GEOLOGICAL SURVEY CIRCULAR 326

STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION IN MONTANA, 1951

Prepared as part of the program of the Department of the Interior for development of the Missouri River Basin and of work done on behalf of the U. S. Atomic Energy Commission. The report is published with the permission of the Commission.

UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary

GEOLOGICAL SURVEY
W. E. Wrather, Director

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STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION IN MONTANA

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By J. A. Peterson, R. F. Gosman, and R. W. Swanson

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INTRODUCTION

The U. S. Geological Survey has recently measured and sampled the Phosphoria formation at many localities in Montana and other western states. These data will not be fully synthesized and analyzed for several years, but segments of the data, accompanied by little or no interpretation, are published as preliminary reports as they are assembled. This report, which contains abstracts of the sections measured in southwestern Montana (fig. 1) during 1951, is the fifth Montana report of this series. The field and laboratory procedures adopted in these investigations are described fully in a previous report (McKelvey and others, 1953).

Many people have taken part in this investigation. The laboratory preparation of samples for chemical analysis was done in Denver, Colo., under the direction of W. P. Huleatt. The P_2O_5 and acid-insoluble analyses were made for the Survey by the U. S. Bureau of Mines at the Northwest Electrodevelopment Laboratory, Albany, Oreg., under the direction of S. M. Shelton, and M. L. Wright. The Al_2O_3, Fe_2O_3, and loss-on-ignition analyses were made in the Trace Elements Section laboratory of the Survey in Washington, D. C., under the supervision of J. C. Rabbitt, by chemists H. Alberty, T. Farley, C. Hoy, and M. Landers.

The data were compiled by K. S. Bergman, and Anita Wise organized most of the tabular data.

ACKNOWLEDGMENTS

Special thanks are due A. E. Weissenborn, who gave much advice and help in carrying out the field program. The cost of the field and laboratory investigations has been borne in part by the Department of the Interior program for development of the Missouri River basin and in part by the Division of Raw Materials of the Atomic Energy Commission. It is a pleasure to acknowledge the fine cooperation extended to the field parties by the local residents and property owners, who furnished information and services and gave access to property.

STRATIGRAPHY OF THE PHOSPHORIA FORMATION IN MONTANA

In southwestern Montana the Phosphoria formation has been divided into five members: two phosphatic shale members, B and D, and three hard members, A, C, and E (fig. 2). The lower two hard members,

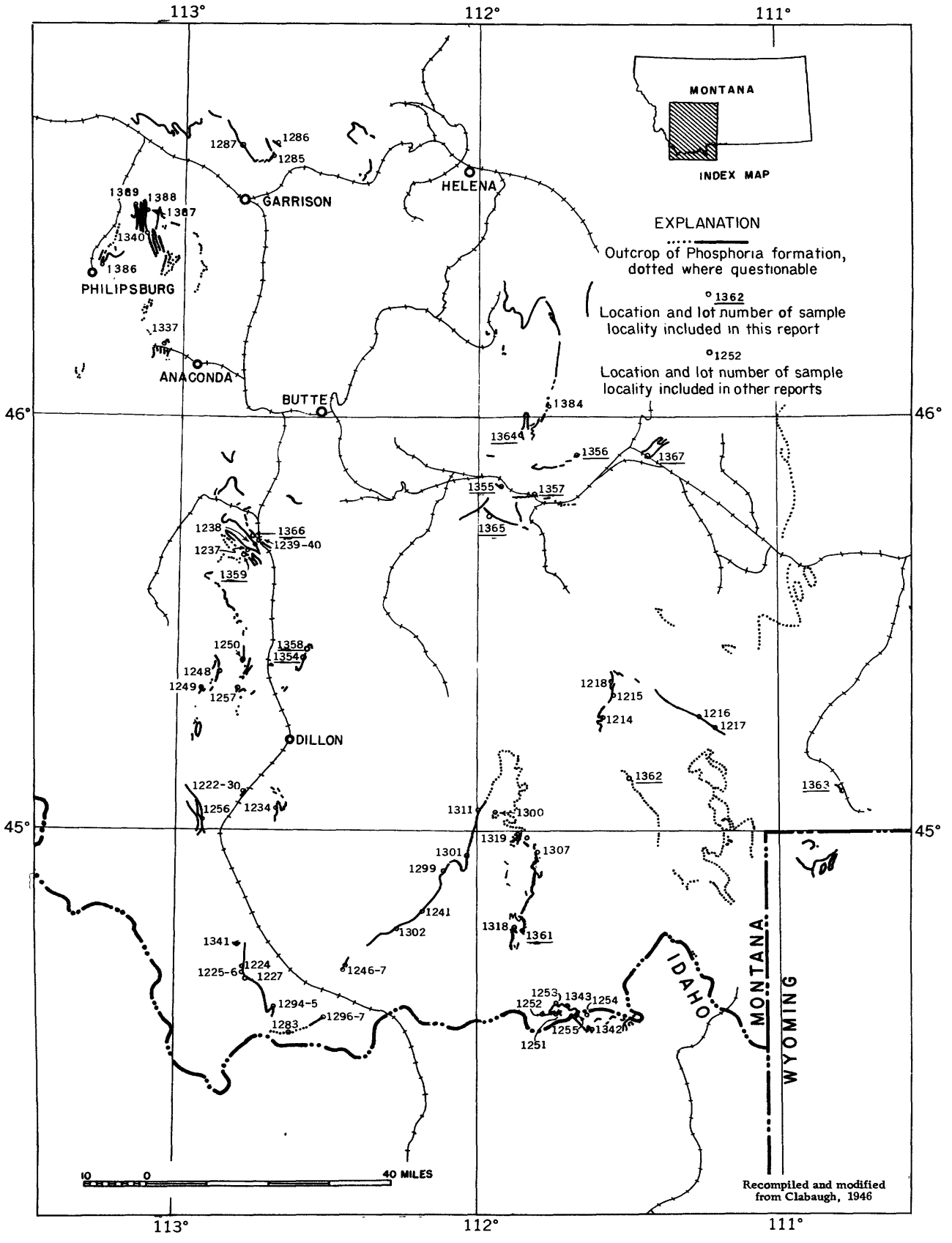

Figure 1.—Outcrops of the Phosphoria formation in Montana and localities sampled.

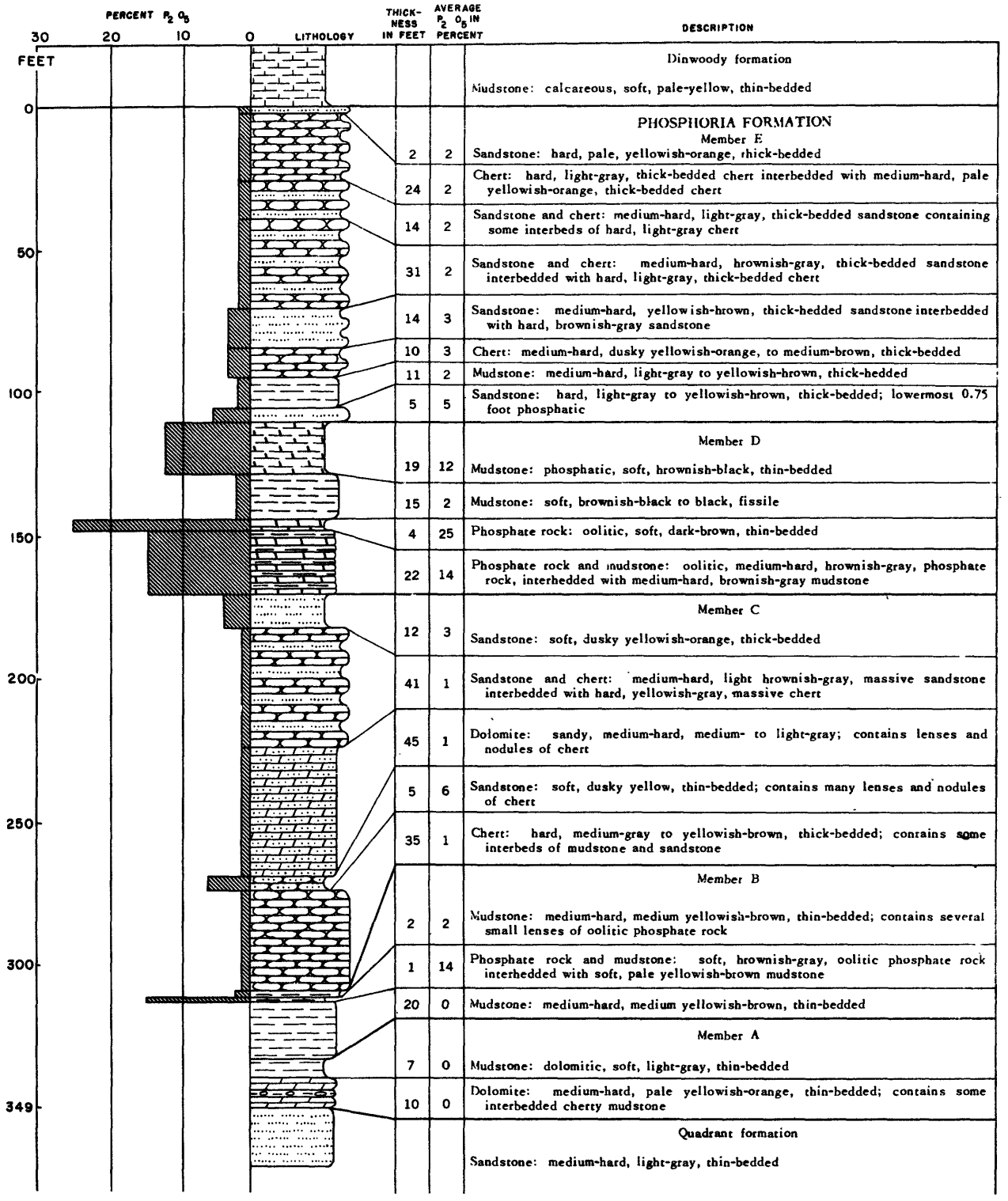

Figure 2.—Generalized sections of the Phosphoria formation at Sheep Creek, Montana (lot no. 1234).

A and C, are dominated by limestone and the top, or E member, by chert and sandstone or quartzite. Most of the members can be identified over a large part of the area of outcrop, though member correlation toward the east and northeast is much more difficult. The formation ranges in thickness from less than 100 to more than 800 feet.

The A member is best developed toward the west and the southwest and consists of limestone or of dolomite, sandstone, mudstone, and chert. It has a maximum thickness of nearly 350 feet, overlies the Quadrant formation of Pennsylvanian age, and is probably equivalent to the upper member of the Wells formation of southeastern Idaho and adjacent Wyoming and Utah (McKelvey, 1949).

Near the southwest corner of the state the lower phosphatic shale [B member] is about 50 feet thick, but thins markedly to the north and east, where in some areas it cannot be recognized. In the Centennial Mountains it contains a rich bed of minable phosphate.

The C member consists of as much as to 200 feet of limestone, chert, and sandstone. The upper phosphatic shale [D member] is similar to and much more uniform and widespread than the B member, though minable phosphate is present only toward the north end of the area where the full thickness of the phosphatic zone may consist of a single 3- to 5-foot bed of high-grade phosphate rock.

The E member is the most widespread and uniform, averaging about 100 feet in thickness and consisting chiefly of siliceous rocks—siltstone, chert, and quartzitic sandstone. In the greater part of the area it is overlain by the Dinwoody formation of Triassic age and toward the north and northeast by the Ellis group of Jurassic age.

STRATIGRAPHIC SECTIONS

Abstracts of stratigraphic sections measured at fourteen localities and analytical data are presented on the following pages. Their locations as well as the locations of other sections previously reported (Swanson and others, 1953a and b, Klepper and others, 1953, Cressman and others, 1953) and sections to be reported later are shown on figure 1.

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North Boulder Creek, Mont., lot 1364

Phosphoria formation measured and sampled in natural exposure on north side of road in NE¼ sec. 4, T. 2 N., R. 2 W., Jefferson County, Mont. Beds strike N. 20° W. and dip 45° NE. Section measured by R. F. Gosman and sampled by J. A. Peterson in August 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)
				P_2O_5	Acid insoluble	
	Ellis group—basal beds only					
Je-2	Sandstone	--	15.0	--	--	15.0
Je-1	Conglomerate	--	1.8	--	--	16.8
	Phosphoria formation					
P-30	Quartzite	--	0.8	--	--	0.8
P-29	Chert	--	7.2	--	--	8.0
P-28	Chert, sandy	--	.9	--	--	8.9
P-27	Mudstone, cherty	--	1.4	--	--	10.3
P-26	Chert	--	2.8	--	--	13.1
P-25	Quartzite	--	.7	--	--	13.8
P-24	Mudstone, cherty	--	1.2	--	--	15.0
P-23	Chert and cherty mudstone	--	5.8	--	--	20.8
P-22	Chert, phosphatic	5533-RFG	.8	16.4	52.5	21.6
P-21	Mudstone, cherty	--	.8	--	--	22.4
P-20	Chert, phosphatic	5532-RFG	.4	14.1	59.0	22.8
P-19	Mudstone, cherty	--	2.0	--	--	24.8
P-18	Chert	5531-RFG	.3	4.3	83.4	25.1
P-17	Covered interval	--	19.0	--	--	44.1
P-16	Quartzite	--	5.4	--	--	49.5
P-15	Chert and quartzite	--	6.3	--	--	55.8
P-14	Quartzite, cherty	--	5.6	--	--	61.4
P-13	Chert, sandy	--	5.0	--	--	66.4
P-12	Sandstone, argillaceous	--	20.0	--	--	86.4
P-11	Carbonate rock, sandy	--	2.7	--	--	89.1
P-10	Mudstone	--	.6	--	--	89.7
P- 9	Sandstone, argillaceous, carbonatic	--	.4	--	--	90.1
P- 8	Mudstone, sandy	--	1.6	--	--	91.7
P- 7	Sandstone, carbonatic	--	4.3	--	--	96.0
P- 6	Mudstone and sandstone	--	4.7	--	--	100.7
P- 5	Sandstone	--	.7	--	--	101.4
P- 4	Quartzite	--	2.3	--	--	103.7

North Boulder Creek—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)
				P_2O_5	Acid insoluble	
P- 3	Mudstone, sandy and carbonatic sandstone ---	--	3.2	--	--	106.9
P- 2	Quartzite and carbonatic sandstone ---------	--	2.0	--	--	108.9
P- 1	Mudstone, carbonatic ----------	--	6.3	--	--	115.2
	Quadrant formation—top bed only					
Cq-1	Quartzite ----------	--	2.5	--	--	2.5

Three Forks, Mont., lot 1356

Phosphoria formation measured and sampled in natural exposure at north end of Milligan Canyon about 300 feet east of Willow Creek road, sec. 24, T. 2 N., R. 1 W., Jefferson County, Mont. Beds strike N. 80° E. and dip 25° N. Section measured by J. A. Peterson and sampled by R. F. Gosman in June 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)
				P_2O_5	Acid insoluble	
	Ellis group—basal bed only					
Je-1	Conglomerate; fos. col. no. 12698[1] ----------	--	--	--	--	--
	Phosphoria formation					
P-29	Quartzite ----------	--	1.0	--	--	1.0
P-28	Mudstone, cherty ----------	--	6.2	--	--	7.2
P-27	Phosphate rock, cherty ----------	5405-JAP	.2	18.8	44.7	7.4
P-26	Chert ----------	--	2.3	--	--	9.7
P-25	Mudstone, phosphatic ----------	--	.1	--	--	9.8
P-24	Carbonate rock ----------	--	.9	--	--	10.7
P-23	Chert ----------	--	.3	--	--	11.0
P-22	Phosphate rock, argillaceous ----------	5404-JAP	.3	20.2	44.7	11.3
P-21	Mudstone, cherty ----------	--	.7	--	--	12.0
P-20	Chert, phosphatic, sandy ----------	5403-JAP	.3	18.9	43.4	12.3
P-19	Chert and carbonate rock ----------	--	7.0	--	--	19.3
P-18	Chert ----------	--	1.0	--	--	20.3
P-17	Chert ----------	--	1.5	--	--	21.8
P-16	Chert and carbonate rock ----------	--	3.5	--	--	25.3
P-15	Chert, phosphatic ----------	5402-JAP	.5	10.9	64.0	25.8
P-14	Phosphate rock, argillaceous ----------	5401-JAP	.5	23.7	35.7	26.3
P-13	Carbonate rock ----------	--	2.5	--	--	28.8
P-12	Chert ----------	--	7.3	--	--	36.1
P-11	Chert, phosphatic ----------	5400-JAP	1.6	16.3	50.0	37.7
P-10	Carbonate rock ----------	--	1.5	--	--	39.2
P- 9	Sandstone and carbonate rock ----------	--	3.5	--	--	42.7
P- 8	Carbonate rock and chert ----------	--	26.3	--	--	69.0
P- 7	Sandstone and quartzite ----------	--	4.3	--	--	73.3
P- 6	Carbonate rock and chert ----------	--	21.3	--	--	94.6
P- 5	Carbonate rock, cherty ----------	--	7.0	--	--	101.6
P- 4	Quartzite ----------	--	1.5	--	--	103.1
P- 3	Carbonate rock ----------	--	2.3	--	--	105.4

[1] Fossil collection made by J. A. Peterson.

Three Forks—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)
				P_2O_5	Acid insoluble	
P- 2	Quartzite	--	0.9	--	--	106.3
P- 1	Mudstone, carbonatic	--	1.7	--	--	108.0
	Quadrant formation—not measured					
Cq-1	Quartzite	--	--	--	--	--

Logan, Mont., lot 1367

Phosphoria formation measured and sampled along ridge on east side of road about 1 mile northwest of Logan, sec. 26, T. 2 N., R. 2 E., Gallatin County, Mont. Beds strike N. 70° E. and dip 20° N. Section measured by R. W. Swanson and J. A. Peterson and sampled by Swanson in September 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)
				P_2O_5	Acid insoluble	
	Ellis group—not measured					
Je-1	Conglomerate	--	--	--	--	--
	Phosphoria formation—top contact approximately located					
P-23	Sandstone, quartzitic	--	17.0	--	--	17.0
P-22	Quartzite	--	4.6	--	--	21.6
P-21	Quartzite	--	13.2	--	--	34.8
P-20	Sandstone, quartzitic	--	6.0	--	--	40.8
P-19	Carbonate rock, chert, and sandstone	--	2.5	--	--	43.3
P-18	Chert and mudstone	--	2.0	--	--	45.3
P-17	Carbonate rock and chert	--	2.0	--	--	47.3
P-16	Mudstone and chert	5593-RWS	1.5	1.4	72.7	48.8
P-15	Chert and carbonatic mudstone	5592-RWS	1.9	.9	68.8	50.7
P-14	Mudstone and chert	5591-RWS	1.7	1.3	62.4	52.4
P-13	Quartzite	--	1.2	--	--	53.6
P-12	Chert and carbonate rock	--	5.8	--	--	59.4
P-11	Quartzite, phosphatic	--	1.1	--	--	60.5
P-10	Carbonate rock and quartzite	--	1.1	--	--	61.6
P- 9	Chert and quartzite	--	1.6	--	--	63.2
P- 8	Chert and quartzite	--	.9	--	--	64.1
P- 7	Mudstone, carbonatic	--	1.1	--	--	65.2
P- 6	Carbonate rock, argillaceous	--	.7	--	--	65.9
P- 5	Mudstone, carbonatic	--	1.0	--	--	66.9
P- 4	Carbonate rock, argillaceous	--	1.3	--	--	68.2
P- 3	Carbonate rock, cherty	--	1.3	--	--	69.5
P- 2	Quartzite, cherty; fos. col. no. 12699[1]	--	1.5	--	--	71.0
P- 1	Sandstone, carbonatic, quartzitic	--	2.9	--	--	73.9

[1]Fossil collection made by J. A. Peterson.

Jefferson Canyon, Mont., lot 1355

Phosphoria formation measured and sampled in natural exposure and hand trench about 200 feet above river on west side of Jefferson Canyon, SE¼ sec. 13, T. 1 N., R. 3 W., Madison County, Mont. Beds strike N. 45° E. and dip 45° NW. Section measured by J. A. Peterson and sampled by R. F. Gosman in June 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	Ellis group—basal bed only						
Je-1	Sandstone, conglomeratic	--	5.0	--	--	5.0	--
	Phosphoria formation						
P-31	Chert	--	1.5	--	--	1.5	--
P-30	Quartzite and chert	--	10.5	--	--	12.0	--
P-29	Chert and quartzite	--	1.9	--	--	13.9	--
P-28	Chert and mudstone	--	1.2	--	--	15.1	--
P-27	Chert	--	7.8	--	--	22.9	--
P-26	Quartzite	--	1.0	--	--	23.9	--
P-25	Chert	--	2.0	--	--	25.9	--
P-24	Quartzite and phosphatic quartzite	--	3.6	--	--	29.5	--
P-23	Chert, sandy	--	.5	--	--	30.0	--
P-22	Quartzite	--	2.8	--	--	32.8	--
P-21	Quartzite and chert	--	7.1	--	--	39.9	--
P-20	Sandstone, phosphatic	5384-JAP	.3	18.6	48.4	40.2	--
P-19	Chert	--	2.9	--	--	43.1	--
P-18	Phosphate rock, cherty	5383-JAP	.5	18.2	45.0	43.6	--
P-17	Chert	--	1.8	--	--	45.4	--
P-16	Chert, phosphatic	5382-JAP	.5	15.5	53.6	45.9	--
P-15	Chert	--	.7	--	--	46.6	--
P-14	Chert, phosphatic	5381-JAP	.6	17.5	46.8	47.2	--
P-13	Carbonate rock and chert	--	1.7	--	--	48.9	--
P-12	Chert and cherty carbonate rock	--	10.4	--	--	59.3	--
P-11	Mudstone, argillaceous	5380-JAP	.5	8.9	64.3	59.8	4.45
P-10	Chert, argillaceous	5379-JAP	3.6	2.0	75.0	63.4	11.65
P- 9	Phosphate rock, argillaceous	5378-JAP	.9	22.1	31.9	64.3	31.54
P- 8	Mudstone, cherty, carbonatic	5377-JAP	3.5	1.1	64.0	67.8	35.39
P- 7	Phosphate rock, argillaceous	5376-JAP	.9	24.7	32.4	68.7	57.62
P- 6	Mudstone	5375-JAP	.4	1.7	72.1	69.1	58.30
P- 5	Chert	--	6.3	--	--	75.4	--
P- 4	Quartzite; fos. col. no. 12693[1]	5374-JAP	1.3	7.3	77.9	76.7	--

P- 3	Mudstone ----------	--	.5	--	--	77.2	--
P- 2	Sandstone, conglomeratic, phosphatic ------	--	.5	--	--	77.7	--
P- 1	Sandstone, chert, and conglomerate -------	--	13.5	--	--	91.2	--
	Quadrant formation—top beds only						
Cq-1	Carbonate rock ----------	--	--	--	--	--	--
Cq-2	Quartzite, carbonatic ----------	--	--	--	--	--	--

[1] Fossil collection made by J. A. Peterson.

Sappington Canyon, Mont., lot 1357

Phosphoria formation measured and sampled in natural exposure along ridge on east side of Jefferson River in sec. 25, T. 1 N., R. 2 W., Gallatin County, Mont. Beds strike N. 80° W. and dip 44° N. Section measured by J. A. Peterson and sampled by R. F. Gosman in July 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	Ellis group—basal beds only						
Je-2	Carbonate rock, argillaceous, sandy	--	4.2	--	--	4.2	--
Je-1	Mudstone, carbonatic	--	1.1	--	--	5.3	--
	Phosphoria formation						
P-41	Quartzite	--	0.9	--	--	0.9	--
P-40	Sandstone, carbonatic, conglomeratic	--	3.0	--	--	3.9	--
P-39	Chert	--	6.5	--	--	10.4	--
P-38	Quartzite, carbonatic	--	1.3	--	--	11.7	--
P-37	Chert and sandstone	--	6.9	--	--	18.6	--
P-36	Quartzite, carbonatic	--	1.6	--	--	20.2	--
P-35	Chert	--	2.4	--	--	22.6	--
P-34	Quartzite, carbonatic	--	3.5	--	--	26.1	--
P-33	Sandstone, carbonatic; fos. col. no. 12697[1]	--	6.2	--	--	32.3	--
P-32	Sandstone, carbonatic	--	9.3	--	--	41.6	--
P-31	Chert	--	16.0	--	--	57.6	--
P-30	Carbonate rock, argillaceous	--	1.3	--	--	58.9	--
P-29	Carbonate rock, argillaceous and chert	--	6.9	--	--	65.8	--
P-28	Chert	--	2.7	--	--	68.5	--
P-27	Phosphate rock, argillaceous	5483-JAP	.2	23.0	34.9	68.7	--
P-26	Chert and mudstone	--	3.0	--	--	71.7	--
P-25	Mudstone, phosphatic	5482-JAP	.2	16.1	47.3	71.9	--
P-24	Mudstone and chert	--	8.0	--	--	79.9	--
P-23	Mudstone	5481-JAP	1.8	2.0	73.6	81.7	3.60
P-22	Phosphate rock, argillaceous	5480-JAP	.5	25.3	30.8	82.2	16.25
P-21	Carbonate rock	5479-JAP	1.2	1.2	6.0	83.4	17.69
P-20	Phosphate rock, argillaceous and mudstone	5478-JAP	.3	17.4	30.7	83.7	22.91
P-19	Phosphate rock, argillaceous	5477-JAP	.2	29.1	18.8	83.9	28.73
P-18	Mudstone, phosphatic	5476-JAP	.3	8.3	48.7	84.2	31.22
P-17	Phosphate rock, argillaceous	5475-JAP	1.1	26.8	18.3	85.3	60.70
P-16	Mudstone, phosphatic, carbonatic	5474-JAP	.5	11.4	30.3	85.8	66.40
P-15	Mudstone	5473-JAP	.4	6.8	57.7	86.2	69.12
P-14	Mudstone	5472-JAP	.7	4.6	64.7	86.9	72.34

P-13	Phosphate rock, argillaceous	5471-JAP	.3	18.3	38.9	87.2	77.83
P-12	Mudstone	5470-JAP	2.3	1.5	72.3	89.5	81.28
P-11	Mudstone, phosphatic	5469-JAP	.5	11.5	59.0	90.0	87.03
P-10	Carbonate rock	--	.9	--	--	90.9	--
P- 9	Chert	--	.7	--	--	91.6	--
P- 8	Quartzite, carbonatic	--	3.0	--	--	94.6	--
P- 7	Chert and carbonate rock	--	9.5	--	--	104.1	--
P- 6	Carbonate rock, sandy	--	1.3	--	--	105.4	--
P- 5	Chert and carbonatic quartzite	--	6.5	--	--	111.9	--
P- 4	Carbonate rock, argillaceous	--	6.9	--	--	118.8	--
P- 3	Carbonate rock, conglomeratic	--	.5	--	--	119.3	--
P- 2	Carbonate rock and chert	--	11.2	--	--	130.5	--
P- 1	Sandstone, carbonatic	--	16.0	--	--	146.5	--
	Quadrant formation—top beds only						
Cq-1	Sandstone, carbonatic, cherty	--	6.0	--	--	6.0	--
Cq-2	Quartzite, carbonatic	--	14.0	--	--	20.0	--
Cq-3	Sandstone, carbonatic and chert	--	5.0	--	--	25.0	--

[1]Fossil collection made by J. A. Peterson.

South Boulder Creek, Mont., lot 1365

Phosphoria formation measured and sampled in hand trench and natural exposure about 200 feet above and west of Jack Creek in NW¼ sec. 10, T. 1 S., R. 3 W., Madison County, Mont. Beds strike east-west and dip 35° N. Section measured by J. A. Peterson and sampled by R. F. Gosman in August 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	Ellis group—basal beds only						
Je-5	Carbonate rock	--	(?)	--	--	--	--
Je-4	Covered interval	--	15.0	--	--	15.0	--
Je-3	Sandstone, carbonatic	--	1.0	--	--	16.0	--
Je-2	Covered interval	--	3.0	--	--	19.0	--
Je-1	Sandstone, calcareous	--	3.0	--	--	22.0	--
	Phosphoria formation						
P-25	Covered interval; (sandstone float in pit)	--	7.0	--	--	7.0	--
P-24	Chert	--	8.3	--	--	15.3	--
P-23	Quartzite, carbonatic, phosphatic	--	1.0	--	--	16.3	--
P-22	Chert	--	11.0	--	--	27.3	--
P-21	Mudstone, phosphatic	5569-JAP	.4	14.4	59.9	27.7	--
P-20	Mudstone, carbonatic	--	1.6	--	--	29.3	--
P-19	Chert, phosphatic	5568-JAP	.4	16.6	52.5	29.7	--
P-18	Chert	--	.7	--	--	30.4	--
P-17	Mudstone, phosphatic	5567-JAP	.5	18.3	47.3	30.9	--
P-16	Carbonate rock	--	3.0	--	--	33.9	--
P-15	Phosphate rock, argillaceous	5566-JAP	.5	18.6	45.5	34.4	--
P-14	Chert	--	7.2	--	--	41.6	--
P-13	Mudstone, carbonatic	5540-JAP	5.5	1.1	68.06	47.1	6.05
P-12	Mudstone	5539-JAP	5.5	2.2	74.3	52.6	18.15
P-11	Phosphate rock, cherty	5538-JAP	.6	25.8	30.26	53.2	33.63
P-10	Mudstone, carbonatic	5537-JAP	1.7	1.8	71.06	54.9	36.69
	Below bed P-10 occurs a much-weathered porphyry sill 3.6 feet thick.						
P- 9	Mudstone	5536-JAP	.6	2.2	70.0	55.5	38.01
P- 8	Phosphate rock, argillaceous	5535-JAP	.7	26.2	29.5	56.2	56.35
P- 7	Chert	--	7.6	--	--	63.8	--
P- 6	Phosphate rock	5534-JAP	.3	30.5	11.9	64.1	--

P- 5	Quartzite	--	5.3	--	--	69.4	--
P- 4	Chert and quartzite	--	5.7	--	--	75.1	--
P- 3	Conglomerate	--	1.0	--	--	76.1	--
P- 2	Quartzite, carbonatic	--	4.0	--	--	80.1	--
P- 1	Conglomerate, carbonatic	--	1.0	--	--	81.1	--
	Quadrant formation—top beds only						
Cq-5	Carbonate rock and carbonatic sandstone	--	6.5	--	--	6.5	--
Cq-4	Carbonate rock and carbonatic sandstone	--	15.0	--	--	21.5	--
Cq-3	Sandstone, carbonatic	--	2.0	--	--	23.5	--
Cq-2	Carbonate rock	--	7.0	--	--	30.5	--
Cq-1	Sandstone, carbonatic	--	(?)	--	--	--	--

La Marche Gulch, Mont., lot 1366

Phosphoria formation measured and sampled in hand trench and natural exposure near La Marche Gulch on west side of Big Hole River in sec. 32, T. 1 S., R. 9 W., Beaverhead County, Mont. Beds strike N. 40° W. and dip 45° SW. Section measured by R. F. Gosman and sampled by J. A. Peterson in August 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Al_2O_3	Fe_2O_3	Loss on ignition	Acid insoluble		
	E member of Phosphoria formation — not measured									
E- 1	Quartzite	--	--	--	--	--	--	--	--	--
	D member of Phosphoria formation									
D-16	Phosphate rock	5585-RFG	0.5	28.4	--	--	--	13.4	0.5	14.20
D-15	Mudstone	5584-RFG	.4	3.9	--	--	--	68.3	0.9	15.76
D-14	Carbonate rock	5583-RFG	1.0	4.3	--	--	--	17.7	1.9	20.06
D-13	Phosphate rock, argillaceous	5582-RFG	.6	22.4	1.49	2.19	14.02	12.1	2.5	33.50
D-12	Phosphate rock and mudstone	5581-RFG	1.5	27.0	4.24	2.60	4.18	22.2	4.0	74.00
D-11	Mudstone, carbonatic	5580-RFG	1.2	.9	2.93	1.38	5.27	73.1	5.2	75.08
D-10	Phosphate rock, argillaceous and carbonate rock	5579-RFG	2.1	24.0	2.26	1.12	17.63	2.9	7.3	125.48
D- 9	Phosphate rock, argillaceous and mudstone	5578-RFG	1.2	22.8	13.6	2.72	5.44	27.8	8.5	152.84
D- 8	Phosphate rock, argillaceous and mudstone	5577-RFG	3.0	23.2	5.20	2.83	6.40	29.4	11.5	222.44
D- 7	Phosphate rock, argillaceous	5576-RFG	2.7	18.7	7.02	3.15	6.94	37.7	14.2	272.93
D- 6	Phosphate rock, argillaceous and mudstone	5575-RFG	4.0	22.7	5.72	2.83	5.70	31.0	18.2	363.73
D- 5	Mudstone, phosphatic	5574-RFG	2.1	15.4	--	--	--	44.4	20.3	396.07
D- 4	Carbonate rock, argillaceous	5573-RFG	1.1	.8	--	--	--	21.8	21.4	396.95
D- 3	Mudstone, phosphatic and phosphate rock	5572-RFG	1.1	15.8	--	--	--	44.7	22.5	414.33
D- 2	Mudstone, phosphatic and phosphate rock	5571-RFG	3.3	16.7	--	--	--	43.8	25.8	469.44
D- 1	Mudstone, phosphatic and phosphate rock	5570-RFG	1.0	13.4	--	--	--	50.7	26.8	482.84
	Lower part of Phosphoria formation									
P-19	Carbonate rock; fos. col. no. 12696[1]	--	13.0	--	--	--	--	--	13.0	--
P-18	Sandstone, carbonatic	--	.8	--	--	--	--	--	13.8	--
P-17	Carbonate rock	--	4.1	--	--	--	--	--	17.9	--
P-16	Mudstone, sandy	--	1.0	--	--	--	--	--	18.9	--
P-15	Carbonate rock	--	9.3	--	--	--	--	--	28.2	--
P-14	Carbonate rock and mudstone	--	11.0	--	--	--	--	--	39.2	--
P-13	Carbonate rock and mudstone	--	4.2	--	--	--	--	--	43.4	--

P-12	Carbonate rock	--	7.5	--	--	--	--	--	50.9	--
P-11	Carbonate rock, sandy and chert	--	18.0	--	--	--	--	--	68.9	--
P-10	Quartzite, carbonatic	--	3.0	--	--	--	--	--	71.9	--
P- 9	Chert and sandstone	--	3.2	--	--	--	--	--	75.1	--
P- 8	Carbonate rock, sandy, cherty	--	3.0	--	--	--	--	--	78.1	--
P- 7	Quartzite, carbonatic	--	6.5	--	--	--	--	--	84.6	--
P- 6	Carbonate rock, cherty	--	18.0	--	--	--	--	--	102.6	--
P- 5	Carbonate rock, cherty	--	14.6	--	--	--	--	--	117.2	--
P- 4	Sandstone, cherty	--	2.0	--	--	--	--	--	119.2	--
P- 3	Carbonate rock, sandy	--	5.5	--	--	--	--	--	124.7	--
P- 2	Sandstone	--	.8	--	--	--	--	--	125.5	--
P- 1	Carbonate rock	--	7.2	--	--	--	--	--	132.7	--
	Quadrant formation—top beds only									
Cq-1	Quartzite, carbonatic	--	4.0	--	--	--	--	--	4.0	--
Cq-2	Carbonate rock, argillaceous	--	7.8	--	--	--	--	--	11.8	--
Cq-3	Quartzite	--	5.0	--	--	--	--	--	16.8	--
Cq-4	Quartzite	--	3.0	--	--	--	--	--	19.8	--

[1]Fossil collection made by J. A. Peterson.

Canyon Creek no. 3, Mont., lot 1359

Phosphoria formation measured and sampled in hand trench and natural exposure about 1,500 feet northeast of Canyon Creek road on northeast limb of broad syncline in NW¼ sec. 13, T. 2 S., R. 10 W., Beaverhead County, Mont. Beds strike N. 25° W. and dip 38° SW. Section measured by J. A. Peterson and sampled by R. F. Gosman in July 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	Dinwoody formation—not measured						
	E member of Phosphoria formation						
E- 7	Quartzite, carbonatic	--	8.0	--	--	8.0	--
E- 6	Covered interval	--	12.0	--	--	20.0	--
E- 5	Quartzite	--	12.0	--	--	32.0	--
E- 4	Chert, sandy	--	25.0	--	--	57.0	--
E- 3	Quartzite and chert	--	5.0	--	--	62.0	--
E- 2	Chert	--	12.0	--	--	74.0	--
E- 1	Chert, sandy	--	2.0	--	--	76.0	--
	D member of Phosphoria formation						
D-13	Phosphate rock	5424-JAP	0.9	31.5	15.8	0.9	28.35
D-12	Carbonate rock	5423-JAP	.9	1.2	16.1	1.8	29.43
D-11	Mudstone, carbonatic	5422-JAP	.4	.7	64.9	2.2	29.71
D-10	Phosphate rock	5421-JAP	.9	29.0	4.9	3.1	55.81
D- 9	Mudstone	5420-JAP	.3	3.6	59.3	3.4	56.89
D- 8	Phosphate rock	5419-JAP	.4	27.3	5.3	3.8	67.81
D- 7	Phosphate rock, argillaceous	5418-JAP	2.2	20.6	22.9	6.0	113.13
D- 6	Mudstone, phosphatic	5417-JAP	1.5	13.6	47.2	7.5	133.53
D- 5	Phosphate rock, argillaceous	5416-JAP	3.0	23.7	24.5	10.5	204.30
D- 4	Mudstone	5415-JAP	3.5	4.5	64.5	14.0	220.38
D- 3	Mudstone, phosphatic	5414-JAP	2.0	10.5	54.1	16.0	241.38
D- 2	Mudstone, phosphatic	5413-JAP	1.2	13.6	38.3	17.2	257.70
D- 1	Sandstone, phosphatic	5412-JAP	.7	15.9	45.3	17.9	268.83
	C member of Phosphoria formation						
C- 5	Carbonate rock; fos. col. no. 12694[1]	--	4.5	--	--	4.5	--
C- 4	Quartzite, carbonatic	--	6.0	--	--	10.5	--
C- 3	Carbonate rock	--	12.7	--	--	23.2	--
C- 2	Carbonate rock and chert	--	18.0	--	--	41.2	--
C- 1	Carbonate rock, sandy	--	5.0	--	--	46.2	--

	B member of Phosphoria formation						
B- 1	Covered interval ---------- Covered interval forms gentle slope between resistant limestone units.	--	16.5	--	--	16.5	--
	A member of Phosphoria formation						
A-10	Carbonate rock and chert ----------	--	2.0	--	--	2.0	--
A- 9	Carbonate rock ----------	--	7.4	--	--	9.4	--
A- 8	Carbonate rock ----------	--	5.7	--	--	15.1	--
A- 7	Covered interval ----------	--	7.0	--	--	22.1	--
A- 6	Carbonate rock ----------	--	3.0	--	--	25.1	--
A- 5	Covered interval ----------	--	7.0	--	--	32.1	--
A- 4	Carbonate rock, cherty ----------	--	7.0	--	--	39.1	--
A- 3	Covered interval ----------	--	6.3	--	--	45.4	--
A- 2	Quartzite, cherty ----------	--	1.5	--	--	46.9	--
A- 1	Carbonate rock ----------	--	6.0	--	--	52.9	--
	Quadrant formation—not measured						
Cq-1	Quartzite ----------	--	--	--	--	--	--

[1]Fossil collection made by J. A. Peterson.

North Big Hole Canyon, Mont., lot 1358

A, B, D, and E members of Phosphoria formation measured and sampled in hand trenches and natural exposures on north side of Big Hole River in NE¼ sec. 3, T. 5 S., R. 8 W., Madison County, Mont., on northwest limb of asymmetrical anticline. Bed nos. A-4 through A-9 measured in lower trench, bed nos. B-1 through B-7 in middle trench, and bed nos. D-1 through D-38 in upper trench. Remainder of beds measured in natural exposure. Beds strike N. 70° E. and dip 20° N. Section measured by J. A. Peterson and sampled by Peterson and R. F. Gosman in June and July 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	Dinwoody formation—not measured						
	Contact between Phosphoria and Dinwoody formations in covered interval at bottom of dip slope on uppermost beds of Phosphoria formation.	--	--	--	--	--	--
	E member of Phosphoria formation—top not exposed						
E- 8	Quartzite, cherty	--	4.6	--	--	4.6	--
E- 7	Chert	--	9.0	--	--	13.6	--
E- 6	Quartzite	--	2.0	--	--	15.6	--
E- 5	Chert	--	8.2	--	--	23.8	--
E- 4	Chert	--	2.0	--	--	25.8	--
E- 3	Quartzite	--	2.0	--	--	27.8	--
E- 2	Chert	--	21.6	--	--	49.4	--
E- 1	Quartzite	--	26.5	--	--	75.9	--
	D member of Phosphoria formation						
D-38	Chert	5461-JAP	0.6	4.5	82.4	0.6	2.70
D-37	Mudstone	5460-JAP	1.0	2.4	71.3	1.6	5.10
D-36	Mudstone	5459-JAP	1.0	4.5	66.4	2.6	9.60
D-35	Mudstone, phosphatic	5458-JAP	2.2	13.3	45.4	4.8	38.86
D-34	Phosphate rock, carbonatic	5457-JAP	.6	15.9	12.4	5.4	48.40
D-33	Mudstone, carbonatic	5456-JAP	.5	4.8	58.6	5.9	50.80
D-32	Mudstone	5455-JAP	.8	4.7	60.7	6.7	54.56
D-31	Phosphate rock	5454-JAP	.6	23.9	10.9	7.3	68.90
D-30	Phosphate rock, argillaceous	5453-JAP	.7	16.4	31.3	8.0	80.38
D-29	Mudstone, phosphatic	5452-JAP	.6	11.7	42.3	8.6	87.40
D-28	Phosphate rock	5451-JAP	1.3	23.7	9.9	9.9	118.21
D-27	Mudstone, carbonatic	5450-JAP	.5	7.7	49.7	10.4	122.06
D-26	Phosphate rock	5449-JAP	1.8	24.3	10.0	12.2	165.80

D-25	Carbonate rock, phosphatic	5448-JAP	.8	12.0	8.0	13.0	175.40
D-24	Phosphate rock, argillaceous	5447-JAP	.6	19.4	21.3	13.6	187.04
D-23	Phosphate rock, argillaceous	5446-JAP	.8	21.9	20.9	14.4	204.56
D-22	Phosphate rock, argillaceous	5445-JAP	1.7	26.3	15.0	16.1	249.27
D-21	Phosphate rock, argillaceous	5444-JAP	1.7	17.0	32.6	17.8	278.17
D-20	Mudstone	5443-JAP	.4	6.3	59.5	18.2	280.69
D-19	Phosphate rock, argillaceous	5442-JAP	1.4	16.3	31.7	19.6	303.51
D-18	Phosphate rock, argillaceous	5441-JAP	1.4	20.6	22.7	21.0	332.35
D-17	Mudstone, phosphatic	5440-JAP	2.3	14.0	38.5	23.3	364.55
D-16	Carbonate rock	5439-JAP	.4	2.3	5.0	23.7	365.47
D-15	Carbonate rock	5438-JAP	.7	2.5	5.8	24.4	367.22
D-14	Carbonate rock	5437-JAP	.4	3.4	7.7	24.8	368.58
D-13	Phosphate rock, argillaceous	5436-JAP	.5	17.6	28.5	25.3	377.38
D-12	Carbonate rock	5435-JAP	.6	5.1	9.9	25.9	380.44
D-11	Mudstone, phosphatic, carbonatic	5434-JAP	1.1	9.8	39.3	27.0	391.22
D-10	Carbonate rock	5433-JAP	1.1	3.5	6.1	28.1	395.07
D- 9	Mudstone, carbonatic	5432-JAP	.7	7.9	48.9	28.8	400.60
D- 8	Mudstone, phosphatic, carbonatic	5431-JAP	.4	11.5	38.4	29.2	405.20
D- 7	Carbonate rock	5430-JAP	.7	3.3	6.1	29.9	407.51
D- 6	Phosphate rock, argillaceous, carbonatic	5429-JAP	.5	14.7	27.2	30.4	414.86
D- 5	Carbonate rock	5428-JAP	1.4	2.2	5.5	31.8	417.94
D- 4	Phosphate rock, argillaceous	5427-JAP	1.5	19.5	27.5	33.3	447.19
D- 3	Mudstone, phosphatic	5426-JAP	1.5	13.8	38.5	34.8	467.89
D- 2	Phosphate rock, argillaceous	5425-JAP	.5	23.2	36.0	35.3	479.49
D- 1	Mudstone, sandy	--	.5	--	--	35.8	--
	C member of Phosphoria formation—not described						
	B member of Phosphoria formation						
B- 7	Mudstone	5411-JAP	1.2	0.6	85.3	1.2	0.72
B- 6	Mudstone	5410-JAP	.8	.5	86.3	2.0	1.12
B- 5	Phosphate rock	5409-JAP	.6	34.0	10.0	2.6	21.52
B- 4	Mudstone, carbonatic	5408-JAP	.9	.8	68.3	3.5	28.72
B- 3	Sandstone, carbonatic	5407-JAP	2.0	0.3	69.0	5.5	34.72
B- 2	Carbonate rock, sandy, and sandy mudstone	--	3.3	--	--	8.8	--
B- 1	Carbonate rock, sandy, and sandy mudstone	--	4.2	--	--	13.0	--
	A member of Phosphoria formation						
	Approximately 50 feet of upper A member not measured. Complete A member measured at South Big Hole Canyon no. 1, lot no. 1354.						
A- 9	Carbonate rock, argillaceous	5390-JAP	1.5	0.3	27.3	1.5	0.45

North Big Hole Canyon—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
A- 8	Carbonate rock, argillaceous	5389-JAP	2.2	0.6	37.0	3.7	1.77
A- 7	Mudstone, argillaceous	5388-JAP	3.4	6	48.2	7.1	3.81
A- 6	Carbonate rock, argillaceous; fos. col. no. 12692	5387-JAP	1.9	.3	35.3	9.0	4.38
A- 5	Mudstone, carbonatic	5386-JAP	1.5	.1	50.2	10.5	4.53
A- 4	Phosphate rock, argillaceous	5385-JAP	1.5	<.1	19.4	12.0	4.68
A- 3	Limestone	--	1.1	--	--	13.1	--
A- 2	Dolomite	--	3.6	--	--	16.7	--
A- 1	Limestone and chert	--	12.9	--	--	29.6	--
	Quadrant formation—top bed only						
Cq-1	Quartzite	--	--	--	--	--	--

[1] Fossil collection made by J. A. Peterson.

South Big Hole Canyon, Mont., lot 1354

A, C, and D members of Phosphoria formation measured and sampled in natural exposure and hand trench near top of ridge on south side of Big Hole River in SE¼ sec. 3, T. 5 S., R. 8 W., Beaverhead County, Mont., on northwest limb of faulted anticline. Beds strike N. 60° E. and dip 20° NW. Section measured by J. A. Peterson and sampled by R. F. Gosman in June 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	D member of Phosphoria formation—lower part only						
D- 8	Mudstone, phosphatic	5468-JAP	1.0	12.6	49.1	1.0	12.60
D- 7	Phosphate rock, argillaceous	5467-JAP	1.6	25.4	22.4	2.6	53.24
D- 6	Phosphate rock, argillaceous	5466-JAP	3.0	20.3	29.5	5.6	114.14
D- 5	Carbonate rock	5465-JAP	1.1	1.1	4.1	6.7	115.35
D- 4	Mudstone, phosphatic	5464-JAP	1.3	16.2	39.1	8.0	136.41
D- 3	Carbonate rock, argillaceous	5463-JAP	1.4	1.8	40.2	9.4	138.93
D- 2	Mudstone, phosphatic	5462-JAP	1.8	17.3	42.5	11.2	170.07
D- 1	Mudstone	--	4.0	--	--	15.2	--
	C member of Phosphoria formation						
C- 5	Carbonate rock	--	3.3	--	--	3.3	--
C- 4	Carbonate rock, cherty, sandy	--	12.5	--	--	15.8	--
C- 3	Carbonate rock, cherty	--	20.3	--	--	36.1	--
C- 2	Carbonate rock	--	29.0	--	--	65.1	--
C- 1	Chert	--	6.6	--	--	71.7	--
	B member apparently lenses out at this locality. Mudstones of B member at North Big Hole Canyon, lot no. 1358, may be represented by upper part of bed A-5 here.						
	A member of Phosphoria formation						
A- 5	Chert and carbonate rock	--	19.0	--	--	19.0	--
A- 4	Carbonate rock and chert	--	39.4	--	--	58.4	--
A- 3	Carbonate rock	--	14.0	--	--	72.4	--
A- 2	Carbonate rock	--	6.7	--	--	79.1	--
A- 1	Carbonate rock	--	10.0	--	--	89.1	--
	Quadrant formation—not measured						
Cq-1	Quartzite	--	--	--	--	--	--

South Big Hole Canyon no. 2, Mont., lot 1354

B member of Phosphoria formation measured and sampled in hand trench along ridge about 1 mile south of Big Hole River in SE¼ sec. 9, T. 5 S., R. 8 W., Beaverhead County, Mont. Section measured by J. A. Peterson and sampled by R. F. Gosman in June 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Al_2O_3	Fe_2O_3	Loss on ignition	Acid insoluble		
	C member of Phosphoria formation—basal bed only									
C-1	Chert	--	6.0	--	--	--	--	--	6.0	--
	B member of Phosphoria formation									
B-8	Mudstone	5399-JAP	2.7	1.7	--	--	--	79.7	2.7	4.59
B-7	Mudstone	5398-JAP	1.4	6.7	--	--	--	68.0	4.1	13.97
	5406-JAP is sample of thin bed of phosphate rock contained in bed B-7 near the middle.									
--	Phosphate rock	5406-JAP	(.2)	30.1	4.80	1.45	2.04	18.3	--	--
B-6	Phosphate rock	5397-JAP	.3	33.0	3.89	.68	2.67	10.7	4.4	23.87
B-5	Phosphate rock	5396-JAP	.5	34.4	1.80	1.99	2.61	7.3	4.9	41.07
B-4	Phosphate rock	5395-JAP	1.0	37.6	1.16	.64	2.74	2.8	5.9	78.67
B-3	Phosphate rock, sandy	5394-JAP	.5	20.5	1.19	2.54	2.25	39.2	6.4	88.92
B-2	Mudstone, carbonatic, sandy	5393-JAP	1.2	.4	--	--	--	69.9	7.6	93.72
B-1	Mudstone, sandy, carbonatic	5392-JAP	5.2	.2	--	--	--	69.9	12.8	94.76
	A member of Phosphoria formation—top bed only									
A-1	Carbonate rock and chert	--	17.3	--	--	--	--	--	17.3	--

Indian Creek, Mont., lot 1362

Phosphoria formation measured and sampled at natural exposure on north side of Indian Creek in sec. 20, T. 8 S., R. 2 E., Madison County, Mont. Section measured by R. F. Gosman and sampled by J. A. Peterson in August 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	Dinwoody formation—basal beds only						
Trd-1	Carbonate rock	--	?	--	--	--	--
Trd-2	Sandstone, carbonatic	--	0.5	--	--	0.5	--
	Phosphoria formation						
P-16	Quartzite	--	78.0	--	--	78.0	--
P-15	Chert	--	39.0	--	--	117.0	--
P-14	Phosphate rock, argillaceous and mudstone	5497-RFG	.3	23.9	32.3	117.3	7.17
P-13	Carbonate rock	5496-RFG	.4	1.7	10.3	117.7	7.85
P-12	Phosphate rock, argillaceous, and phosphatic mudstone	5495-RFG	2.0	23.9	16.3	119.7	55.65
P-11	Phosphate rock	5494-RFG	1.1	31.9	3.9	120.8	90.74
P-10	Mudstone, carbonatic	5493-RFG	1.0	3.8	63.3	121.8	94.54
P- 9	Carbonate rock	5492-RFG	.4	1.6	8.1	122.2	95.18
P- 8	Mudstone and argillaceous phosphate rock	5491-RFG	.7	19.5	26.5	122.9	108.83
P- 7	Mudstone, phosphatic	5490-RFG	.6	15.0	47.5	123.5	117.83
P- 6	Quartzite, carbonatic	--	5.7	--	--	129.2	--
P- 5	Mudstone, carbonatic and quartzite	--	4.5	--	--	133.7	--
P- 4	Quartzite	--	6.5	--	--	140.2	--
P- 3	Mudstone, sandy, carbonatic	--	3.4	--	--	143.6	--
P- 2	Sandstone and sandy carbonate rock	--	8.7	--	--	152.3	--
P- 1	Sandstone, carbonatic	--	.3	--	--	152.6	--
	Quadrant formation—top beds only						
Cq-1	Sandstone, carbonatic	--	17.0	--	--	17.0	--
Cq-2	Sandstone, carbonatic and chert	--	10.5	--	--	27.5	--

Cinnabar Mountain, Mont., lot 1363

Phosphoria formation measured and sampled in natural exposure on east side of Cinnabar Mountain, sec. 31, T. 8 S., R. 8 E., Park County, Montana. Beds strike N. 50° W. and dip 75° SW. Section measured by J. A. Peterson and sampled by R. F. Gosman in August 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	Dinwoody formation—basal beds only						
Td-3	Carbonate rock, argillaceous	--	1.5	--	--	1.5	--
Td-2	Carbonate rock	--	2.0	--	--	3.5	--
Td-1	Carbonate rock; fos. col. no. 12695[1]	--	4.8	--	--	8.3	--
	Phosphoria formation						
P-17	Quartzite, carbonatic	--	6.5	--	--	6.5	--
P-16	Chert and carbonate rock	--	11.8	--	--	18.3	--
P-15	Quartzite	--	7.2	--	--	25.5	--
P-14	Carbonate rock	--	2.5	--	--	28.0	--
P-13	Quartzite, cherty, carbonatic	--	8.0	--	--	36.0	--
P-12	Quartzite, cherty	--	7.0	--	--	43.0	--
P-11	Chert and mudstone	5530-JAP	1.3	2.1	72.7	44.3	2.73
P-10	Chert, argillaceous	5529-JAP	2.0	3.4	71.9	46.3	9.53
P- 9	Mudstone, contains gypsum	5528-JAP	.8	4.9	64.5	47.1	13.45
P- 8	Phosphate rock, argillaceous	5527-JAP	2.3	19.9	35.8	49.4	59.22
P- 7	Carbonate rock, phosphatic	5526-JAP	1.0	8.3	9.3	50.4	67.52
P- 6	Phosphate rock, argillaceous	5519-JAP	2.2	21.6	23.03	52.6	115.04
P- 5	Phosphate rock, argillaceous	5518-JAP	1.7	21.3	23.7	54.3	151.25
P- 4	Phosphate rock, argillaceous	5517-JAP	1.5	23.4	17.5	55.8	186.35
P- 3	Mudstone, carbonatic, phosphatic	5516-JAP	1.4	12.6	32.5	57.2	203.99
P- 2	Phosphate rock, argillaceous	5499-JAP	.7	16.8	36.3	57.9	215.75
P- 1	Conglomerate, phosphatic	5498-JAP	1.0	12.4	49.6	58.9	228.15
	Quadrant formation—top beds only						
Cq-1	Sandstone, carbonatic, argillaceous	--	3.0	--	--	3.0	--
Cq-2	Quartzite	--	50.0	--	--	53.0	--

[1] Fossil collection made by J. A. Peterson.

Landon Ridge, Mont., lot 1361

B member of Phosphoria formation measured and sampled in bulldozer trench in SW¼ sec. 27, T. 12 S., R. 2 W., Beaverhead County, Mont. Beds strike east-west and dip 25° S. Section measured by J. A. Peterson and sampled by Peterson and R. F. Gosman in August 1951. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P_2O_5 (cumulative)
				P_2O_5	Acid insoluble		
	C member of Phosphoria formation—basal bed only						
C-1	Quartzite, phosphatic	--	3.0	--	--	3.0	--
	B member of Phosphoria formation						
B-6	Phosphate rock, sandy	5489-JAP	0.2	19.3	41.5	0.2	3.86
B-5	Chert, phosphatic	5488-JAP	.4	18.7	46.4	.6	11.34
B-4	Phosphate rock, argillaceous	5487-JAP	1.1	28.8	18.0	1.7	43.02
B-3	Phosphate rock, sandy	5486-JAP	1.4	27.6	20.5	3.1	81.66
B-2	Phosphate rock, argillaceous	5485-JAP	1.1	28.7	18.3	4.2	113.23
B-1	Phosphate rock, cherty	5484-JAP	1.2	26.3	20.6	5.4	144.79
	A member of Phosphoria formation—top bed only						
A-1	Chert, carbonatic	--	0.6	--	--	0.6	--

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