29 S., R. 24 E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 0.001% U.

OFFICIAL USE ONLY

EXPLANATION

15 / 52.0 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is long tons of phosphate per acre in hundreds.

— — — Outline of mining cuts.

Minima.

Maxima.

80 — Isograde line of long tons of phosphate per acre in hundreds, i.e.- 80 = 8000 long tons.

CAUTION

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MAP OF TONS OF PHOSPHATE PER ACRE IN THE -3+20 MESH FRACTION OF THE MATRIX.

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 500 long tons per acre.

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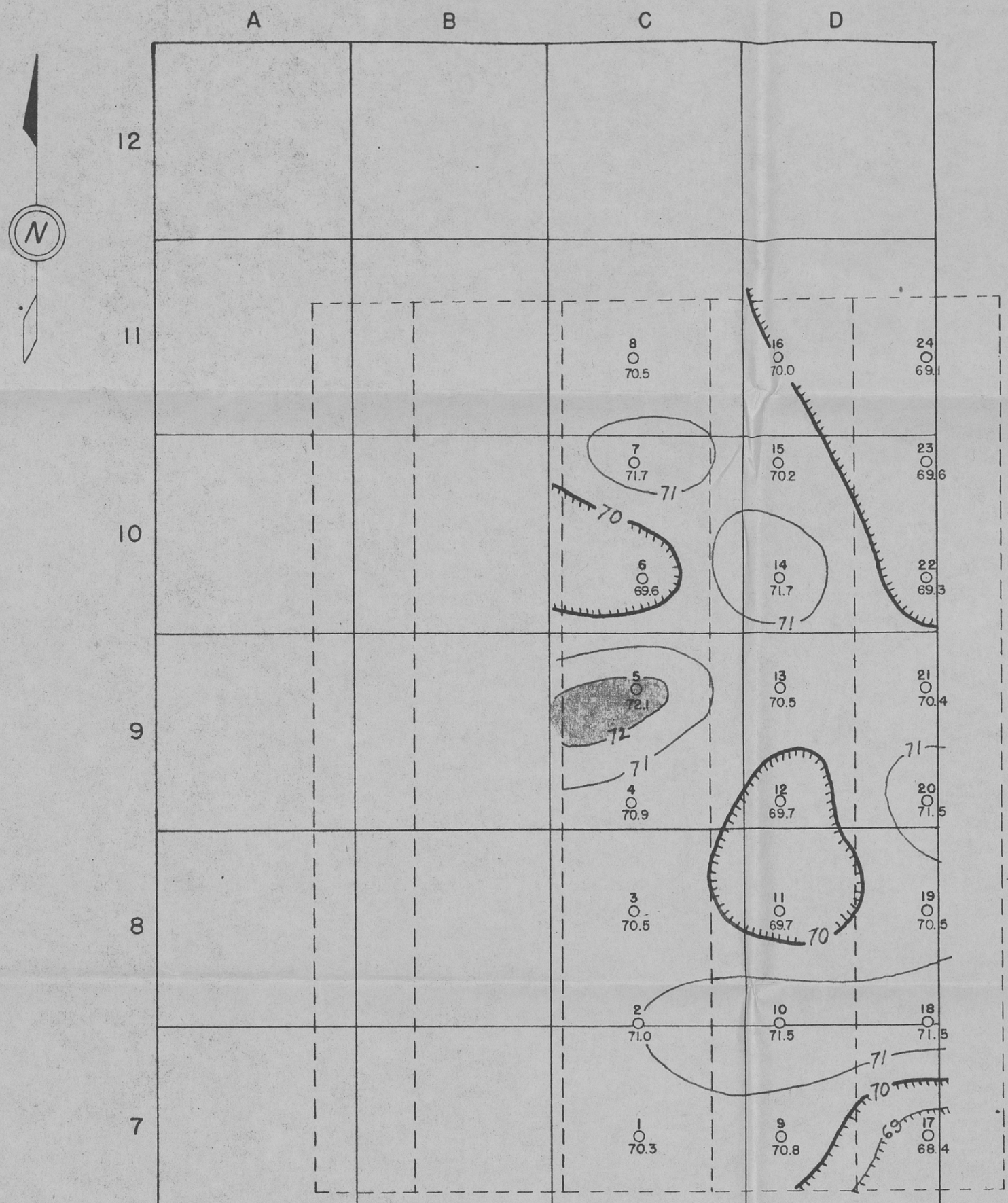
TRACE ELEMENTS MEMORANDUM REPORT 231

FIGURE 13



EXPLANATION

15 / 70.2 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent B.P.L. (B.P.L. is percent P_2O_5 X 2.18).

Outline of mining cuts.

Minima.

Maxima.

CAUTION

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ISOGRADE MAP OF THE PHOSPHATE CONTENT (PERCENT B.P.L.) IN THE -3+20 MESH FRACTION OF THE MATRIX.

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1.0 percent B.P.L.

EXPLANATION

15 / 21 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent uranium in thousandths.

Outline of mining cuts.

Minima.

Maxima.

20 — Isograde line of uranium content in thousandths of a percent, i.e.- 20 = 0.020 percent uranium.

CAUTION

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ISOGRADE MAP OF THE URANIUM IN THE −3 +20 MESH FRACTION OF THE MATRIX

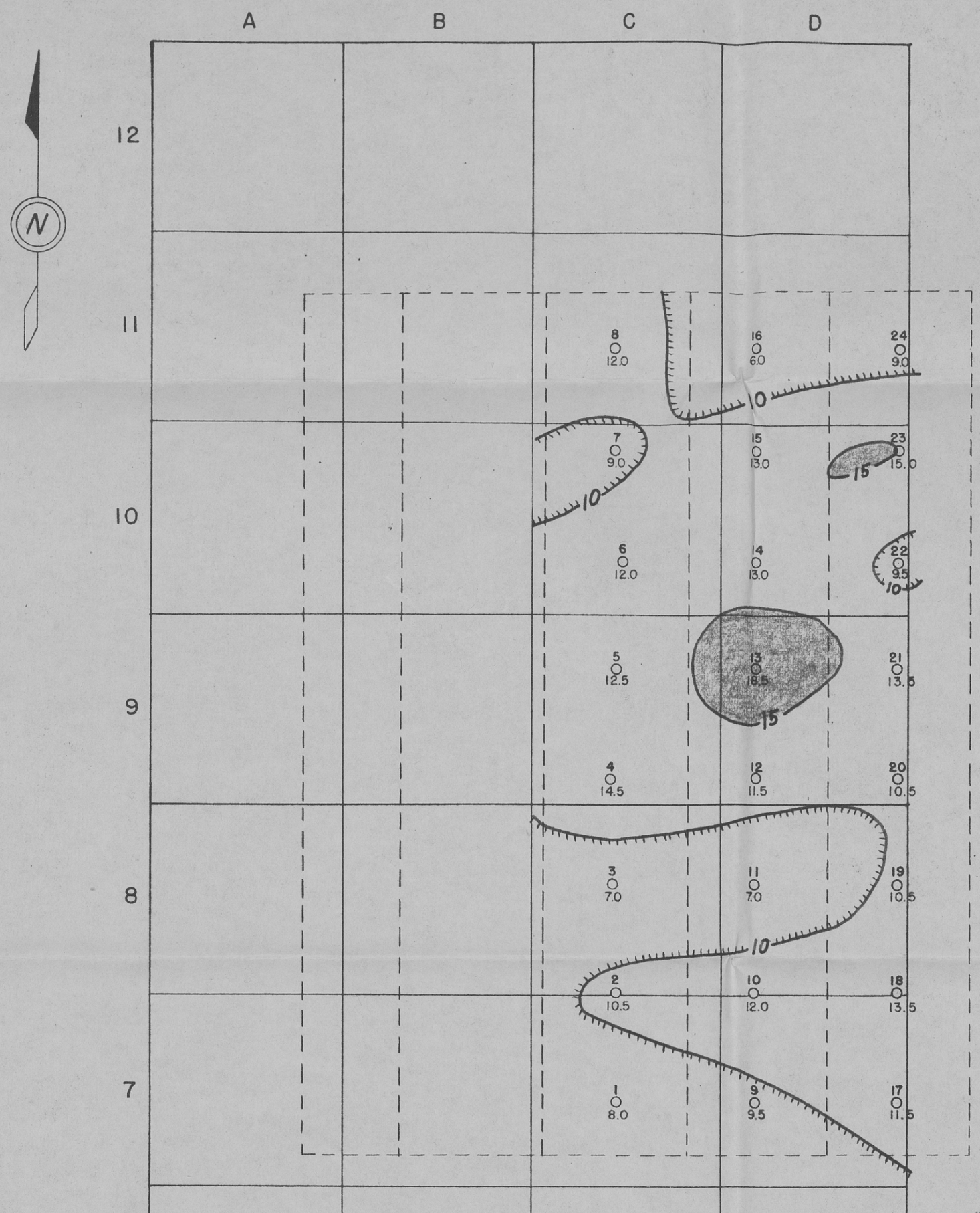
SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29S., R. 24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 0.001 % U.



EXPLANATION

15 / 13.0 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is long tons of phosphate per acre in hundreds.

——— Outline of mining cuts.

Minima.

Maxima.

15 — Isograde line of long tons of phosphate per acre in hundreds, i.e.- 15 = 1500 long tons.

CAUTION

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MAP OF TONS OF PHOSPHATE PER ACRE IN THE -20 + 48 MESH (CONCENTRATE) FRACTION OF THE MATRIX.

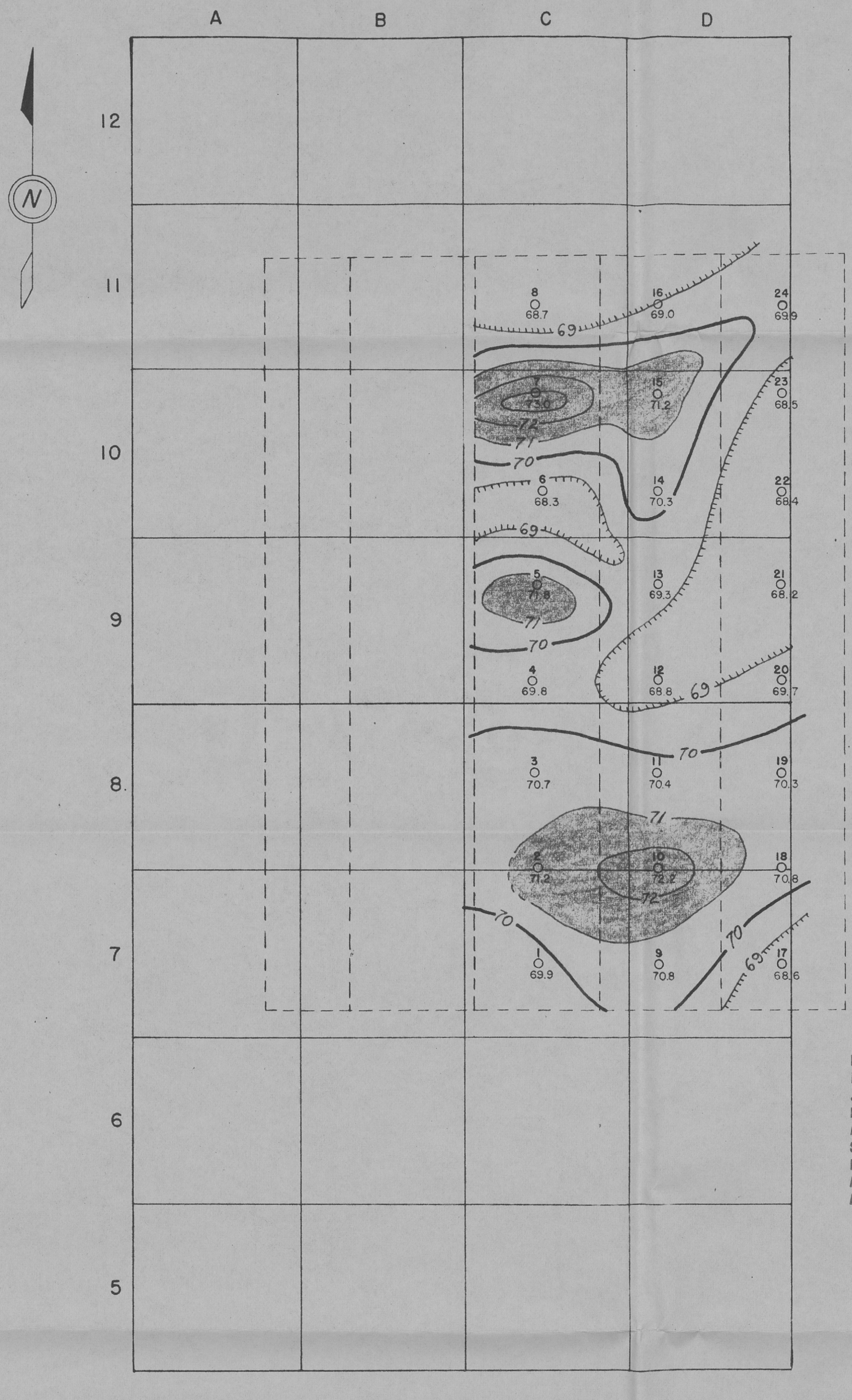
SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 500 long tons per acre.



EXPLANATION

15 / 71.2 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent B.P.L. (B.P.L. is percent P_2O_5 X 2.18).

– – – – Outline of mining cuts.

Minima.

Maxima.

CAUTION

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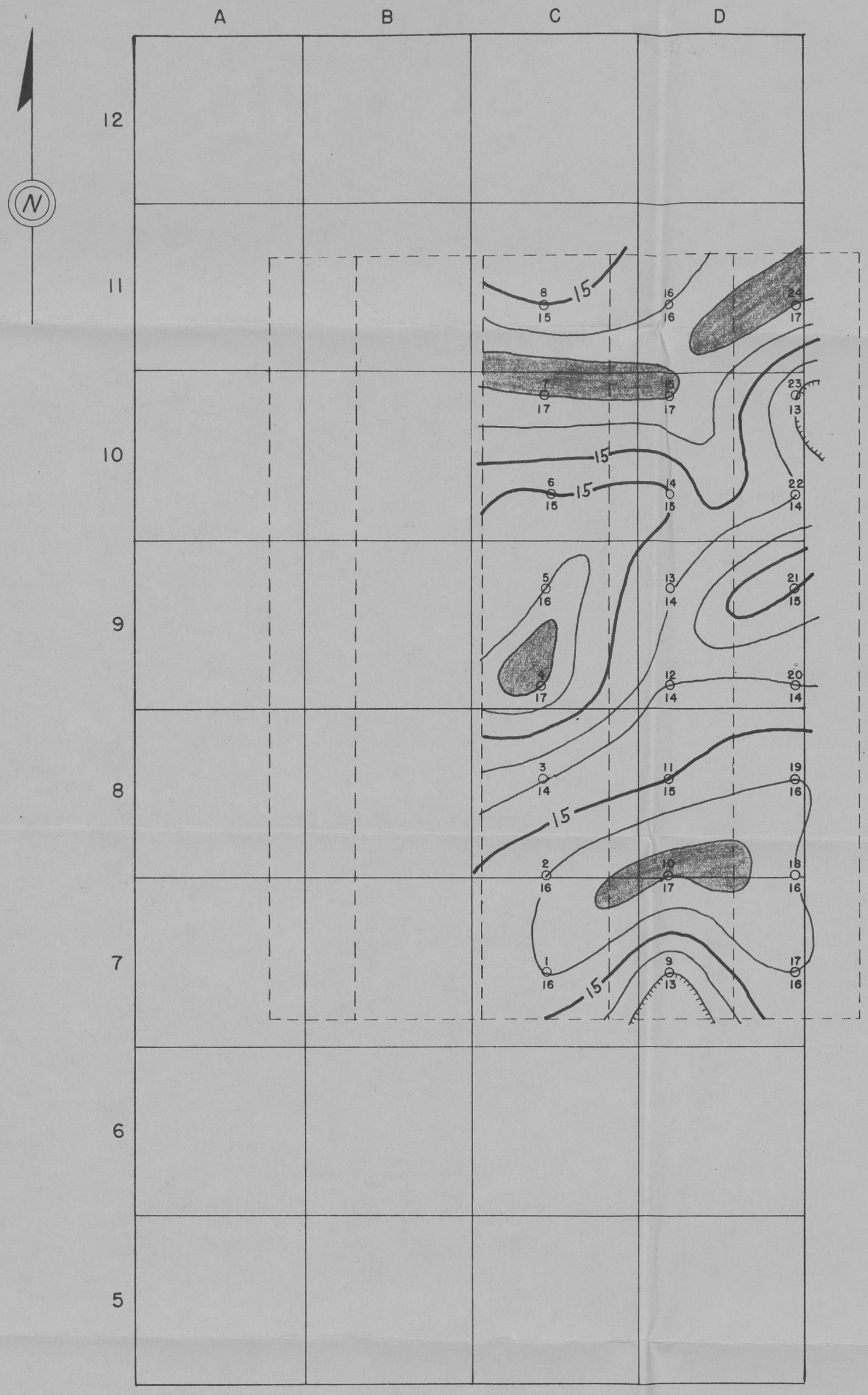
ISOGRADE MAP OF THE PHOSPHATE CONTENT (PERCENT B.P.L.) IN THE −20+48 MESH (CONCENTRATE) FRACTION OF THE MATRIX.

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.
Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1.0 percent B.P.L.



EXPLANATION

15 / 17 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent uranium in thousandths.

– – – Outline of mining cuts.

Minima.

Maxima.

15 — Isograde line of uranium content in thousandths of a percent, i.e. - 15 = 0.015 percent uranium.

CAUTION

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ISOGRADE MAP OF THE URANIUM IN THE -20 + 48 MESH (CONCENTRATE) FRACTION OF THE MATRIX

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29S., R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 0.001% U.

OFFICIAL USE ONLY

EXPLANATION

15 / 9 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent uranium in thousandths.

— — — Outline of mining cuts.

Minima.

Maxima.

5 — Isograde line of uranium content in thousandths of a percent, i.e.- 5 = 0.005 percent uranium.

CAUTION

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ISOGRADE MAP OF THE URANIUM IN THE −20 + 48 MESH (FEED) FRACTION OF THE MATRIX

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29S., R.24E.
Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 0.001 % U.

EXPLANATION

15/7 Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent uranium in thousandths.

— — — Outline of mining cuts.

Minima.

Maxima.

5 Isograde line of uranium content in thousandths of a percent, i.e.- 5 = 0.005 percent uranium.

CAUTION

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ISOGRADE MAP OF THE URANIUM IN THE -48+150 MESH FRACTION OF THE MATRIX

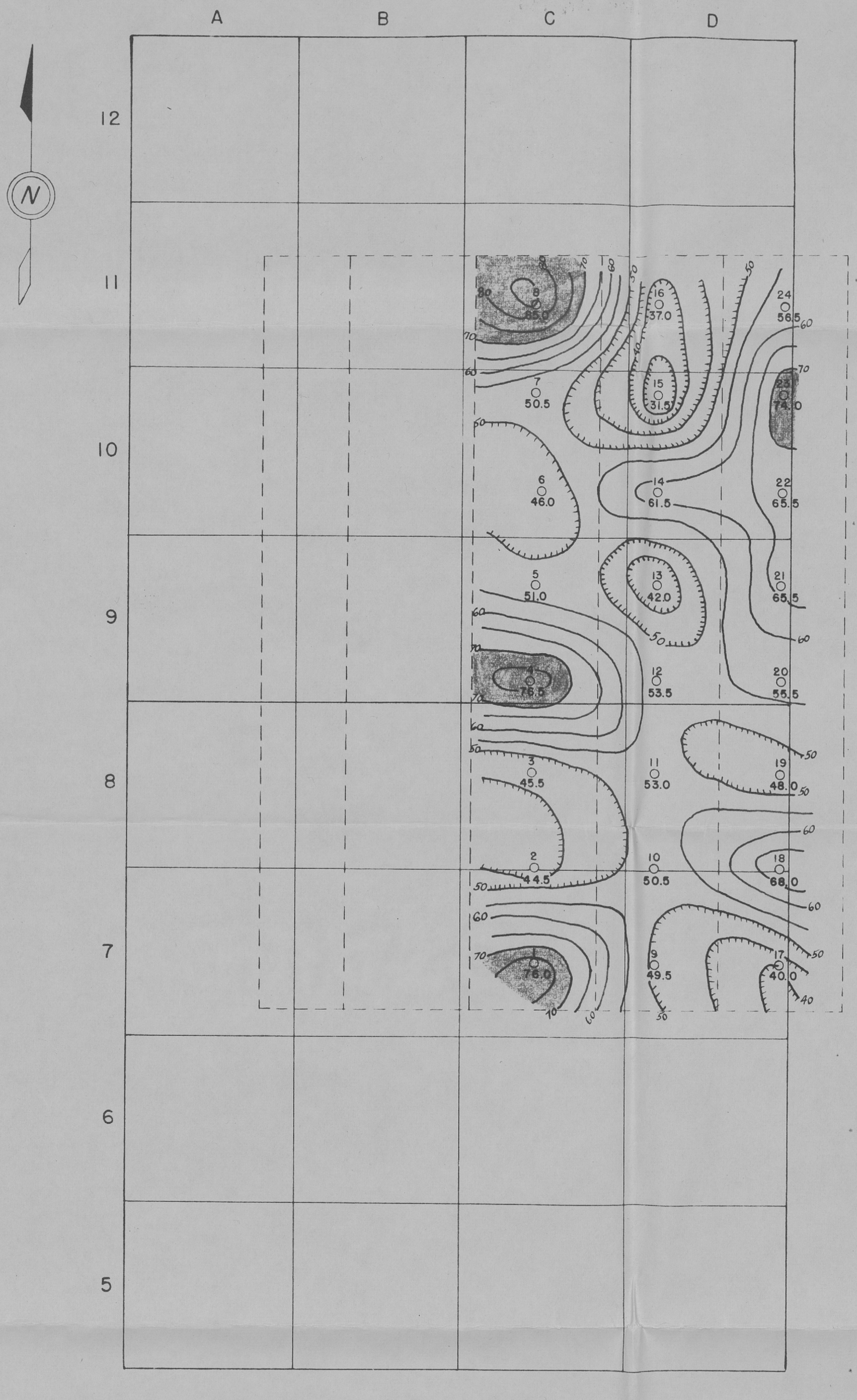
SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T. 29 S., R. 24 E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 0.001 % U.



EXPLANATION

15 / 31.5 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is long tons per acre in hundreds.

——— Outline of mining cuts.

Minima.

Maxima.

50 — Isograde line of long tons of phosphate per acre in hundreds, i.e.- 50 = 5000 long tons.

CAUTION

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MAP OF TONS PER ACRE OF THE -150 MESH (SLIME) FRACTION OF THE MATRIX.

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 500 long tons per acre.

EXPLANATION

15 / 44.0 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent B.P.L. (B.P.L. is percent P_2O_5 X 2.18.)

Outline of mining cuts.

Minima.

Maxima.

CAUTION

INFORMATION CONTAINED IN THIS DOCUMENT IS CONSIDERED "COMPANY CONFIDENTIAL" BY Dawson Chem Corp. **AND SHALL BE TREATED AS SUCH WITHIN THE USGS AND AEC. ITS CLASSIFICATION OF "** O.U.O. **" SHALL NOT BE CANCELLED NOR SHALL THE MATERIAL HEREIN BE PUBLISHED WITHOUT THE APPROVAL OF** Dawson Chem. Corp. **AND RAW MATERIALS OPERATIONS, AEC.**

ISOGRADE MAP OF THE PHOSPHATE CONTENT (PERCENT B.P.L.) IN THE -150 MESH (SLIME) FRACTION OF THE MATRIX.

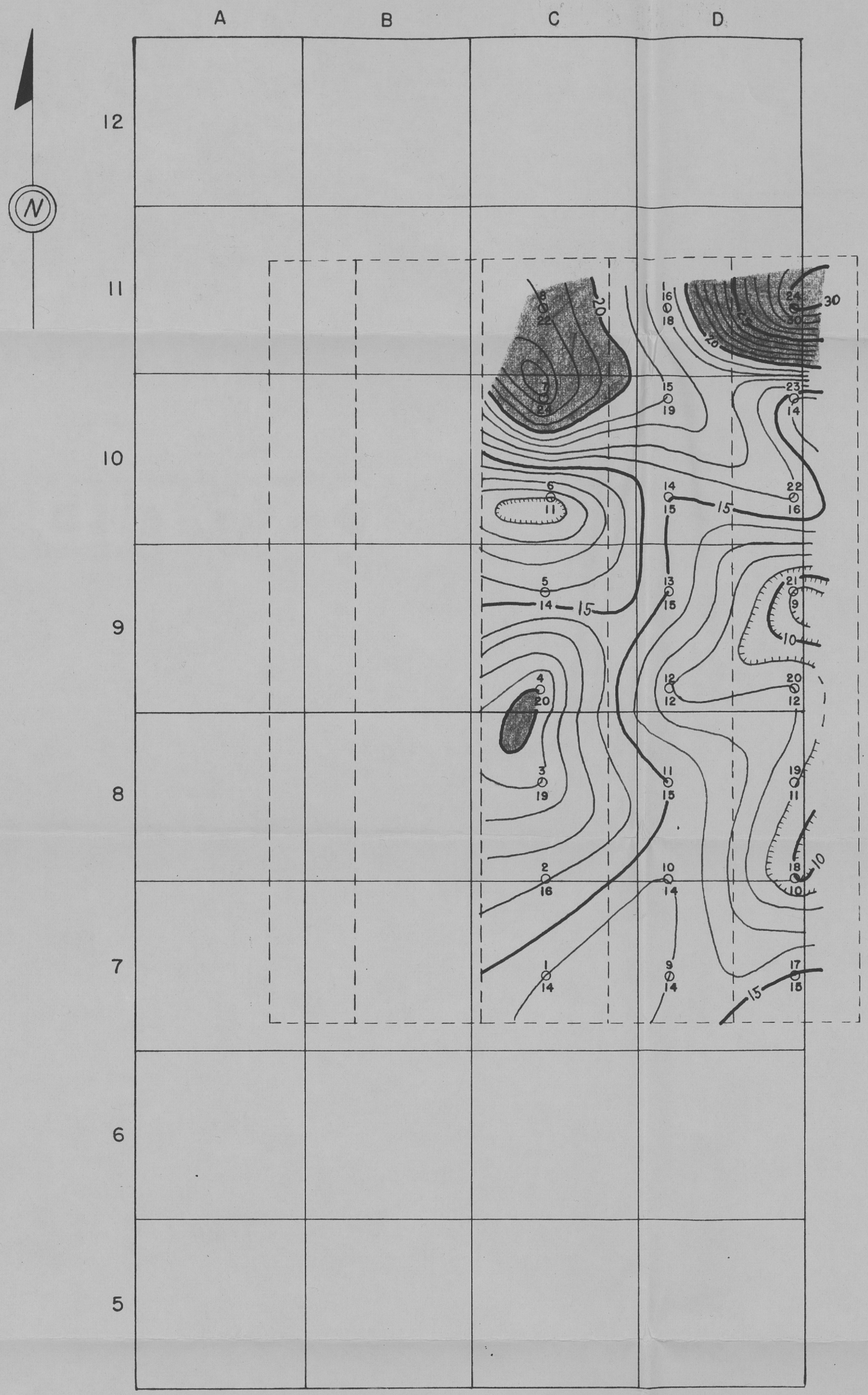
SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 1.0 percent B.P.L.



EXPLANATION

15 / 19 — Location of prospect holes. Top figure is U.S.G.S. hole number; bottom figure is percent uranium in thousandths.

– – – – Outline of mining cuts.

Minima.

Maxima.

Isograde line of uranium content in thousandths of a percent, i.e. - 15 = 0.015 percent uranium.

CAUTION

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ISOGRADE MAP OF THE URANIUM IN THE −150 MESH (SLIME) FRACTION OF THE MATRIX

SW. 1/4 NW. 1/4 and NW. 1/4 SW. 1/4 sec. 32, T.29S, R.24E.

Polk County, Florida.

OFFICIAL USE ONLY

100 0 100 200 300 400 500 feet.

Contour interval 0.001 % U.