

GEOLOGICAL SURVEY CIRCULAR 327



STRATIGRAPHIC SECTIONS OF  
THE PHOSPHORIA FORMATION  
IN IDAHO, 1950-51

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UNITED STATES DEPARTMENT OF THE INTERIOR  
Douglas McKay, Secretary

GEOLOGICAL SURVEY  
W. E. Wrather, Director

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Washington, D. C., 1954

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Free on application to the Director, Geological Survey, Washington 25, D. C.

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## INTRODUCTION

The U. S. Geological Survey has recently measured and sampled the Phosphoria formation of Permian age at many localities in Idaho 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 many of the sections measured in southeastern Idaho (fig. 1), is one of this series and is the sixth report of data gathered in Idaho; it includes the data gathered in Idaho during 1950 and 1951. The field and laboratory procedures adopted in these investigations are described in a previous report (McKelvey and others, 1953a).

Many people have taken part in this investigation. E. R. Cressman, F. D. Frieske, R. A. Gulbrandsen, H. W. Peirce, J. A. Peterson, B. K. Replogle, and M. A. Warner participated in the description of strata and the collection of samples referred to in this report. Crushing and splitting of samples in the field was done by T. K. Rigby. The laboratory preparation of samples for chemical analysis was done in Denver, Colo., under the direction of W. P. Huleatt.

Most of 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 rest were made in the Survey laboratory in Denver, Colo., under the supervision of L. F. Rader, by chemists M. Appling, G. T. Burrow, N. Jammer, W. Mountjoy, and M. Stevens. The  $Al_2O_3$ ,  $Fe_2O_3$ , and loss-on-ignition analyses were made in the Survey laboratory in Washington, D. C., under the direction of J. C. Rabbitt, by chemists H. Alberty, I. Barlow, and C. Hoy.

The data were compiled largely by K. S. Bergman under the supervision of R. W. Swanson. Anita Wise organized the tabular data.

## ACKNOWLEDGMENTS

Special thanks are due W. W. Rubey, J. Steele Williams, and A. E. Weissenborn who have given much advice in planning and organizing the field program. The cost of both the field and laboratory investigations has been partly borne 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, property owners, and operating phosphate companies, who furnished information and services and gave access to property. A. J. Winters, Superintendent of the Montpelier Schools; E. M. Norris, C. T. Russell, and L. E. Traeger of the Anaconda Copper Mining Co.; D. L. King of the San Francisco Chemical Co.; G. A. McHugh of the Simplot Fertilizer

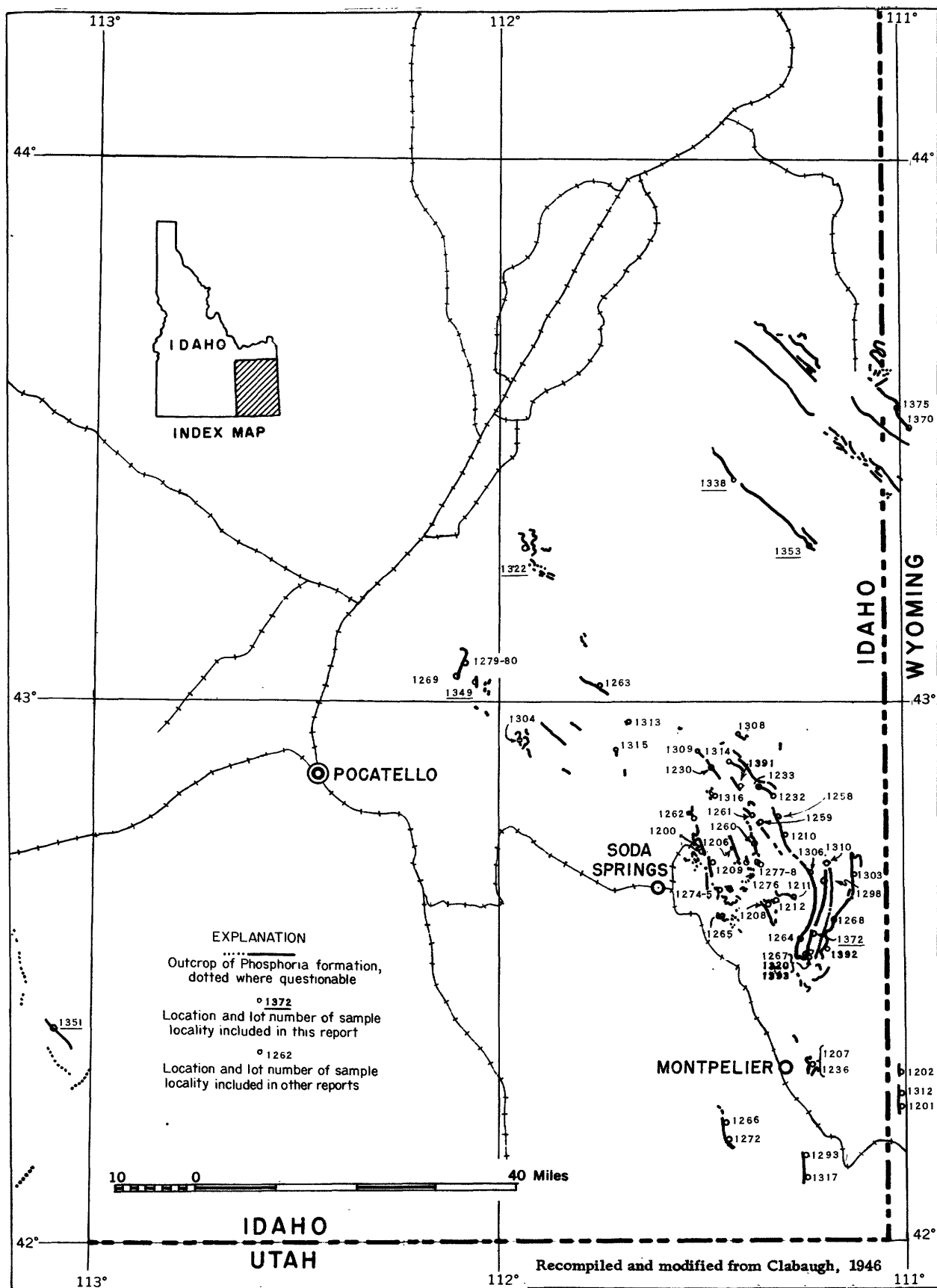


Figure 1. — Outcrops of the Phosphoria formation in Idaho and localities sampled.

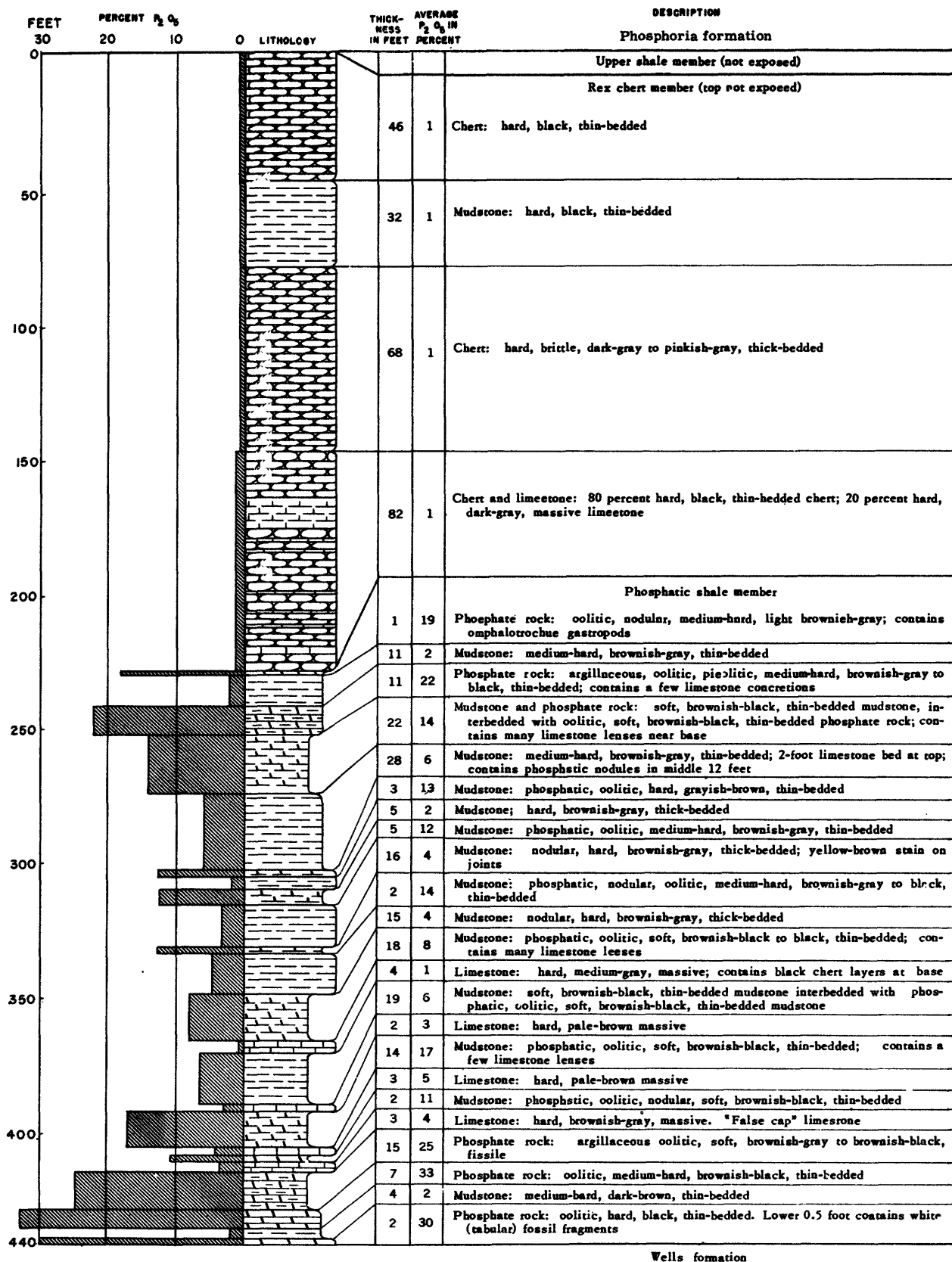


Figure 2. —Generalized section of the Phosphoria formation at Trail Canyon, Idaho (lot no. 1206).

Co.; and O. A. Power of the Westvaco Chemical Division, Food Machinery and Chemical Corp., have been especially helpful in this connection.

#### STRATIGRAPHY OF THE PHOSPHORIA FORMATION IN SOUTHEASTERN IDAHO

At its type locality in southeastern Idaho (Richards and Mansfield, 1912), the Phosphoria formation consists of a lower member, the phosphatic shale, about 180 feet thick and an upper member, the Rex chert, about 240 feet thick. Though not well defined at the type locality, a third member, a thin-bedded cherty mudstone 15 to 75 feet thick, overlies the Rex chert member in most of southeastern Idaho and western Wyoming. The phosphatic shale member thins progressively northward to a thickness of about 60 feet.

The Phosphoria formation overlies the Wells formation of Pennsylvania age and underlies the Dinwoody formation of Triassic age. The upper 50 to 75 feet of the Wells formation consists of a gray fossiliferous cherty limestone that contains some thin phosphatic layers and may be the correlative of the lowermost member (A member) of the Phosphoria formation in Montana and, according to McKelvey, the lower limestone member of the Park City formation in Utah.

In southeastern Idaho most of the phosphatic beds are in the phosphatic shale member, and it is on this member that most of the studies have been focused. It consists of many thin layers, some of which persist over the whole area. They may be grouped into several broad units, as yet unnamed, as shown in figure 2.

#### STRATIGRAPHIC SECTIONS

Abstracts of stratigraphic sections measured at six localities, and the available analytical data, are

presented in the following pages. Their locations, as well as the locations of sections reported previously (McKelvey and others, 1953a and b, and O'Malley and others, 1953, Sheldon and others, 1953, Davidson and others, 1953) are shown in figure 1.

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Fall Creek, Idaho, lot 1338

Phosphoria formation measured and sampled in bulldozer trench and at natural exposure on north side of Fall Creek near Swan Valley, SW $\frac{1}{4}$  sec. 18, T. 1 N., R. 43 E., Bonneville County, Idaho, on the southwest limb of an anticline trending northwest. Beds strike N. 40° W. and dip 45° SW. Section measured and sampled by R. P. Sheldon, F. D. Frieske, T. M. Cheney and R. G. Waring in September 1950. Samples analyzed for P<sub>2</sub>O<sub>5</sub> and acid insoluble by U. S. Bureau of Mines laboratory, Albany, Oreg., and for other constituents by Trace Elements Section laboratory, U. S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)				Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition		
Rex chert member of Phosphoria formation—top not exposed									
R-15	Chert -----	--	26.5	--	--	--	--	26.5	--
R-14	Limestone; fos. col. no. 12296 <sup>1</sup> -----	--	22.0	--	--	--	--	48.5	--
R-13	Mudstone, cherty, calcareous -----	--	31.0	--	--	--	--	89.5	--
R-12	Phosphate rock -----	--	.2	--	--	--	--	89.7	--
R-11	Sandstone; fos. col. no. 12295 -----	--	1.4	--	--	--	--	91.1	--
R-10	Limestone; fos. col. no. 12294 -----	--	1.9	--	--	--	--	93.0	--
R-9	Siltstone -----	--	5.2	--	--	--	--	98.2	--
R-8	Limestone, cherty -----	--	6.4	--	--	--	--	104.6	--
R-7	Chert -----	--	4.2	--	--	--	--	108.8	--
R-6	Phosphate rock -----	5339-RGW	.4	25.4	--	--	9.4	109.2	--
R-5	Mudstone -----	--	1.8	--	--	--	--	111.0	--
R-4	Chert -----	--	2.7	--	--	--	--	113.7	--
R-3	Chert -----	--	7.4	--	--	--	--	121.1	--
R-2	Chert, dolomitic -----	--	2.4	--	--	--	--	123.5	--
R-1	Chert -----	--	18.0	--	--	--	--	141.5	--
Phosphatic shale member of Phosphoria formation									
P-33	Carbonate rock -----	5338-RGW	1.0	0.8	--	--	--	1.0	0.80
P-32	Phosphate rock, argillaceous -----	5337-RGW	1.0	30.8	--	--	--	2.0	31.60
P-31	Phosphate rock; fos. col. no. 12293 -----	5336-RGW	1.4	34.3	--	--	--	3.4	79.62
P-30	Carbonate rock, argillaceous -----	5335-RGW	.6	1.1	--	--	--	4.0	80.28
P-29	Phosphate rock, argillaceous -----	5334-RGW	.4	27.2	--	--	--	4.4	91.16
P-28	Mudstone, carbonatic -----	5333-RGW	.7	1.0	--	--	--	5.1	91.86
P-27	Phosphate rock, argillaceous -----	5332-RGW	1.4	17.6	--	--	--	6.5	116.50
P-26	Mudstone -----	5331-RGW	1.3	.5	--	--	--	7.8	117.15
P-25	Carbonate rock, argillaceous -----	5330-RGW	1.1	.6	--	--	--	8.9	117.81
P-24	Mudstone, carbonatic -----	5329-RGW	.6	4.1	--	--	--	9.5	120.27
P-23	Mudstone -----	5328-RGW	2.1	6.0	--	--	--	11.6	132.87

<sup>1</sup> Fossil collection made by J. E. Smedley, U. S. Geological Survey.

<sup>2</sup> Acid-insoluble analysis probably too high.

## Fall Creek—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)
				$P_2O_5$	$Al_2O_3$	$Fe_2O_3$	Loss on ignition	Acid insoluble		
P- 22	Carbonate rock, argillaceous-----	5327-RGW	2.8	0.7	--	--	--	25.8	14.4	134.83
P- 21	Mudstone, carbonatic-----	5326-RGW	2.2	.7	--	--	--	49.6	16.6	136.37
P- 20	Mudstone, phosphatic, carbonatic -----	5325-RGW	1.2	10.7	--	--	--	40.3	17.8	149.21
P- 19	Carbonate rock, argillaceous -----	5324-RGW	.9	1.5	--	--	--	24.9	18.7	150.56
P- 18	Mudstone, phosphatic, carbonatic -----	5323-RGW	.4	12.6	--	--	--	33.1	19.1	155.60
P- 17	Carbonate rock -----	5322-RGW	.9	2.7	--	--	--	15.0	20.0	158.03
P- 16	Phosphate rock, argillaceous, and argillaceous carbonate rock -----	5321-RGW	1.4	13.2	--	--	--	26.4	21.4	176.51
P- 15	Phosphate rock and carbonatic phosphate rock-----	5320-RGW	1.6	24.4	--	--	--	11.7	23.0	215.55
P- 14	Limestone, argillaceous-----	5319-RGW	3.3	1.6	--	--	--	23.1	26.3	220.83
P- 13	Limestone, argillaceous-----	5318-RGW	.9	3.9	--	--	--	28.7	27.2	224.34
P- 12	Carbonate rock, argillaceous, and phosphatic mudstone, interbedded -----	5317- RPS	2.4	10.2	--	--	--	26.1	29.6	248.82
P- 11	Phosphate rock, argillaceous and carbonate rock, interbedded; fos. col. no. 12292 -----	5316- RPS	2.6	15.8	3.20	1.25	22.62	15.1	32.2	289.90
P- 10	Phosphate rock and argillaceous phosphate rock -----	5315- RPS	2.1	24.2	2.77	1.46	15.60	12.0	34.3	340.72
P- 9	Carbonate rock -----	5314- RPS	1.7	5.5	1.83	.51	37.88	6.7	36.0	350.07
P- 8	Phosphate rock and mudstone, interbedded -----	5313- RPS	.7	26.3	2.55	.92	10.54	12.6	36.7	368.48
P- 7	Carbonate rock, argillaceous, contains small amounts of fluorite; fos. col. no. 12291 -----	5312- RPS	1.0	2.4	.62	1.78	26.72	37.7	37.7	370.88
P- 6	Phosphate rock, calcareous -----	5311- FDF	.9	20.4	3.79	1.50	16.83	18.7	38.6	389.24
P- 5	Phosphate rock, calcareous, and phosphatic mudstone; fos. col. no. 12290-----	5310- FDF	2.4	28.9	5.72	.75	9.02	6.7	41.0	458.60
P- 4	Mudstone, carbonatic -----	5309- FDF	1.2	.6	5.36	1.80	19.78	55.0	42.2	459.32
P- 3	Phosphate rock -----	5308- FDF	.9	31.7	.62	.43	6.90	4.3	43.1	487.85
P- 2	Mudstone -----	5307- FDF	.7	3.5	--	--	--	72.3	43.8	490.30
P- 1	Carbonate rock, argillaceous and mudstone -----	5306- FDF	9.6	.9	--	--	--	35.9	53.4	498.94
.	A fault near base of bed P-1 omits .5 to 5 feet of section.									



## Wells formation—upper part only

Cw- 1	Chert, sandy, calcareous, and calcareous sandstone -----	--	1.3	--	--	--	--	1.3	--	--
Cw- 2	Chert, sandy, and calcareous sandstone -----	--	.9	--	--	--	--	2.2	--	--
Cw- 3	Dolomite, argillaceous, sandy-----	--	5.8	--	--	--	--	8.0	--	--
Cw- 4	Dolomite, silty and chert; fos. col. no. 12289 -----	--	11.0	--	--	--	--	19.0	--	--
Cw- 5	Limestone, argillaceous -----	--	9.8	--	--	--	--	28.8	--	--
Cw- 6	Siltstone and calcareous siltstone -----	--	1.2	--	--	--	--	30.0	--	--
Cw- 7	Siltstone -----	--	5.5	--	--	--	--	35.5	--	--
Cw- 8	Siltstone, calcareous -----	--	5.0	--	--	--	--	40.5	--	--
Cw- 9	Siltstone, sandy -----	--	18.0	--	--	--	--	58.5	--	--
Cw-10	Sandstone -----	--	14.0	--	--	--	--	72.5	--	--
Cw-11	Covered interval -----	--	32.	--	--	--	--	104.5	--	--
Cw-12	Sandstone, calcareous -----	--	4.0	--	--	--	--	108.5	--	--
Cw-13	Covered interval -----	--	5.	--	--	--	--	113.5	--	--
Cw-14	Limestone -----	--	4.0	--	--	--	--	117.5	--	--
Cw-15	Covered interval -----	--	15.	--	--	--	--	132.5	--	--
Cw-16	Limestone -----	--	5.0	--	--	--	--	137.5	--	--
Cw-17	Limestone, cherty -----	--	5.0	--	--	--	--	142.5	--	--
Cw-18	Dolomite -----	--	2.0	--	--	--	--	144.5	--	--
Cw-19	Limestone -----	--	5.0	--	--	--	--	149.5	--	--
Cw-20	Limestone, sandy -----	--	5.0	--	--	--	--	154.5	--	--
Cw-21	Limestone, cherty -----	--	2.0	--	--	--	--	156.5	--	--
Cw-22	Limestone -----	--	3.0	--	--	--	--	159.5	--	--
Cw-23	Sandstone, calcareous -----	--	1.4	--	--	--	--	160.9	--	--
Cw-24	Limestone -----	--	22.6	--	--	--	--	183.5	--	--
Cw-25	Dolomite, sandy, argillaceous -----	--	11.0	--	--	--	--	194.5	--	--

Phosphatic shale member of Phosphoria formation sampled in a bulldozer trench in Wolverine Canyon, SE $\frac{1}{4}$  NW $\frac{1}{4}$  sec. 31, T. 1 S., R. 39 E., Bingham County, Idaho. Beds strike north-south and dip 65° W. Section measured and sampled by R. A. Gulbrandsen, J. W. Hill, B. K. Replogle, E. R. Cressman, and H. W. Peirce in June 1950. Samples analyzed for P<sub>2</sub>O<sub>5</sub> and acid insoluble by U. S. Bureau of Mines laboratory, Albany, Oreg., and for other constituents by Trace Elements Section laboratory, U. S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			
Rex chert member of Phosphoria formation—lower bed only, base not exposed											
R- 1	Limestone ----- Thrust and normal faults occur at Rex-phosphatic shale contact; thickness of missing strata unknown.	--	0.8	--	--	--	--	--	0.8	--	
Phosphatic shale member of Phosphoria formation—top not exposed											
P- 48	Phosphate rock -----	4840-HWP	0.6	29.5	--	--	--	11.2	0.6	17.70	
P- 47	Phosphate rock ----- Bed P-47 is highly crumpled and weathered.	4839-HWP	1.4	25.3	--	--	--	10.3	2.0	53.12	
P- 46	Phosphate rock -----	4838-HWP	1.0	32.5	--	--	--	6.0	3.0	85.62	
P- 45	Limestone; fos. col. no. 12115 -----	4837-HWP	.7	2.2	--	--	--	3.6	3.7	87.16	
P- 44	Phosphate rock, argillaceous -----	4836-HWP	.8	23.3	--	--	--	18.9	4.5	105.80	
P- 43	Mudstone -----	4835-HWP	1.2	6.4	--	--	--	57.1	5.7	113.48	
P- 42	Limestone, argillaceous; fos. col. no. 12114 -----	4834-HWP	1.0	1.2	--	--	--	25.8	6.7	114.68	
P- 41	Phosphate rock, argillaceous -----	4833-HWP	.7	19.9	--	--	--	29.8	7.4	128.61	
P- 40	Phosphate rock, argillaceous -----	4832-HWP	1.5	19.0	--	--	--	33.8	8.9	157.11	
P- 39	Mudstone, phosphatic; fos. col. no. 12113 -----	4831-HWP	1.3	13.8	--	--	--	48.3	10.2	175.05	
P- 38	Phosphate rock, argillaceous -----	4830-HWP	1.0	17.3	--	--	--	40.5	11.2	192.35	
P- 37	Phosphate rock, argillaceous -----	4829-HWP	.7	24.1	--	--	--	22.1	11.9	209.22	
P- 36	Limestone, argillaceous -----	4828-HWP	.9	2.7	--	--	--	34.1	12.8	211.65	
P- 35	Phosphate rock, argillaceous -----	4827-HWP	.6	23.2	--	--	--	23.5	13.4	225.57	
P- 34	Mudstone, phosphatic; fos. col. no. 12112 -----	4826-BKR	4.8	12.7	--	--	--	43.4	18.2	286.53	
P- 33	Mudstone, phosphatic -----	4825-BKR	3.7	10.5	--	--	--	48.0	21.9	325.38	
P- 32	Phosphate rock, argillaceous and mudstone -----	4824-BKR	2.4	19.7	--	--	--	26.7	24.3	372.66	

Due to structural complications, the stratigraphic interval between beds P-31 and P-32 is unknown.

P- 31	Limestone (lens?) -----	4823-RAG	1.3	1.6	--	--	--	6.6	25.6	*2.08
P- 30	Mudstone, phosphatic, carbonatic; fos. col. no. 12111 -----	4822-RAG	3.0	12.6	--	--	--	24.0	28.6	39.88
P- 29	Phosphate rock, carbonatic -----	4821-RAG	.9	20.5	--	--	--	13.2	29.5	58.33
P- 28	Phosphate rock, argillaceous, carbonatic -----	4820-RAG	.6	16.1	--	--	--	15.7	30.1	67.99
P- 27	Limestone; fos. col. no. 12110 -----	4819-RAG	1.3	5.9	--	--	--	7.5	31.4	75.66
P- 26	Phosphate rock, argillaceous -----	4818-RAG	1.8	23.1	4.35	1.52	10.72	24.3	33.2	117.24
P- 25	Mudstone, phosphatic -----	4817-RAG	.5	11.8	7.06	2.19	11.99	46.3	33.7	123.14
P- 24	Limestone, argillaceous -----	4816-RAG	.8	5.2	3.23	1.10	33.08	18.0	34.5	127.30
P- 23	Phosphate rock and argillaceous phosphate rock -----	4815-RAG	1.0	28.3	2.29	.88	9.98	13.9	35.5	155.60
P- 22	Limestone -----	4814-RAG	.7	3.7	2.77	.88	36.36	15.2	36.2	158.19
P- 21	Phosphate rock -----	4813-RAG	1.5	27.9	2.83	.90	11.66	11.7	37.7	200.04
P- 20	Phosphate rock -----	4812-RAG	.7	24.6	2.30	.96	15.48	10.6	38.4	217.26
P- 19	Limestone -----	4811-RAG	1.7	1.5	.87	.27	43.41	4.3	40.1	219.81
P- 18	Phosphate rock -----	4810-RAG	1.1	27.4	2.84	1.15	11.22	12.9	41.2	249.95
P- 17	Phosphate rock, argillaceous -----	4809-RAG	.7	20.1	5.56	1.92	10.96	24.7	41.9	264.02
P- 16	Limestone (lens?) -----	4808-RAG	.7	3.0	1.97	.75	38.86	9.7	42.6	266.12
P- 15	Phosphate rock, argillaceous -----	4807-RAG	1.2	23.4	4.04	1.52	12.98	19.6	43.8	294.20
P- 14	Phosphate rock, argillaceous -----	4806-RAG	1.6	26.3	2.29	.83	12.15	14.6	45.4	336.28
P- 13	Limestone, phosphatic -----	4805-ERC	.7	9.2	1.54	.37	32.61	10.1	46.1	342.72
P- 12	Mudstone, phosphatic -----	4804-ERC	2.4	13.4	5.44	1.81	13.32	40.1	48.5	374.88
P- 11	Limestone, argillaceous -----	4803-ERC	.8	.3	3.15	1.17	33.63	22.4	49.3	375.12
P- 10	Phosphate rock, argillaceous -----	4802-ERC	.4	16.4	6.10	.18	13.82	39.7	49.7	381.68
P- 9	Phosphate rock -----	4801-ERC	1.3	33.0	.74	.54	6.87	5.0	51.0	424.58
P- 8	Phosphate rock -----	4800-ERC	1.0	29.6	2.29	.73	9.16	12.9	52.0	454.18
P- 7	Mudstone, phosphatic -----	4799-ERC	.5	11.5	6.28	1.91	12.69	43.7	52.5	459.93
P- 6	Phosphate rock and mudstone, interbedded -----	4798-ERC	2.0	23.4	3.99	1.13	7.82	26.0	54.5	506.73
P- 5	Limestone, argillaceous; fos. col. no. 12109 -----	4797-ERC	1.3	5.4	2.35	.86	30.60	17.9	55.8	513.75
P- 4	Phosphate rock; contains limestone lens 0.05 foot above base -----	4796-ERC	1.9	34.2	1.12	.55	6.01	5.2	57.7	578.73
P- 3	Phosphate rock -----	4795-ERC	1.1	36.2	.69	.44	4.10	3.1	58.8	618.55
P- 2	Phosphate rock -----	4794-ERC	1.0	37.4	.38	.35	3.29	1.7	59.8	655.95
P- 1	Phosphate rock -----	4793-ERC	.8	24.3	.40	.23	15.69	5.7	60.6	**675.39

Wells formation — top beds only

Cw- 1	Limestone, cherty -----	4792-BKR	2.4	0.7	--	--	27.8	27.8	2.4	1.68
Cw- 2	Limestone, cherty -----	4791-BKR	2.6	1.0	--	--	--	78.6	5.0	4.28

<sup>1</sup> Fossil collection made by J. E. Smedley, U. S. Geological Survey.  
\* Cumulative data incomplete due to missing information.  
\*\* Note incompleteness of cumulative data.

Wolverine Canyon—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative) <sup>5</sup>
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble		
Cw- 3	Limestone, cherty -----	4790-BKR	3.8	1.0	--	--	--	68.9	8.8	8.08
Cw- 4	Limestone, cherty -----	4789-BKR	2.3	.8	--	--	--	62.8	11.1	9.92

Bear Creek, Idaho, lot 1353

Phosphatic shale and upper shale members of the Phosphoria formation sampled near Bear Creek, NE $\frac{1}{4}$  sec. 31, T. 1 S., R. 45 E., Bonneville County, Idaho, on the west limb of an anticline trending N. 35° W. and plunging southeast. Beds strike N. 70° W. and dip from 45° to 75° S. Section measured by R. P. Sheldon, T. M. Cheney, R. G. Waring, and M. A. Warner in August 1951. Samples analyzed for P<sub>2</sub>O<sub>5</sub> and acid insoluble by U. S. Bureau of Mines laboratory, Albany, Oreg., and for other constituents by Trace Elements Section laboratory, U. S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)	
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble			
Dinwoody formation—lower beds only											
Td-4	Mudstone, carbonatic; fos. col. no. 12535 <sup>1</sup>	--	70.5	--	--	--	--	--	70.5	--	
Td-3	Mudstone, carbonatic	--	32.0	--	--	--	--	--	102.5	--	
Td-2	Mudstone, carbonatic and mudstone	--	13.0	--	--	--	--	--	115.5	--	
Td-1	Mudstone	--	1.2	--	--	--	--	--	116.7	--	
Upper shale member of Phosphoria formation											
U- 3	Mudstone	--	0.9	--	--	--	--	--	0.9	--	
U- 2	Mudstone	--	1.2	--	--	--	--	--	2.1	--	
U- 1	Phosphate rock, argillaceous	6571-MAW	.9	23.8	--	--	--	28.5	3.0	--	
Rex chert member of Phosphoria formation											
R- 4	Chert; fos. col. no. 12536	--	24.0	--	--	--	--	--	24.0	--	
R- 3	Covered interval; rocks probably faulted	--	(?)	--	--	--	--	--	--	--	
R- 2	Mudstone, cherty	--	2.3	--	--	--	--	--	26.3	--	
R- 1	Mudstone, cherty	--	1.4	--	--	--	--	--	27.7	--	
Phosphatic shale member of Phosphoria formation											
P-61	Phosphate rock	6567-MAW	0.6	31.1	0.82	0.70	10.33	15.4	0.6	19.08	
P-60	Phosphate rock	6566-MAW	2.3	29.5	1.94	.90	9.41	13.5	2.9	86.93	
P-59	Phosphate rock	6565-MAW	1.0	35.4	.57	.68	7.72	6.9	3.9	122.83	
P-58	Phosphate rock	6564-MAW	1.9	35.8	.88	.46	9.07	5.8	5.8	192.18	
P-57	Phosphate rock; fos. col. no. 12534	6563-MAW	1.1	34.2	.72	.51	8.65	3.5	6.9	230.46	
P-56	Phosphate rock; fos. col. no. 12534	6562-MAW	1.6	35.4	.23	.15	5.85	2.3	8.5	288.38	
P-55	Phosphate rock; fos. col. no. 12534	6561-MAW	1.3	35.6	.30	.25	7.89	2.4	9.8	334.66	
P-54	Phosphate rock and mudstone; fos. col. no. 12534	6560-MAW	1.2	24.2	3.78	1.70	4.03	30.2	11.0	363.46	
P-53	Phosphate rock; fos. col. no. 12534	6559-MAW	1.4	34.8	.56	.30	11.04	4.3	12.4	412.74	
P-52	Phosphate rock	6558-MAW	.3	31.5	1.80	1.28	11.52	11.9	12.7	422.43	
P-51	Mudstone and phosphate rock	6557-MAW	.6	12.2	--	--	--	57.1	13.3	429.69	
P-50	Mudstone	6556-MAW	1.3	3.7	--	--	--	79.0	14.6	434.44	

<sup>1</sup> Fossil collection by J. E. Smedley, U. S. Geological Survey.

Bear Creek—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)
				$P_2O_5$	$Al_2O_3$	$Fe_2O_3$	Loss on ignition	Acid insoluble		
P-49	Phosphate rock and mudstone	6555-MAW	0.5	24.8	--	--	--	23.3	15.1	446.90
P-48	Mudstone	6554-MAW	.5	4.1	--	--	--	74.0	15.6	448.94
P-47	Phosphate rock, argillaceous	6553-MAW	.7	21.7	--	--	--	26.1	16.3	463.78
P-46	Mudstone, phosphatic	6552-MAW	1.0	10.0	--	--	--	48.7	17.3	473.78
P-45	Mudstone	6551-MAW	2.0	.3	--	--	--	76.6	19.3	474.38
P-44	Mudstone	6550-MAW	2.6	5.8	--	--	--	68.0	21.9	489.46
P-43	Mudstone	6549-RGW	.9	1.0	--	--	--	82.9	22.8	490.36
P-42	Mudstone	6548-RGW	.5	4.5	--	--	--	75.0	23.3	492.60
P-41	Mudstone	6547-RGW	1.5	.4	--	--	--	84.9	24.8	493.20
P-40	Mudstone	6546-TMC	1.3	7.7	--	--	--	55.3	26.1	503.22
P-39	Mudstone, carbonatic	6545-TMC	1.6	5.1	--	--	--	54.3	27.7	511.38
P-38	Mudstone	6544-TMC	.6	6.6	--	--	--	64.2	28.3	515.34
P-37	Mudstone	6543-TMC	1.2	3.0	--	--	--	78.9	29.5	518.94
P-36	Mudstone, phosphatic	6542-TMC	1.3	14.1	--	--	--	44.5	30.8	537.26
P-35	Mudstone	6541-TMC	.5	5.9	--	--	--	71.1	31.3	540.22
P-34	Mudstone, phosphatic	6540-TMC	.7	13.7	--	--	--	43.5	32.0	549.80
P-33	Mudstone, phosphatic	6539-TMC	.4	9.4	--	--	--	61.1	32.4	553.56
P-32	Phosphate rock, argillaceous and mudstone	6538-TMC	.7	17.5	--	--	--	35.4	33.1	565.82
P-31	Mudstone, phosphatic	6537-TMC	.7	8.4	--	--	--	47.3	33.8	571.70
P-30	Mudstone and phosphate rock	6536-TMC	1.3	14.6	--	--	--	35.7	35.1	590.68
P-29	Phosphate rock	6535-TMC	.9	28.4	--	--	--	9.7	36.0	616.24
P-28	Phosphate rock	6534-TMC	1.2	26.8	--	--	--	12.5	37.2	648.40
P-27	Mudstone	6533-TMC	1.0	3.4	--	--	--	77.3	38.2	651.80
P-26	Mudstone	6532-TMC	.7	2.9	--	--	--	78.7	38.9	653.82
P-25	Mudstone	6531-TMC	.5	7.5	--	--	--	56.1	39.4	657.58
P-24	Mudstone	6530-TMC	.8	5.0	--	--	--	69.0	40.2	661.58
P-23	Mudstone and phosphatic mudstone	6529-TMC	.7	10.0	--	--	--	46.5	40.9	668.58
P-22	Mudstone and phosphatic mudstone	6528-TMC	.7	13.0	--	--	--	40.5	41.6	677.68
P-21	Mudstone, carbonatic	6527-TMC	.4	4.9	--	--	--	57.3	42.0	679.64
P-20	Phosphate rock, argillaceous	6526-TMC	.7	19.2	5.48	2.29	11.96	27.5	42.7	693.08
P-19	Phosphate rock, argillaceous	6525-TMC	.4	19.3	5.44	2.36	11.23	28.3	43.1	700.80
P-18	Mudstone, phosphatic and mudstone	6524-RPS	.5	12.2	8.60	3.18	14.54	40.9	43.6	706.90
P-17	Phosphate rock, argillaceous	6523-RPS	1.0	24.8	3.70	1.50	9.83	17.4	44.6	731.70
P-16	Phosphate rock, argillaceous	6522-RPS	.9	22.8	4.94	1.70	10.02	22.9	45.5	752.22
P-15	Phosphate rock, argillaceous	6521-RPS	.6	20.4	6.64	2.18	10.12	27.0	46.1	764.46
P-14	Phosphate rock, argillaceous	6520-RPS	.9	18.4	5.80	2.65	12.36	30.5	47.0	781.02
P-13	Phosphate rock	6519-RPS	1.3	27.1	2.60	1.29	9.40	11.7	48.3	816.24

P-12	Phosphate rock, argillaceous	6518- RPS	1.0	22.6	5.10	2.20	8.97	21.9	49.3	838.84
P-11	Phosphate rock, argillaceous	6517- RPS	1.0	25.2	3.84	1.60	7.45	19.0	50.3	864.04
P-10	Mudstone	6516- RPS	.8	7.0	8.92	3.43	8.85	64.5	51.1	869.64
P-9	Phosphate rock	6515- RPS	1.4	27.2	2.64	1.37	8.49	6.2	52.5	907.72
P-8	Phosphate rock	6514- RPS	1.0	32.8	1.14	.84	4.61	4.6	53.5	940.52
P-7	Phosphate rock, argillaceous	6513- RPS	.3	26.5	3.74	1.30	7.28	15.0	53.8	948.48
P-6	Phosphate rock	6512- RPS	1.8	31.5	.72	.60	4.27	9.1	55.6	1,005.18
P-5	Mudstone	6511- RPS	1.6	.9	8.48	3.83	6.73	83.1	57.2	1,006.62
P-4	Phosphate rock	6510- RPS	1.0	31.2	.74	.56	5.82	6.5	58.2	1,037.82
P-3	Mudstone	6509- RPS	1.3	5.0	6.48	3.18	8.73	69.1	59.5	1,044.32
P-2	Phosphate rock	6508- RPS	.4	31.7	.80	.73	5.68	6.6	59.9	1,057.00
P-1	Carbonate rock, argillaceous	6570- RPS	2.0	1.7	--	--	--	36.3	61.9	1,060.40

Wells formation—upper beds only

Cw-24	Carbonate rock, sandy, fos. col. no. 12531	--	2.7	--	--	--	--	--	2.7	--
Cw-23	Chert, phosphatic, and cherty phosphate rock	6569- TMC	.5	8.8	--	--	--	61.9	3.2	--
Cw-22	Sandstone, carbonatic	--	3.1	--	--	--	--	--	6.3	--
Cw-21	Chert, siltstone, and cherty, carbonatic siltstone	--	3.9	--	--	--	--	--	10.2	--
Cw-20	Mudstone	--	.5	--	--	--	--	--	10.7	--
Cw-19	Chert	--	3.0	--	--	--	--	--	13.7	--
Cw-18	Mudstone, cherty, argillaceous carbonate rock, and chert	--	1.2	--	--	--	--	--	14.9	--
Cw-17	Mudstone, phosphatic	6568- TMC	.5	8.1	--	--	--	66.9	15.4	--
Cw-16	Sandstone	--	22.0	--	--	--	--	--	37.4	--
Cw-15	Sandstone; fos. col. no. 12530	--	10.0	--	--	--	--	--	47.4	--
Cw-14	Carbonate rock	--	12.0	--	--	--	--	--	59.4	--
Cw-13	Covered interval	--	52.0	--	--	--	--	--	111.4	--
Cw-12	Carbonate rock	--	13.0	--	--	--	--	--	124.4	--
Cw-11	Quartzite, carbonatic	--	39.0	--	--	--	--	--	163.4	--
Cw-10	Sandstone, cherty, carbonatic and carbonate rock	--	9.0	--	--	--	--	--	172.4	--
Cw-9	Carbonate rock, cherty	--	9.0	--	--	--	--	--	181.4	--
Cw-8	Carbonate rock	--	42.0	--	--	--	--	--	223.4	--
Cw-7	Covered interval	--	20.0	--	--	--	--	--	243.4	--
Cw-6	Sandstone, carbonatic	--	3.0	--	--	--	--	--	246.4	--
Cw-5	Sandstone	--	47.0	--	--	--	--	--	293.4	--
Cw-4	Sandstone, cherty	--	12.0	--	--	--	--	--	305.4	--
Cw-3	Carbonate rock	--	15.0	--	--	--	--	--	320.4	--
Cw-2	Carbonate rock	--	10.0	--	--	--	--	--	330.4	--
Cw-1	Quartzite, carbonatic	--	25.0	--	--	--	--	--	355.4	--

Upper portion of phosphatic shale member of Phosphoria formation sampled in bulldozer trench of the Westvaco Chemical Division, Food Machinery and Chemical Corporation, on Fort Hall Indian Reservation, sec. 23 (?), T. 4 S., R. 37 E., Bingham County, Idaho. Beds strike N. 50° W. and dip 25° SW. Section measured and sampled by M. A. Warner and R. A. Smart in July 1951. Samples analyzed by Trace Elements Section laboratory, U. S. Geological Survey, Denver, Colo.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble		
Rex chert member of Phosphoria formation — basal bed only							
R- 1	Mudstone, cherty -----	--	2.5	--	--	2.5	--
Phosphatic shale member of Phosphoria formation— upper part only							
P-67	Mudstone-----	--	0.6	--	--	0.6	--
P-66	Mudstone and mantle -----	--	11.5	--	--	12.1	34.02
P-65	Phosphate rock, argillaceous-----	6337- RAS	1.8	18.9	42.1	13.9	34.02
P-64	Mudstone-----	6336- RAS	2.6	5.25	73.0	16.5	47.67
Beds P-64 through P-67 badly weathered and slumped.							
P-63	Mudstone-----	6335- RAS	1.6	1.40	84.7	18.1	49.91
P-62	Phosphate rock and mudstone-----	6334- RAS	1.5	28.0	16.3	19.6	91.91
P-61	Mudstone-----	6333- RAS	3.5	6.80	72.3	23.1	115.71
P-60	Mudstone-----	6332- RAS	2.5	7.65	70.6	25.6	134.84
P-59	Phosphate rock, argillaceous -----	6331-MAW	2.3	20.0	37.4	27.9	180.84
Beds P-59 through P-61 badly weathered.							
P-58	Phosphate rock -----	6330-MAW	.6	29.5	16.8	28.5	198.54
P-57	Mudstone, phosphatic-----	6329-MAW	2.8	8.15	66.5	31.3	221.36
P-56	Phosphate rock, argillaceous -----	6328-MAW	.6	26.8	23.7	31.9	237.44
P-55	Phosphate rock, argillaceous -----	6327-MAW	2.1	18.0	42.0	34.0	275.24
P-54	Mudstone, phosphatic -----	6326-MAW	1.5	10.8	58.7	35.5	291.44
P-53	Mudstone, phosphatic -----	6325-MAW	2.6	15.4	44.2	38.1	331.48
P-52	Mudstone, phosphatic -----	6324-MAW	3.0	17.0	44.4	41.1	382.48
P-51	Phosphate rock -----	6323-MAW	1.1	32.8	9.14	42.2	418.56
P-50	Mudstone-----	6322-MAW	.6	6.85	72.0	42.8	422.66
P-49	Phosphate rock -----	6321-MAW	1.5	33.0	11.8	44.3	472.16
Bed P-49 (sample 6321-MAW) correlates with bed P-49 (sample 2720-WOM) of lot 1269.							

<sup>1</sup>See O'Malley and others, 1953.



Phosphatic shale member of Phosphoria formation measured and sampled on Snowdrift Mountain, NW $\frac{1}{4}$ NW $\frac{1}{4}$ , sec. 8, T. 10 S., R. 45 E., Caribou County, Idaho, on the east limb of the Georgetown syncline. Beds strike N. 20° E. and dip 65° W. Section measured and sampled by T. M. Cheney, J. A. Peterson, R. G. Waring, R. A. Smart, and E. R. Cressman in September 1951. Samples analyzed for P<sub>2</sub>O<sub>5</sub> and acid insoluble by U. S. Bureau of Mines laboratory, Albany, Oreg., and for other constituents by Trace Elements Section laboratory, U. S. Geological Survey, Washington, D. C.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative) <sup>5</sup>
				P <sub>2</sub> O <sub>5</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Loss on ignition	Acid insoluble		
Rex chert member of Phosphoria formation — basal bed only										
R- 1	Chert and mudstone	6775- JAP	2.6	2.3	--	--	--	75.3	2.6	--
Phosphatic shale member of Phosphoria formation										
P-156	Phosphate rock, argillaceous	6774- JAP	0.5	29.5	--	--	--	21.3	0.5	14.75
P-155	Mudstone	6773- JAP	.8	2.4	--	--	--	75.5	1.3	16.67
P-154	Mudstone	6772- JAP	1.0	7.3	--	--	--	60.8	2.3	23.97
P-153	Mudstone; fos. col. no. 12595	6771- JAP	1.9	1.2	--	--	--	81.4	4.2	26.25
P-152	Mudstone; fos. col. no. 12595	6770- JAP	6.0	1.6	--	--	--	78.5	10.2	35.85
P-151	Mudstone	6769- JAP	6.2	3.6	--	--	--	73.0	16.4	58.17
P-150	Mudstone, carbonatic	6768- JAP	1.2	6.5	--	--	--	53.4	17.6	65.97
Bed P-150 highly weathered.										
P-149	Mudstone; fos. col. no. 12594	6767- JAP	1.4	6.4	--	--	--	68.9	19.0	74.93
P-148	Mudstone	6766- JAP	2.1	1.8	--	--	--	80.7	21.1	78.71
P-147	Mudstone, phosphatic	6765- JAP	.6	9.3	--	--	--	51.0	21.7	84.29
P-146	Phosphate rock	6764- JAP	.5	30.9	--	--	--	12.6	22.2	99.74
P-145	Mudstone; fos. col. no. 12593	6763- JAP	2.0	1.5	--	--	--	80.4	24.2	102.74
P-144	Mudstone	6762- JAP	.7	2.7	--	--	--	73.4	24.9	104.63
P-143	Phosphate rock	6761- JAP	1.0	36.2	0.49	0.37	5.52	2.5	25.9	140.83
P-142	Phosphate rock	6760- JAP	.5	35.7	.98	.53	4.41	2.8	26.4	158.68
P-141	Phosphate rock	6759- JAP	.9	34.7	.95	.55	5.58	5.2	27.3	189.91
P-140	Mudstone	6758- JAP	1.6	4.4	10.24	3.43	6.04	71.1	28.9	196.95
P-139	Phosphate rock and mudstone	6757-ERC	1.1	23.4	4.84	1.81	5.45	28.2	30.0	222.69
P-138	Phosphate rock, argillaceous	6756-ERC	1.9	27.4	3.63	1.24	5.68	20.6	31.9	274.75
P-137	Phosphate rock	6755-ERC	.8	32.0	2.02	.88	4.81	10.03	32.7	300.35
P-136	Phosphate rock	6754-ERC	1.7	33.6	1.80	.75	5.28	6.63	34.4	357.47
P-135	Phosphate rock	6753-ERC	.9	30.3	2.74	1.24	6.22	13.3	35.3	384.74
P-134	Phosphate rock, argillaceous	6752-RGW	.6	17.7	7.04	2.23	6.92	40.6	35.9	395.36
P-133	Phosphate rock, argillaceous and phosphatic mudstone	6751-RGW	.8	23.4	5.92	1.56	7.44	26.5	36.7	414.08
P-132	Phosphate rock	6750-RGW	.6	34.6	1.67	.65	4.11	6.3	37.3	434.84

<sup>5</sup> Fossil collection made by J. E. Smedley, U. S. Geological Survey.

## Snowdrift Mountain—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)					Cumulative thickness (feet)	Thickness x percent $P_2O_5$ (cumulative)
				$P_2O_5$	$Al_2O_3$	$Fe_2O_3$	Loss on ignition	Acid insoluble		
P-131	Phosphate rock	6749-RGW	0.8	29.9	3.66	1.18	5.37	14.6	38.1	458.76
P-130	Phosphate rock	6748-RGW	.8	36.7	.78	.40	4.95	1.2	38.9	488.12
P-129	Phosphate rock	6747-RGW	.8	36.6	1.18	.53	5.49	2.3	39.7	517.40
P-128	Phosphate rock	6746-RGW	.7	34.5	1.74	.75	5.75	7.7	40.4	541.55
P-127	Phosphate rock, argillaceous	6745-RGW	1.1	26.9	4.44	1.38	10.98	16.6	41.5	571.14
P-126	Phosphate rock	6744-RGW	1.4	31.6	2.27	1.04	14.79	8.2	42.9	615.38
P-125	Phosphate rock	6743-RGW	1.4	28.5	3.10	1.40	10.72	12.9	44.3	655.28
P-124	Phosphate rock, argillaceous	6742-RGW	1.2	26.5	3.88	1.20	11.88	15.4	45.5	687.08
P-123	Phosphate rock, argillaceous	6741-RGW	1.5	25.8	4.72	1.39	12.76	16.8	47.0	725.78
P-122	Phosphate rock, argillaceous	6740-RGW	.8	23.6	4.30	1.65	14.39	19.2	47.8	744.66
P-121	Phosphate rock, argillaceous	6739-RGW	1.3	18.6	--	--	--	30.2	49.1	768.84
P-120	Mudstone, phosphatic	6738-RGW	.7	11.7	--	--	--	50.3	49.8	777.03
P-119	Mudstone	6737-RGW	1.7	5.3	--	--	--	68.7	51.5	786.04
P-118	Mudstone, phosphatic	6736-RGW	1.0	12.4	--	--	--	47.9	52.5	798.44
P-117	Phosphate rock, argillaceous	6735-RGW	.8	14.9	--	--	--	34.7	53.3	810.36
P-116	Phosphate rock, argillaceous	6734-RGW	1.6	19.6	--	--	--	34.3	54.9	841.72
P-115	Mudstone, phosphatic	6733-RGW	.7	11.4	--	--	--	54.1	55.6	849.70
P-114	Phosphate rock, argillaceous	6732-RGW	1.5	18.6	--	--	--	38.9	57.1	877.60
P-113	Mudstone, phosphatic	6731-RGW	.6	15.7	--	--	--	43.2	57.7	887.02
P-112	Phosphate rock, argillaceous	6730-RGW	1.3	26.9	--	--	--	19.2	59.0	921.99
P-111	Mudstone	6729-RGW	.6	3.2	--	--	--	80.2	59.6	923.91
P-110	Mudstone, phosphatic	6728-RGW	1.3	7.8	--	--	--	69.4	60.9	934.05
P-109	Phosphate rock, argillaceous	6727-RGW	.7	23.6	--	--	--	25.2	61.6	950.57
P-108	Mudstone, phosphatic; fos. col. no. 12592	6726-RGW	1.4	12.7	--	--	--	55.3	63.0	968.35
P-107	Mudstone, phosphatic	6725-RGW	1.8	8.7	--	--	--	64.9	64.8	984.01
P-106	Mudstone	6724-RGW	1.4	5.6	--	--	--	69.0	66.2	991.85
P-105	Phosphate rock, argillaceous and mudstone	6723-RGW	1.0	13.5	--	--	--	48.7	67.2	1,005.35
P-104	Phosphate rock, argillaceous	6722-RGW	.6	22.8	--	--	--	30.8	67.8	1,019.03
P-103	Mudstone, phosphatic and mudstone	6721-RGW	1.9	8.1	--	--	--	59.9	69.7	1,034.42
P-102	Mudstone	6720-RGW	2.5	3.8	--	--	--	76.06	72.2	1,043.92
P-101	Mudstone	6719-RAS	1.3	7.4	--	--	--	58.5	73.5	1,053.54
P-100	Mudstone	6718-RAS	1.7	5.5	--	--	--	67.0	75.2	1,062.89
P-99	Mudstone	6717-RAS	.9	2.2	--	--	--	78.3	76.1	1,064.87
P-98	Mudstone	6716-RAS	3.3	3.3	--	--	--	72.0	79.4	1,075.76
P-97	Phosphate rock, argillaceous	6715-RAS	.7	15.7	--	--	--	35.0	80.1	1,086.75
P-96	Mudstone, phosphatic; fos. col. no. 12591	6714-RAS	1.3	8.4	--	--	--	64.0	81.4	1,097.67
P-95	Mudstone, phosphatic	6713-RAS	.5	10.3	--	--	--	47.7	81.9	1,102.82
P-94	Phosphate rock, argillaceous	6712-RAS	.6	18.3	--	--	--	32.9	82.5	1,113.80

P- 93	Phosphate rock -----	6711- RAS	.5	31.5	--	--	--	8.4	83.0	1, 129.55
P- 92	Phosphate rock, argillaceous and phosphate rock -----	6710- RAS	.5	19.9	--	--	--	26.9	83.5	1, 139.50
P- 91	Mudstone, phosphatic -----	6709- RAS	.4	14.1	--	--	--	47.2	83.9	1, 145.14
P- 90	Mudstone, phosphatic -----	6708- RAS	.4	11.3	--	--	--	54.4	84.3	1, 149.66
P- 89	Phosphate rock, argillaceous -----	6707- RAS	.7	21.9	--	--	--	32.7	85.0	1, 164.90
P- 88	Mudstone -----	6706- RAS	1.8	4.2	--	--	--	79.4	86.8	1, 172.55
P- 87	Carbonate rock, argillaceous -----	6705- RAS	3.5	1.3	--	--	--	18.7	90.3	1, 177.10
P- 86	Mudstone, cherty, phosphatic -----	6704- RAS	.5	9.6	--	--	--	64.6	90.8	1, 181.90
P- 85	Mudstone -----	6703- RAS	.9	2.7	--	--	--	82.6	91.7	1, 184.33
P- 84	Phosphate rock, argillaceous, cherty; fos. col. no. 12590 -----	6702- RAS	.8	22.7	--	--	--	32.5	92.5	1, 202.49
P- 83	Mudstone, phosphatic -----	6701- RAS	.9	9.5	--	--	--	64.0	93.4	1, 211.04
P- 82	Phosphate rock, argillaceous -----	6700- RAS	.4	19.3	--	--	--	33.6	93.8	1, 218.76
P- 81	Mudstone -----	6699- RAS	2.2	3.0	--	--	--	77.4	96.0	1, 225.36
P- 80	Mudstone and phosphatic mudstone -----	6698- TMC	.7	12.9	--	--	--	38.4	96.7	1, 234.39
P- 79	Phosphate rock, argillaceous, calcareous -----	6697- TMC	1.0	15.4	--	--	--	28.9	97.7	1, 249.79
P- 78	Mudstone and calcareous, argillaceous phosphate rock -----	6696- TMC	.5	18.6	--	--	--	26.8	98.2	1, 259.09
P- 77	Mudstone -----	6695- TMC	1.0	6.3	--	--	--	64.2	99.2	1, 265.39
P- 76	Phosphate rock -----	6694- TMC	.7	22.3	--	--	--	18.5	99.9	1, 281.00
P- 75	Mudstone, phosphatic, calcareous -----	6693- TMC	.7	11.3	--	--	--	45.6	100.6	1, 288.91
P- 74	Phosphate rock, argillaceous -----	6692- TMC	.5	15.9	--	--	--	38.2	101.1	1, 296.86
P- 73	Mudstone, phosphatic -----	6691- TMC	.6	9.4	--	--	--	52.5	101.7	1, 302.50
P- 72	Phosphate rock, argillaceous; phosphatic mudstone, and mudstone -----	6690- TMC	1.1	12.9	--	--	--	38.4	102.8	1, 316.69
P- 71	Phosphate rock, argillaceous and mudstone -----	6689- TMC	.7	16.3	--	--	--	33.2	103.5	1, 328.10
P- 70	Mudstone, calcareous, phosphatic -----	6688- TMC	.8	9.5	--	--	--	42.1	104.3	1, 335.70
P- 69	Mudstone, phosphatic, mudstone and argillaceous phosphate rock -----	6687- TMC	.5	16.8	--	--	--	55.9	104.8	1, 344.10
P- 68	Mudstone, phosphatic -----	6686- TMC	.8	14.7	--	--	--	39.1	105.6	1, 355.86
P- 67	Mudstone, phosphatic -----	6685- TMC	2.2	11.6	--	--	--	45.7	107.8	1, 381.38
P- 66	Mudstone -----	6684- TMC	2.0	2.6	--	--	--	71.7	109.8	1, 386.58
P- 65	Mudstone -----	6683- TMC	3.1	.5	--	--	--	92.5	112.9	1, 388.13
P- 64	Mudstone, cherty -----	6682- TMC	1.2	.3	--	--	--	88.5	114.1	1, 388.49
P- 63	Mudstone -----	6681- TMC	1.6	2.4	--	--	--	74.6	115.7	1, 392.33
P- 62	Mudstone -----	6680- TMC	2.2	3.9	--	--	--	69.3	117.9	1, 400.91
P- 61	Mudstone -----	6679- TMC	4.5	4.4	--	--	--	70.9	122.4	1, 420.71
P- 60	Mudstone -----	6678- TMC	2.0	2.2	--	--	--	71.8	124.4	1, 425.11
P- 59	Mudstone, phosphatic -----	6677- TMC	1.9	12.4	--	--	--	48.9	126.3	1, 448.67
P- 58	Phosphate rock, argillaceous -----	6676- TMC	.7	18.7	--	--	--	35.6	127.0	1, 461.76

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		
P-57	Mudstone, phosphatic	6675-TMC	1.7	9.4	--	--	--	59.1	128.7	1,477.74
P-56	Phosphate rock, argillaceous	6674-TMC	.8	20.2	--	--	--	30.1	129.5	1,493.90
P-55	Phosphate rock, argillaceous	6673-TMC	1.0	20.8	--	--	--	27.7	130.5	1,514.70
P-54	Phosphate rock, argillaceous, calcareous	6672-TMC	.5	17.7	--	--	--	29.3	131.0	1,523.55
P-53	Phosphate rock, argillaceous and calcareous mudstone	6671-TMC	.5	17.1	--	--	--	33.4	131.5	1,532.10
P-52	Phosphate rock, argillaceous and phosphatic mudstone; fos. col. no. 12589	6670-TMC	1.1	17.5	--	--	--	37.1	132.6	1,551.35
P-51	Mudstone	6669-TMC	.7	7.6	--	--	--	65.8	133.3	1,556.67
P-50	Mudstone, phosphatic	6668-TMC	.9	13.6	--	--	--	45.9	134.2	1,568.91
P-49	Mudstone, phosphatic	6667-TMC	1.2	14.4	--	--	--	42.5	135.4	1,586.19
P-48	Mudstone, phosphatic and mudstone	6666-TMC	.9	19.2	--	--	--	30.5	136.3	1,603.47
P-47	Phosphate rock, argillaceous	6665-TMC	.5	19.1	--	--	--	29.7	136.8	1,613.02
P-46	Phosphate rock, argillaceous	6664-TMC	1.0	16.7	--	--	--	34.5	137.8	1,629.72
P-45	Mudstone, phosphatic	6663-TMC	2.6	12.4	--	--	--	46.6	140.4	1,661.96
P-44	Mudstone, phosphatic	6662-TMC	.9	13.1	--	--	--	47.3	141.3	1,673.75
P-43	Phosphate rock, argillaceous	6661-TMC	.7	21.9	6.08	2.02	11.78	25.4	142.0	1,689.08
P-42	Phosphate rock, argillaceous	6660-TMC	1.1	19.1	6.92	1.30	11.25	32.2	143.1	1,710.09
P-41	Phosphate rock, calcareous	6659-TMC	.6	23.4	4.48	1.73	14.82	18.7	143.7	1,724.13
P-40	Phosphate rock	6658-TMC	.5	25.2	3.80	1.20	12.80	14.1	144.2	1,736.73
P-39	Phosphate rock	6657-TMC	1.3	25.0	4.20	1.58	12.57	16.7	145.5	1,769.23
P-38	Phosphate rock, argillaceous	6656-TMC	.8	24.6	4.08	1.62	9.36	21.1	146.3	1,788.91
P-37	Phosphate rock	6655-TMC	1.1	31.2	1.65	.90	10.55	6.9	147.4	1,823.23
P-36	Phosphate rock	6654-TMC	.7	25.5	3.72	1.64	9.59	18.9	148.1	1,841.08
P-35	Mudstone, calcareous	6653-TMC	.4	3.5	7.70	4.34	25.43	47.1	148.5	1,842.48
P-34	Phosphate rock	6652-TMC	.7	23.7	3.22	1.77	13.74	18.1	149.2	1,859.07
P-33	Phosphate rock	6651-TMC	.6	26.4	2.54	1.43	12.20	11.4	149.8	1,874.91
P-32	Phosphate rock, argillaceous and mudstone	6650-TMC	.6	21.8	4.04	1.65	11.56	25.3	150.4	1,887.99
P-31	Phosphate rock	6649-TMC	.6	24.8	3.33	1.28	10.14	20.1	151.0	1,902.87
P-30	Mudstone, phosphatic	6648-JAP	2.0	12.7	7.20	2.35	8.98	52.9	153.0	1,928.27
P-29	Mudstone, phosphatic	6647-JAP	3.0	11.2	8.94	2.84	7.89	53.5	156.0	1,961.87
P-28	Mudstone	6646-JAP	2.5	7.6	9.22	3.38	6.74	64.8	158.5	1,980.87
P-27	Phosphate rock, argillaceous	6645-JAP	1.2	21.5	3.62	1.28	5.89	29.5	159.7	2,006.67
P-26	Phosphate rock	6644-JAP	1.0	29.6	2.14	.78	6.89	15.2	160.7	2,036.27
P-25	Phosphate rock	6643-JAP	2.9	27.1	2.76	.84	8.39	18.1	163.6	2,114.86
P-24	Phosphate rock, argillaceous	6642-JAP	1.8	23.2	4.36	1.45	6.86	28.4	165.4	2,156.62
P-23	Mudstone, phosphatic	6641-JAP	1.9	12.6	7.76	2.12	6.85	52.9	167.3	2,180.56
P-22	Phosphate rock; fos. col. no. 12558	6640-JAP	3.5	27.3	2.60	.95	7.22	19.3	170.8	2,276.11

P-21	Phosphate rock -----	6639- JAP	.6	28.8	2.22	.59	7.95	15.9	171.4	2,293.39
P-20	Phosphate rock -----	6638- JAP	.8	29.5	2.04	.60	7.80	14.2	172.2	2,316.99
P-19	Phosphate rock -----	6637- JAP	2.2	28.1	2.52	.74	7.05	17.1	174.4	2,378.81
P-18	Phosphate rock, argillaceous -----	6636- JAP	2.1	21.7	4.86	1.30	7.77	30.1	176.5	2,424.38
P-17	Phosphate rock -----	6635- JAP	.6	30.6	3.10	.93	6.37	15.7	177.1	2,442.74
P-16	Mudstone, phosphatic -----	6634- JAP	.7	11.5	8.34	1.88	7.43	50.3	177.8	2,450.79
P-15	Phosphate rock, argillaceous; fos. col. no. 12587 -----	6633- JAP	2.7	23.3	.92	1.20	5.97	27.9	180.5	2,513.70
P-14	Phosphate rock, argillaceous and phosphatic mudstone -----	6632- JAP	1.4	17.7	5.72	2.22	5.94	39.4	181.9	2,538.48
P-13	Phosphate rock -----	6631- JAP	.9	32.6	1.70	.53	6.56	6.7	182.8	2,567.82
P-12	Phosphate rock -----	6630- JAP	.9	33.7	1.00	.33	7.04	3.3	183.7	2,598.15
P-11	Phosphate rock -----	6629- JAP	1.5	33.4	1.03	.37	7.42	3.5	185.2	2,648.25
P-10	Phosphate rock -----	6628- JAP	1.5	34.9	.46	.50	6.34	2.3	186.7	2,700.60
P-9	Phosphate rock -----	6627- JAP	2.2	32.3	1.19	.69	5.89	6.0	188.9	2,771.66
P-8	Limestone, argillaceous -----	6626- JAP	2.6	1.0	--	--	--	38.0	191.5	2,774.26
P-7	Limestone, argillaceous -----	6625- JAP	2.0	.4	--	--	--	34.1	193.5	2,775.06
P-6	Limestone, argillaceous -----	6624- JAP	2.0	.9	--	--	--	45.7	195.5	2,776.86
P-5	Phosphate rock -----	6623- JAP	.5	33.8	--	--	--	6.5	196.0	2,793.76
P-4	Limestone -----	6622- JAP	.9	1.2	--	--	--	2.8	196.9	2,794.84
P-3	Phosphate rock, calcareous; fos. col. no. 12585 -----	6621- JAP	.7	29.4	--	--	--	4.1	197.6	2,815.42
P-2	Dolomite, argillaceous; fos. col. no. 12584- no. 12585 -----	6620- JAP	1.2	.7	--	--	--	27.8	198.8	2,816.26
P-1	Phosphate rock, fos. col. no. 12583 -----	6619- JAP	.7	32.3	--	--	--	6.2	199.5	2,838.87

Wells formation—not measured

Cw-1	Dolomite, siliceous -----	--	--	--	--	--	--	--	--	--
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\*\* Note incompleteness of cumulative data.

Phosphatic shale member of Phosphoria formation measured and sampled near Mud Spring, sec. 7, T. 12 S., R. 29 E., Cassia County, Idaho. Beds strike N. 75° W. and dip 30° S. Section measured and sampled by T. M. Cheney, R. A. Smart, R. G. Waring, and M. A. Warner in July 1951. Samples analyzed by Trace Elements Section laboratory, U. S. Geological Survey, Denver, Colo.

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)			Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative) <sup>5</sup>
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			
Rex chert member of Phosphoria formation—lower part only								
R-13	Mudstone; fos. col. no. 12642 <sup>1</sup> made 3.5 feet higher -----	--	1.4	--	--	1.4	--	
R-12	Mudstone -----	--	2.1	--	--	4.1	--	
R-11	Mudstone -----	--	7.3	--	--	11.4	--	
R-10	Mudstone -----	--	5.6	--	--	17.0	--	
R-9	Mudstone -----	--	3.0	--	--	20.0	--	
R-8	Mudstone -----	--	3.5	--	--	23.5	--	
R-7	Mudstone -----	--	5.6	--	--	29.1	--	
R-6	Mudstone -----	--	5.0	--	--	34.1	--	
R-5	Mudstone -----	--	4.6	--	--	38.7	--	
R-4	Mudstone -----	--	3.6	--	--	42.3	--	
R-3	Mudstone -----	--	3.8	--	--	46.1	--	
R-2	Mudstone -----	--	2.9	--	--	49.0	--	
R-1	Mudstone -----	--	3.8	--	--	52.8	--	
Phosphatic shale member of Phosphoria formation								
P-47	Mudstone, phosphatic -----	6454-RGW	1.4	10.2	52.6	1.4	14.28	
P-46	Mudstone -----	6453-RGW	.9	6.95	62.8	2.3	20.54	
P-45	Mudstone -----	6452-RGW	2.0	3.10	75.1	4.3	26.74	
P-44	Mudstone -----	6451-RGW	2.0	2.65	79.1	6.3	32.04	
P-43	Mudstone -----	6450-RGW	2.0	4.50	73.2	8.3	41.04	
P-42	Mudstone and argillaceous phosphate rock -----	6449-RGW	1.0	10.8	59.2	9.3	51.84	
P-41	Mudstone, phosphatic -----	6448-RGW	1.0	11.6	57.4	10.3	63.44	
Beds P-41 through P-45 highly crumpled, slumped, and weathered. Thicknesses are only approximate.								
P-40	Mudstone -----	6447-RGW	5.2	4.85	71.8	15.5	88.66	
P-39	Mudstone, phosphatic -----	6446-RGW	2.3	9.50	58.7	17.8	110.51	
P-38	Mudstone, phosphatic -----	6445-RGW	2.4	10.4	57.2	20.2	135.46	
P-37	Mudstone, phosphatic; fos. col. no. 12641 ---	6444-RGW	1.4	9.65	58.7	21.6	148.98	

P-36	Mudstone, cherty, phosphatic -----	6443-RGW	1.9	9.05	62.1	23.5	166.17
P-35	Mudstone -----	6442-TMC	2.2	7.50	69.0	25.7	182.67
P-34	Mudstone and chert; fos. col. no. 12639 -----	6441-TMC	.6	7.20	66.1	26.3	186.99
P-33	Mudstone -----	6440-TMC	2.0	5.70	70.0	28.3	198.39
P-32	Phosphate rock, argillaceous; fos. col. no. 12640 -----	6439-TMC	.9	21.8	33.0	29.2	218.01
P-31	Phosphate rock -----	6438-TMC	2.0	28.4	17.6	31.2	274.81
P-30	Phosphate rock, argillaceous -----	6437-TMC	1.4	23.3	32.5	32.6	307.43
P-29	Mudstone, phosphatic and argillaceous phosphate rock -----	6436-TMC	1.0	19.2	42.2	33.6	326.63
P-28	Mudstone, phosphatic -----	6435-TMC	2.2	10.4	64.4	35.8	349.51
P-27	Phosphate rock, argillaceous -----	6434-RAS	2.0	19.5	40.4	37.8	388.51
P-26	Mudstone, phosphatic -----	6433-RAS	.7	16.4	46.2	38.5	399.99
P-25	Mudstone, phosphatic -----	6432-RAS	1.0	9.35	66.8	39.5	409.34
P-24	Mudstone, phosphatic -----	6431-RAS	1.1	10.0	64.1	40.6	420.34
P-23	Mudstone -----	6430-RAS	.8	7.75	71.6	41.4	426.54
P-22	Mudstone -----	6429-RAS	3.2	2.20	86.7	44.6	433.58
P-21	Mudstone -----	6428-RAS	2.5	4.90	78.1	47.1	445.83
P-20	Mudstone -----	6427-RAS	1.4	2.20	86.1	48.5	448.91
P-19	Mudstone -----	6426-RAS	1.0	6.50	71.1	49.5	455.41
P-18	Mudstone -----	6425-MAW	2.2	.75	84.8	51.7	457.06
Beds P-18 and P-19 highly weathered.							
P-17	Mudstone, phosphatic -----	6424-MAW	3.5	9.15	61.9	55.2	489.08
P-16	Mudstone -----	6423-MAW	4.0	6.75	70.5	59.2	516.08
P-15	Mudstone -----	6422-MAW	4.0	1.80	88.7	63.2	523.28
P-14	Mudstone -----	6421-MAW	3.9	.95	92.0	67.1	526.99
P-13	Phosphate rock -----	6420-MAW	1.0	32.3	15.9	68.1	559.29
P-12	Phosphate rock, argillaceous -----	6419-MAW	1.5	26.0	26.6	69.6	598.29
P-11	Mudstone, phosphatic -----	6418-RAS	5.2	9.40	63.9	74.8	647.17
P-10	Phosphate rock, argillaceous -----	6417-RAS	1.1	19.9	38.3	75.9	669.06
P-9	Phosphate rock, argillaceous -----	6416-RAS	.9	30.1	15.7	76.8	696.15
P-8	Phosphate rock, argillaceous -----	6415-RAS	.6	21.5	33.8	77.4	709.05
P-7	Phosphate rock -----	6414-RAS	.9	28.2	18.9	78.3	734.43
P-6	Phosphate rock, argillaceous -----	6413-RAS	.6	27.1	23.4	78.9	750.69
P-5	Mudstone, phosphatic -----	6412-RAS	.8	11.9	57.0	79.7	760.21
P-4	Mudstone; fos. col. no. 12638 -----	6411-RAS	1.0	.90	93.6	80.7	761.11
P-3	Phosphate rock, argillaceous; fos. col. no. 12638 -----	6410-RAS	.7	19.7	42.8	81.4	774.90
P-2	Mudstone, phosphatic -----	6409-RAS	1.3	12.8	55.6	82.7	791.54
P-1	Mudstone and phosphate rock; fos. col. no. 12637 -----	6408-RAS	.9	28.0	24.9	83.6	816.74

Mud Spring—Continued

Bed no.	Rock description	Sample no.	Thickness (feet)	Chemical analyses (percent)		Cumulative thickness (feet)	Thickness x percent P <sub>2</sub> O <sub>5</sub> (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble		
Wells formation							
	Formation present but not measured; fos. col. no. 12636 taken 37 feet below bed P-1; fos. col. no. 12635 taken 83 feet below bed P-1.	--	--	--	--	--	--