

\* (200)  
T67K  
no-362

~~RESTRICTED~~  
~~SECURITY INFORMATION~~

~~OFFICIAL USE ONLY~~

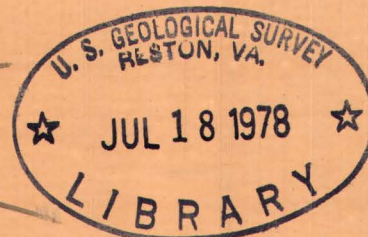
Declassified 3/10/69

# Stratigraphic Sections of the Phosphoria Formation in Montana, 1949-1950, Part II

*1914 -*  
By R. W. Swanson, E. R. Cressman, R. S. Jones, and B. K. Replogle

*362*

~~This material contains information affecting  
the national defense of the United States  
within the meaning of the espionage laws,  
Title 18, U.S.C., Secs. 793 and 794. The  
transmission or revelation of which in any  
manner to an unauthorized person is pro-  
hibited by law.~~



*Trace Elements Investigations Report 362*

UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

~~OFFICIAL USE ONLY~~

~~RESTRICTED~~  
~~SECURITY INFORMATION~~

\*(200)  
T 67 R  
no. 362

~~OFFICIAL USE ONLY~~  
~~RESTRICTED~~  
~~SECURITY INFORMATION~~

Geology and Mineralogy

This document consists of 26  
pages.  
Series A.

UNITED STATES DEPARTMENT OF THE INTERIOR

✓ U.S. GEOLOGICAL SURVEY

STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION

IN MONTANA, 1949-1950, PART II\*

Classification changed to OFFICIAL USE ONLY  
by authority of P. L. Merrit

By

by *Bernice Phillips* 4/1/54  
(Signature of person making change, and date thereof)

R. W. Swanson, E. R. Cressman,  
R. S. Jones, and B. K. Replogle

July 1953

Trace Elements Investigations Report 362

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

~~This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.~~

\*This report concerns work done partly on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

OFFICIAL USE ONLY

~~RESTRICTED~~

~~SECURITY INFORMATION~~



USGS - TEI - 362

GEOLOGY AND MINERALOGY

Distribution (Series A)

No. of copies

American Cyanamid Company, Winchester . . . . .	1
Argonne National Laboratory . . . . .	1
Atomic Energy Commission, Washington . . . . .	1
Battelle Memorial Institute, Columbus . . . . .	1
Carbide and Carbon Chemicals Company, Y-12 Area . . . . .	1
Division of Raw Materials, Butte . . . . .	1
Division of Raw Materials, Denver . . . . .	1
Division of Raw Materials, Grants . . . . .	1
Division of Raw Materials, Hot Springs . . . . .	1
Division of Raw Materials, New York . . . . .	6
Division of Raw Materials, Richfield . . . . .	1
Division of Raw Materials, Salt Lake City . . . . .	1
Division of Raw Materials, Washington . . . . .	3
Dow Chemical Company, Pittsburg . . . . .	1
Exploration Division, Grand Junction Operations Office . . . . .	1
Grand Junction Operations Office . . . . .	1
Technical Information Service, Oak Ridge . . . . .	6
Tennessee Valley Authority, Wilson Dam . . . . .	1

U. S. Geological Survey:

Alaskan Geology Branch, Washington . . . . .	1
Fuels Branch, Washington . . . . .	1
Geochemistry and Petrology Branch, Washington . . . . .	1
Geophysics Branch, Washington . . . . .	1
Mineral Deposits Branch, Washington . . . . .	2
E. H. Bailey, San Francisco . . . . .	1
K. L. Buck, Denver . . . . .	2
N. M. Denson, Denver . . . . .	1
C. E. Dutton, Madison . . . . .	1
R. P. Fischer, Grand Junction . . . . .	1
M. R. Klepper, Washington . . . . .	1
A. H. Koschmann, Denver . . . . .	1
R. A. Laurence, Knoxville . . . . .	1
D. M. Lemmon, Washington . . . . .	1
R. G. Petersen, Plant City . . . . .	1
R. J. Roberts, Salt Lake City . . . . .	1
R. W. Swanson, Spokane . . . . .	2
A. E. Weissenborn, Spokane . . . . .	2
TEPCO, Denver . . . . .	2
TEPCO, RPS, Washington . . . . .	2

(Including master)

56

CONTENTS

	Lot no.	Page
Introduction . . . . .		4
Acknowledgments . . . . .		6
Stratigraphy of the Phosphoria formation in Montana . . . . .		7
Stratigraphic sections . . . . .		9
Literature cited . . . . .		9
Tables of stratigraphic sections . . . . .		
Moonlight Adit, Mont. . . . .	1340	10
Anaconda Quarry, Mont. . . . .	1337	12
Canyon Camp, Mont. . . . .	1311	13
Warm Springs Creek, Mont. . . . .	1300	16
Lazyman Hill, Mont. . . . .	1319	18
Alpine Creek, Mont. . . . .	1307	21
Sliderock Mountain, Mont. . . . .	1301	23
Taylor Creek, Idaho . . . . .	1342	26

ILLUSTRATIONS

Figure 1. Outcrops of the Phosphoria formation in Montana and localities sampled . . . . .	5
2. Generalized section of the Phosphoria formation at Sheep Creek, Montana, lot no. 1234 . . . . .	8



STRATIGRAPHIC SECTIONS OF THE PHOSPHORIA FORMATION IN MONTANA,  
1949-1950, PART II

By R. W. Swanson, E. R. Cressman, R. S. Jones, and B. K. Replogle

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 many of the sections in southwestern Montana (fig. 1), is one of this series and is the fourth Montana report; it includes the second half of the data gathered in Montana during 1949 and 1950. The field and laboratory procedures adopted in these investigations are described rather fully in a previous report (McKelvey and others, 1953).

Many people have taken part in this investigation. The program of which this work is a part was organized by V. E. McKelvey. J. L. Elliott, W. J. Garmoe, R. F. Gosman, C. W. Tandy, and W. H. Wilson participated in the description of strata and the collection of samples referred to in this report. Crushing and splitting of the 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.





6  
OFFICIAL USE ONLY

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 direction of J. C. Rabbitt by chemists H. Alberty, I. Barlow, T. Farley, C. Hoy, and M. Landers. The radioactivity analyses were made in this laboratory by F. J. Flanagan and J. J. Warr, Jr., and in the Trace Elements Section laboratory in Denver, Colo., by J. N. Rosholt, under the direction of L. F. Rader. The chemical uranium analyses were made in the Washington laboratory by A. B. Caemmerer and A. L. White and in the Denver laboratory by G. T. Burrow and W. Mountjoy.

Compilation of the data has been by K. S. Bergman. Organization of the tabular data has been largely by Anita Wise.

## Acknowledgments

Special thanks are due A. E. Weissenborn and M. R. Klepper, who gave much advice and help in carrying out the field program. The cost of the field and laboratory investigations has been borne partly by the Missouri River Basin Division of the Bureau of Reclamation and the Division of Raw Materials of the Atomic Energy Commission. Their support is gratefully acknowledged.

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

The Phosphoria formation in southwestern Montana consists in general of five members, two phosphatic shale members and three hard members (fig. 2). The lower two hard members are dominated by limestone and the top hard 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 feet to more than 800 feet.

The lowermost or A member is best developed toward the west and southwest and consists of limestone or dolomite, sandstone, mudstone, and chert with a maximum thickness of nearly 350 feet. It 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).

The lower phosphatic shale or B member is about 50 feet thick near the southwest corner of the state but thins markedly to the north and east where in some areas it cannot be recognized.

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



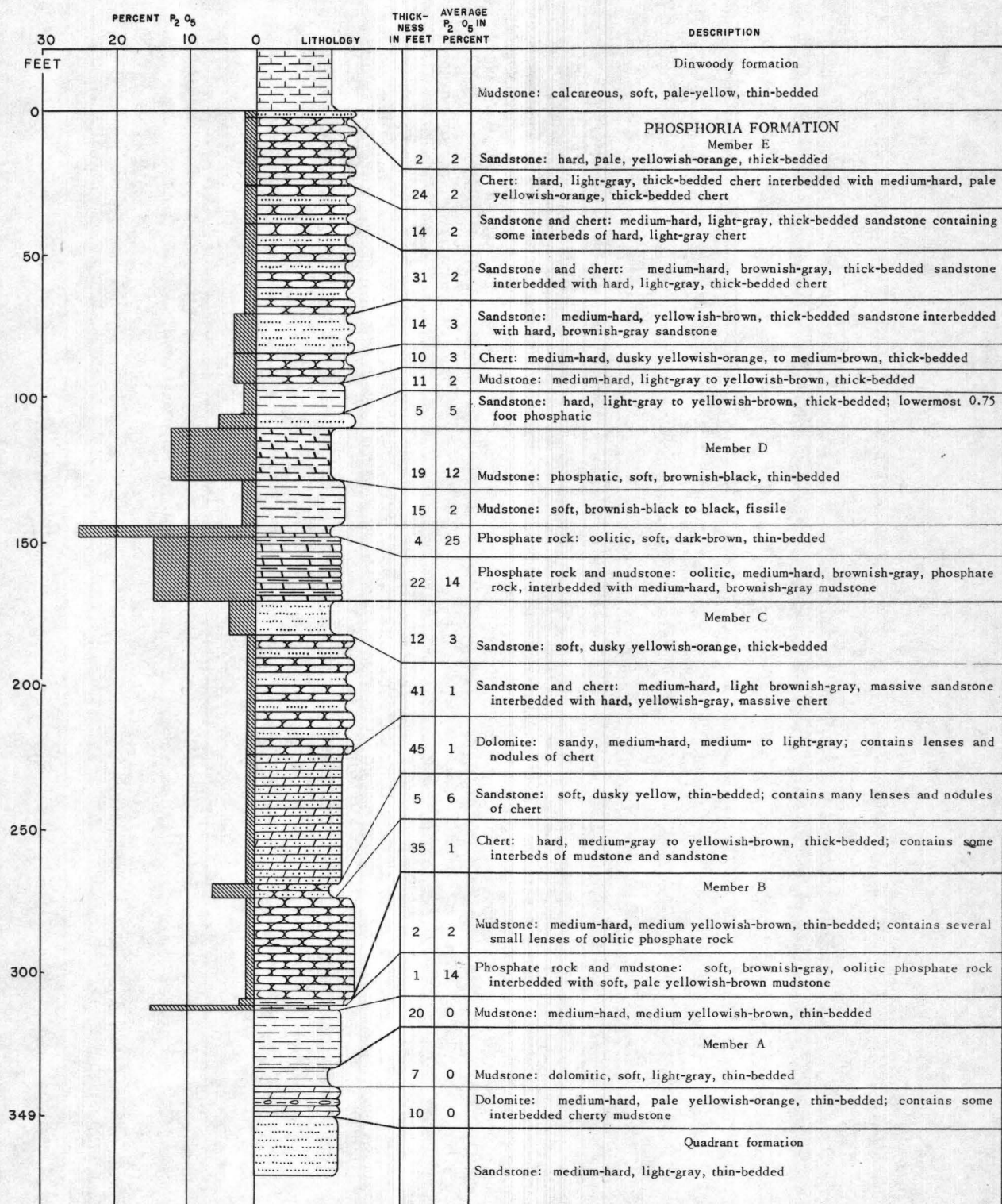


Figure 2. -- Generalized section of Phosphoria formation at Sheep Creek, Montana (lot no. 1234)

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

### STRATIGRAPHIC SECTIONS

Analytical data and abstracts of stratigraphic sections measured at eight localities follow. Their locations as well as the locations of other sections previously reported (Swanson and others, 1953, Klepper and others, 1953, and Cressman and others, 1953) and sections to be reported later are shown in figure 1.

### LITERATURE CITED

- Clabaugh, P. S., 1946, Permian phosphate deposits on Montana, Idaho, Wyoming and Utah: U. S. Geol. Survey, Strategic Minerals Inv. Prelim. Map 3-198.
- Cressman, E. R., Wilson, W. H., Tandy, C. W., and Garmoe, W. J., 1953, Stratigraphic sections of the Phosphoria formation in Montana, 1949-50, part I: U. S. Geol. Survey Circ. 302.
- Klepper, M. R., Honkala, F. S., Payne, O. A., and Ruppel, E. T., 1953, Stratigraphic sections of the Phosphoria formation in Montana, 1948: U. S. Geol. Survey Circ. 260.
- McKelvey, V. E., 1949, Geological studies of the western phosphate field: Am. Inst. Min. Met. Eng. Mining Trans., v. 184, p. 270-279.
- McKelvey, V. E., Davidson, D. F., O'Malley, F. W., and Smith, L. E., 1953, Stratigraphic sections of the Phosphoria formation in Idaho, 1947-48, part I: U. S. Geol. Survey Circ. 208.
- Swanson, R. W., Lowell, W. R., Cressman, E. R., and Bostwick, D. A., 1953, Stratigraphic sections of the Phosphoria formation in Montana, 1947-48: U. S. Geol. Survey Circ. 209.



Moonlight Adit, Mont., lot. 1340

D member of Phosphoria formation sampled in Moonlight adit of Sunlight Mining Company, NW $\frac{1}{4}$  sec. 29, T. 8 N., R. 12 W., Granite County, Mont. Samples 5903-5907 cut from top of stope above main drift of adit, samples 5908-5914 cut from south end of drift on phosphatic shale member, and samples 5915-5916 cut from same drift at junction with crosscut. Beds strike N. 30° W. and dip 40° NE. 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, Washington, D. C.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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)	Uranium content (percent)		Thickness x percent eU (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			eU <sup>1</sup>	Chem. U	
E member of Phosphoria formation—basal bed only													
E- 1	Chert-----	--	0.5	--	--	--	--	--	0.5	--	--	--	--
D member of Phosphoria formation													
D-13	Phosphate rock-----	5907-RWS	1.9	35.4	0.78	1.69	1.17	7.7	1.9	67.26	0.005	0.006	0.011
D-12	Phosphate rock and mudstone-----	5906-RWS	.5	22.3	5.66	5.16	2.68	28.5	2.4	78.41	.003	.004	.013
D-11	Phosphate rock-----	5905-RWS	.7	37.0	1.29	1.25	1.22	3.8	3.1	104.31	.003	.004	.016
D-10	Phosphate rock and mudstone-----	5904-RWS	.4	26.7	4.86	5.01	2.85	18.2	3.5	114.99	.003	.003	.017
D- 9	Phosphate rock-----	5908-RWS	1.4	33.6	2.47	1.35	1.67	9.8	4.9	162.03	.004	.005	.024
D- 8	Phosphate rock and mudstone-----	5909-RWS	.3	26.2	5.54	2.25	3.56	21.8	5.2	169.89	.004	.004	.026
--	Phosphate rock-----	5903-RWS	(1.1)	32.8	3.11	2.27	2.29	10.4	--	--	.005	.004	--
	Sample 5903-RWS represents same beds as samples 5908-RWS and 5909-RWS.												
D- 7	Mudstone, phosphatic-----	5910-RWS	1.3	13.0	9.52	4.06	4.51	49.4	6.5	186.79	.005	.005	.032
D- 6	Mudstone, phosphatic-----	5911-RWS	.3	8.4	10.3	5.59	5.11	57.3	6.8	189.31	.004	.004	.033
D- 5	Mudstone-----	5912-RWS	1.6	6.4	10.6	4.03	3.52	66.2	8.4	199.55	.004	.003	.038
D- 4	Mudstone-----	5913-RWS	.4	1.4	11.4	5.83	4.47	79.7	8.8	200.11	.004	.002	.039
D- 3	Phosphate rock, argillaceous-----	5914-RWS	1.0	21.4	7.10	4.39	3.95	29.7	9.8	221.51	.005	.007	.046
D- 2	Phosphate rock-----	5915-RWS	.8	34.2	2.39	1.38	1.97	7.7	10.6	248.87	.003	.004	.049
D- 1	Phosphate rock-----	5916-RWS	.6	31.0	2.63	1.58	2.19	13.0	11.2	267.47	.005	.005	.052
C member of Phosphoria formation—upper part only													
C- 2	Chert and quartzite-----	--	1.3	--	--	--	--	--	1.3	--	--	--	--
C- 1	Breccia, phosphatic sandstone, and limestone-----	--	2.0	--	--	--	--	--	3.3	--	--	--	--
Lower part of Phosphoria formation measured in outcrop and hand trenches on north side of Little Gold Creek, SW $\frac{1}{4}$ sec. 29, T. 8 N., R. 12 W., Granite County, Mont. This locality is nearly 1 mile SE of Moonlight adit portal. Beds strike N. 40° W. and dip 25° NE. Strata are metamorphosed and D member is sheared and not well enough exposed to sample.													
E member of Phosphoria formation—basal part only													
E- 2	Quartzite-----	--	3.0	--	--	--	--	--	3.0	--	--	--	--
E- 1	Limestone, sandy-----	--	1.0	--	--	--	--	--	4.0	--	--	--	--

<sup>1</sup> Equivalent uranium.

## Moonlight Adit—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)	Uranium content (percent)		Thickness x percent eU (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			eU	Chem. U	
D member of Phosphoria formation													
D- 2	Phosphatic mudstone and phosphate rock --	--	5.3	--	--	--	--	--	5.3	--	--	--	--
D- 1	Phosphate rock and mudstone -----	--	1.7	--	--	--	--	--	7.0	--	--	--	--
	Bed D-1 probably equivalent to beds D-1 and D-2 of Moonlight adit.												
C member of Phosphoria formation													
C-20	Sandstone, quartzitic -----	--	2.4	--	--	--	--	--	2.4	--	--	--	--
C-19	Limestone, cherty, recrystallized -----	--	13.0	--	--	--	--	--	15.4	--	--	--	--
C-18	Limestone, cherty-----	--	4.0	--	--	--	--	--	19.4	--	--	--	--
C-17	Covered -----	--	1.2	--	--	--	--	--	20.6	--	--	--	--
C-16	Limestone, recrystallized, contains sulfides -----	--	1.9	--	--	--	--	--	22.5	--	--	--	--
C-15	Marble -----	--	5.3	--	--	--	--	--	27.8	--	--	--	--
C-14	Covered -----	--	2.5	--	--	--	--	--	30.3	--	--	--	--
C-13	Marble, cherty-----	--	5.3	--	--	--	--	--	35.6	--	--	--	--
C-12	Marble and chert-----	--	9.1	--	--	--	--	--	44.7	--	--	--	--
C-11	Marble, cherty-----	--	3.0	--	--	--	--	--	47.7	--	--	--	--
C-10	Quartzite -----	--	1.8	--	--	--	--	--	49.5	--	--	--	--
C- 9	Marble, cherty -----	--	2.0	--	--	--	--	--	51.5	--	--	--	--
C- 8	Marble, cherty -----	--	9.8	--	--	--	--	--	61.3	--	--	--	--
C- 7	Marble, cherty -----	--	1.3	--	--	--	--	--	62.6	--	--	--	--
C- 6	Quartzite -----	--	3.7	--	--	--	--	--	66.3	--	--	--	--
C- 5	Marble -----	--	5.3	--	--	--	--	--	71.6	--	--	--	--
C- 4	Quartzite -----	--	.2	--	--	--	--	--	71.8	--	--	--	--
C- 3	Marble -----	--	1.0	--	--	--	--	--	72.8	--	--	--	--
C- 2	Marble -----	--	3.8	--	--	--	--	--	76.6	--	--	--	--
C- 1	Sandstone, conglomerate, and silt-----	--	.7	--	--	--	--	--	77.3	--	--	--	--
	Possibly glacial debris forced between beds at Quadrant-Phosphoria contact.												
Quadrant formation—top bed only													
Cq-1	Quartzite -----	--	5.	--	--	--	--	--	5.	--	--	--	--



Anaconda Quarry, Mont., lot 1337

Part of Phosphoria formation measured and sampled in outcrop and hand trench in bluff about  $\frac{1}{4}$  mile east of limestone quarry of Anaconda Copper Mining Company, north side of Warm Spring Creek, sec. 23, T. 5 N., R. 12 W., Deerlodge County, Mont. Beds in lower half of D member much sheared and graphitic, correlations uncertain. Beds strike N. 75° E. and dip 25° N. Section measured by R. W. Swanson and sampled by R. A. Zeller in August 1950. Samples analyzed for  $P_2O_5$  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.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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)	Uranium content (percent)		Thickness x percent chem. U (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			eU	Chem. U	
E member of Phosphoria formation—top not exposed													
E- 3	Quartzite -----	--	3.8	--	--	--	--	--	3.8	--	--	--	--
E- 2	Quartzite -----	--	28.7	--	--	--	--	--	32.5	--	--	--	--
E- 1	Quartzite -----	--	7.7	--	--	--	--	--	40.2	--	--	--	--
D member of Phosphoria formation													
D-12	Quartzite, phosphatic -----	5902-RWS	0.8	18.9	1.48	1.41	0.94	4.8	0.8	15.12	0.007	0.006	0.005
D-11	Phosphate rock -----	5901-RWS	.9	29.0	1.87	2.23	2.55	6.3	1.7	41.22	.011	.013	.016
D-10	Phosphate rock -----	5900-RWS	.9	26.6	4.68	1.02	6.79	20.1	2.6	65.16	.011	.008	.024
D- 9	Phosphate rock -----	5899-RWS	.6	32.8	1.28	.68	4.96	10.5	3.2	84.84	.008	.009	.029
D- 8	Phosphate rock -----	5896-RWS	1.8	30.2	3.25	1.25	7.79	11.1	5.0	139.20	.010	.013	.052
D- 7	Mudstone, phosphatic -----	5898-RWS	.9	11.8	9.12	1.23	12.66	45.7	5.9	149.82	.007	.005	.057
--	Phosphate rock, argillaceous (appears to be same bed as D-7) -----	5895-RWS	(.5)	19.2	7.30	2.80	16.52	24.7	--	--	.011	.013	--
D- 6	Mudstone and phosphate rock -----	5897-RWS	.4	14.0	9.96	7.93	13.68	30.1	6.3	155.42	.007	.007	.060
D- 5	Phosphate rock -----	5894-RWS	1.2	30.6	3.60	1.45	10.72	10.8	7.5	192.14	.011	.016	.079
D- 4	Phosphate rock, argillaceous -----	5893-RWS	1.2	19.3	7.92	3.35	16.36	25.6	8.7	215.30	.009	.008	.089
D- 3	Mudstone, phosphatic -----	5892-RWS	1.0	10.0	10.9	4.54	20.08	44.1	9.7	225.30	.008	.005	.094
D- 2	Mudstone -----	5891-RWS	.6	3.9	14.8	7.52	20.54	46.7	10.3	227.64	.004	.006	.097
D- 1	Mudstone, phosphatic -----	5890-RWS	.6	7.2	11.6	12.1	25.16	39.1	10.9	231.96	.004	.004	.100
C member of Phosphoria formation—top bed only													
C- 1	Quartzite -----	--	2.	--	--	--	--	--	2.	--	--	--	--

Canyon Camp, Mont., lot 1311

Phosphoria formation measured and B and D members sampled at Canyon Camp, Ruby River Canyon, NE $\frac{1}{4}$  sec. 18, T. 9 S., R. 3 W., Madison County, Mont., on overturned west limb of Ruby Valley syncline. Beds strike N. 10° W. and dip 50° W. Beds A-1 through C-8 are from natural exposures on north side of canyon 300 feet above river; rest of section from south side of canyon, beds C-10 through C-25 and E-7 through E-23 from natural exposures and beds D-1 through E-6 from prospect trench. Section measured by C. W. Tandy, R. S. Jones, E. R. Cressman, R. F. Gosman, and W. J. Garmoe and sampled by Gosman and Garmoe in August 1949. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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>	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Dinwoody formation—basal bed only										
Td-1	Carbonate rock, argillaceous-----	--	1.8	--	--	1.8	--	--	--	--
E member of Phosphoria formation										
E-23	Covered; Phosphoria-Dinwoody contact arbitrarily placed at top of covered interval.-	--	15.0	--	--	15.0	--	--	--	--
E-22	Mudstone, cherty -----	--	12.3	--	--	27.3	--	--	--	--
E-21	Sandstone, cherty, and dolomitic mudstone -	--	.9	--	--	28.2	--	--	--	--
E-20	Chert -----	--	2.7	--	--	30.9	--	--	--	--
E-19	Chert, sandy -----	--	4.2	--	--	35.1	--	--	--	--
E-18	Chert -----	--	12.8	--	--	47.9	--	--	--	--
E-17	Chert, dolomitic -----	--	6.0	--	--	53.9	--	--	--	--
E-16	Chert, dolomitic and dolomite -----	--	2.1	--	--	56.0	--	--	--	--
E-15	Sandstone, cherty and mudstone -----	--	2.0	--	--	58.0	--	--	--	--
E-14	Chert -----	--	1.6	--	--	59.6	--	--	--	--
E-13	Sandstone, cherty -----	--	23.3	--	--	82.9	--	--	--	--
E-12	Chert, sandy -----	--	14.0	--	--	96.9	--	--	--	--
E-11	Chert -----	--	15.0	--	--	111.9	--	--	--	--
	Faults of unknown but probably small displacement occur within and at base of bed E-11; thickness given is uncertain.									
E-10	Chert -----	--	1.7	--	--	113.6	--	--	--	--
E- 9	Chert, dolomitic -----	--	3.0	--	--	116.6	--	--	--	--
	Fault of unknown displacement at base of bed E-9.									
E- 8	Chert, dolomitic -----	--	1.5	--	--	118.1	--	--	--	--
E- 7	Chert, dolomitic -----	--	.4	--	--	118.5	--	--	--	--
E- 6	Chert -----	725- RSJ	.5	0.8	80.5	119.0	0.40	0.001	0.001	0.000
E- 5	Chert -----	724- RSJ	2.0	.8	81.7	121.0	2.00	.001	.001	.002
E- 4	Chert -----	723- RSJ	.5	.6	85.1	121.5	2.30	.001	.001	.003

Lot no. 1311.

II - Montana 4



E- 3	Chert -----	722- RSJ	1.1	.3	84.4	122.6	2.63	.002	.001	.004
E- 2	Chert, calcareous -----	721- RSJ	1.4	1.8	76.8	124.0	5.15	.002	.002	.007
E- 1	Chert, carbonatic -----	720- RSJ	1.2	.5	57.3	125.2	5.79**	.000	.001	.008*

D member of Phosphoria formation

D-20	Mudstone -----	719- RSJ	2.3	3.0	69.3	2.3	6.90	0.002	0.003	0.007
D-19	Mudstone, carbonatic -----	718- RSJ	3.2	2.8	60.6	5.5	15.86	.003	.002	.013
D-18	Mudstone -----	717- RSJ	.9	.3	70.0	6.4	16.13	.002	.001	.014
D-17	Mudstone, carbonatic -----	716- RSJ	.8	6.9	50.8	7.2	21.65	.005	.004	.017
D-16	Phosphate rock -----	715- RSJ	1.4	25.5	11.3	8.6	57.35	.008	.009	.030
D-15	Phosphate rock and carbonate rock -----	714- RSJ	2.0	17.6	5.8	10.6	92.55	.008	.006	.042
D-14	Mudstone and phosphate rock -----	713- RSJ	3.1	15.5	33.6	13.7	140.60	.008	.007	.064
D-13	Phosphate rock, argillaceous -----	712-CWT	2.6	15.2	27.2	16.3	180.12	.008	.009	.087
D-12	Mudstone, carbonatic -----	711-CWT	1.1	5.8	41.2	17.4	186.50	.007	.005	.093
D-11	Mudstone, carbonatic -----	710-CWT	1.6	7.4	38.8	19.0	198.34	.007	.007	.104
D-10	Mudstone, carbonatic -----	709-CWT	.6	6.1	44.0	19.6	202.00	.007	.006	.107
The base of bed D-10 may be a bedding plane fault.										
D- 9	Mudstone, carbonatic -----	708-CWT	.9	6.4	46.0	20.5	207.76	.007	.005	.112
D- 8	Dolomite -----	707-CWT	1.6	1.3	8.7	22.1	209.84	.001	.001	.114
D- 7	Mudstone, carbonatic -----	706-CWT	1.2	6.8	40.7	23.3	218.00	.005	.005	.120
D- 6	Phosphate rock; fos. col. no. 11683 <sup>1</sup> -----	705-CWT	2.0	23.9	11.8	25.3	265.80	.008	.009	.138
D- 5	Mudstone, carbonatic -----	704-CWT	3.0	1.6	43.2	28.3	270.60	.002	.001	.140
D- 4	Mudstone, phosphatic -----	703-CWT	.7	10.0	47.0	29.0	277.60	.005	.005	.144
D- 3	Phosphate rock, carbonatic -----	702-CWT	1.4	22.9	11.6	30.4	309.66	.011	.012	.161
D- 2	Mudstone; fos. col. no. 11683 -----	701-CWT	2.4	2.7	67.8	32.8	316.14	.003	.002	.166
D- 1	Chert -----	700-CWT	.6	6.5	71.3	33.4	320.04	.004	.004	.168

C member of Phosphoria formation

C-25	Chert, sandy -----	--	1.1	--	--	1.1	--	--	--	--
C-24	Chert, sandy -----	--	2.0	--	--	3.1	--	--	--	--
C-23	Chert, sandy -----	--	1.2	--	--	4.3	--	--	--	--
C-22	Chert, sandy -----	--	2.2	--	--	6.5	--	--	--	--
C-21	Dolomite, sandy -----	--	1.8	--	--	8.3	--	--	--	--
C-20	Dolomite, argillaceous -----	--	1.2	--	--	9.6	--	--	--	--
C-19	Dolomite and chert -----	--	6.4	--	--	16.0	--	--	--	--
C-18	Dolomite -----	--	14.3	--	--	30.3	--	--	--	--
C-17	Chert, dolomitic, argillaceous -----	--	1.7	--	--	32.0	--	--	--	--
C-16	Chert -----	--	.5	--	--	32.5	--	--	--	--
C-15	Dolomite, argillaceous -----	--	4.3	--	--	36.8	--	--	--	--
C-14	Dolomite -----	--	2.1	--	--	38.9	--	--	--	--
C-13	Sandstone, dolomitic -----	--	4.5	--	--	43.4	--	--	--	--
C-12	Dolomite -----	--	8.2	--	--	51.6	--	--	--	--

<sup>1</sup> Fossil collection made by W. R. Record, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Canyon Camp, Mont., lot 1311

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)	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
C-11	Mudstone -----	--	3.0	--	--	54.6	--	--	--	--
C-10	Mudstone -----	--	14.3	--	--	68.9	--	--	--	--
C-9	Covered; unable to correlate from north to south side of canyon. -----	--	--	--	--	--	--	--	--	--
C-8	Chert -----	--	1.3	--	--	70.2	--	--	--	--
C-7	Dolomite -----	--	.6	--	--	70.8	--	--	--	--
C-6	Chert, sandy -----	--	1.1	--	--	71.9	--	--	--	--
C-5	Sandstone -----	--	.9	--	--	72.8	--	--	--	--
C-4	Limestone, sandy, cherty -----	--	1.4	--	--	74.2	--	--	--	--
C-3	Mudstone and chert -----	--	1.4	--	--	75.6	--	--	--	--
C-2	Chert -----	--	4.7	--	--	80.3	--	--	--	--
C-1	Chert -----	732-ERC	5.0	0.9	75.4	85.3	4.50	0.000	0.001	--
B member of Phosphoria formation										
B-5	Chert, argillaceous -----	731-ERC	0.7	1.1	85.8	0.7	0.77	0.000	0.001	0.001
B-4	Phosphate rock; fos. col. no. 11682 -----	730-ERC	.5	27.0	18.7	1.2	14.27	.007	.008	.005
B-3	Carbonate rock -----	729-ERC	1.0	3.0	8.8	2.2	17.27	.000	.002	.007
B-2	Chert -----	728-ERC	.8	2.5	77.7	3.0	19.27	.001	.002	.008
B-1	Carbonate rock -----	727-ERC	.5	5.6	15.8	3.5	22.02	.007	.008	.012
A member of Phosphoria formation—base not exposed										
A-12	Dolomite, dolomitic chert, and quartzite -----	726-ERC	2.1	1.2	28.2	2.1	--	0.000	0.001	--
A-11	Dolomite -----	--	1.4	--	--	3.5	--	--	--	--
A-10	Chert, dolomitic -----	--	.3	--	--	3.8	--	--	--	--
A-9	Dolomite -----	--	.6	--	--	4.4	--	--	--	--
A-8	Chert -----	--	.25	--	--	4.65	--	--	--	--
A-7	Dolomite -----	--	1.3	--	--	5.95	--	--	--	--
A-6	Chert -----	--	.2	--	--	6.15	--	--	--	--
A-5	Dolomite -----	--	1.7	--	--	7.85	--	--	--	--
A-4	Chert, dolomitic -----	--	.25	--	--	8.10	--	--	--	--
A-3	Dolomite -----	--	2.4	--	--	10.50	--	--	--	--
A-2	Dolomite -----	--	3.5	--	--	14.00	--	--	--	--
A-1	Mudstone, calcareous -----	--	5.6	--	--	19.60	--	--	--	--



Warm Springs Creek, Mont., lot 1300

Phosphoria formation measured and B and D members sampled near Warm Springs Creek, NW $\frac{1}{4}$  sec. 22, T. 9 S., R. 3 W., Madison County, Mont., near crest of small anticline. D member measured and sampled in hand trench; rest of formation measured and B member sampled from natural exposures. Beds strike N. 30° E. and dip 2° NW. Section measured by W. H. Wilson, B. K. Replogle, and J. L. Elliott and sampled by Elliott, Replogle, and R. F. Gosman in August 1949. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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>	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—top not exposed										
--	Dinwoody-Phosphoria contact covered, approximate thickness of covered interval	--	4.5	--	--	4.5	--	--	--	--
E-13	Sandstone, carbonatic, contains glauconite-----	--	4.4	--	--	8.9	--	--	--	--
E-12	Chert -----	--	1.4	--	--	10.3	--	--	--	--
E-11	Sandstone, contains glauconite-----	--	5.0	--	--	15.3	--	--	--	--
E-10	Sandstone -----	--	40.3	--	--	55.6	--	--	--	--
E- 9	Chert -----	--	.5	--	--	56.1	--	--	--	--
E- 8	Sandstone -----	--	2.3	--	--	58.4	--	--	--	--
E- 7	Chert, argillaceous -----	--	6.8	--	--	65.2	--	--	--	--
E- 6	Chert -----	--	32.1	--	--	97.3	--	--	--	--
E- 5	Chert -----	--	21.5	--	--	118.8	--	--	--	--
E- 4	Chert -----	--	5.0	--	--	123.8	--	--	--	--
E- 3	Chert -----	3385-WHW	1.9	0.5	92.8	125.7	--	0.001	--	--
E- 2	Chert -----	3384-WHW	2.5	.4	93.2	128.2	--	.001	--	--
E- 1	Chert -----	3383-WHW	2.0	.7	93.6	130.2	--	.0005	0.001	--
D member of Phosphoria formation										
D- 7	Phosphate rock, argillaceous-----	3382-WHW	1.7	18.5	41.3	1.7	31.45	0.001	--	0.002
D- 6	Phosphate rock, argillaceous-----	3381-WHW	.9	27.3	23.0	2.6	56.02	.008	0.008	.009
D- 5	Phosphate rock, argillaceous-----	3380-WHW	.7	26.7	20.2	3.3	74.71	.010	.010	.016
D- 4	Phosphate rock -----	3379-WHW	1.7	31.2	10.5	5.0	127.75	.009	.009	.031
D- 3	Mudstone, phosphatic-----	3378-WHW	1.1	10.4	43.7	6.1	139.19	.007	.007	.039
D- 2	Mudstone-----	3377-WHW	1.5	1.8	75.5	7.6	141.89	.003	--	.043
D- 1	Mudstone, phosphatic, cherty mudstone, and chert -----	3376-WHW	1.8	3.3	80.5	9.4	147.83	.003	--	.049
C member of Phosphoria formation										
C-10	Chert -----	3375-WHW	1.2	0.4	92.0	1.2	--	0.001	--	--
C- 9	Chert and sandstone -----	--	8.5	--	--	9.7	--	--	--	--
C- 8	Sandstone -----	--	5.0	--	--	14.7	--	--	--	--

Warm Springs Creek, Mont., lot 1300

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)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
C- 7	Sandstone and mudstone -----	--	10.0	--	--	24.7	--	--	--	--
C- 6	Carbonate rock -----	--	3.8	--	--	28.3	--	--	--	--
C- 5	Carbonate rock, argillaceous -----	--	3.4	--	--	31.9	--	--	--	--
C- 4	Sandstone, cherty -----	--	18.7	--	--	50.6	--	--	--	--
C- 3	Sandstone -----	--	3.1	--	--	53.7	--	--	--	--
C- 2	Chert -----	--	3.2	--	--	56.9	--	--	--	--
C- 1	Sandstone -----	750-WHW	1.3	3.3	78.3	58.2	--	0.001	0.001	--
B member of Phosphoria formation										
B- 2	Sandstone, phosphatic and phosphate rock -	743-WHW	1.2	19.4	45.4	0.9	--	0.004	0.005	--
B- 1	Phosphate rock, cherty, sandy -----	743-WHW	1.2	21.9	39.3	2.1	--	.004	.004	--
A member of Phosphoria formation—base not exposed										
A- 3	Sandstone -----	--	2.5	--	--	2.5	--	--	--	--
A- 2	Mudstone, carbonatic -----	--	9.8	--	--	12.3	--	--	--	--
A- 1	Carbonate rock; fos. col. no. 11681 <sup>1</sup> -----	--	15.0	--	--	27.3	--	--	--	--

<sup>1</sup> Fossil collection made by W. R. Record, Paleontology and Stratigraphy Branch, U. S. Geological Survey.



Lazyman Hill, Mont., lot 1319

Phosphoria formation sampled on Lazyman Hill, sec. 9, T. 10 S., R. 2 W., Madison County, Mont., on east limb of Ruby Valley syncline. Beds D-1 through E-2 exposed in hand trench on east face of hill; E member measured from natural exposure on east face of hill; all other samples taken and rest of formation measured from natural exposures on northeast face of hill. Beds strike N. 10° E. and dip 13° W. Section measured by E. R. Cressman, B. K. Replogle, and W. J. Garmoe and sampled by R. F. Gosman in September 1949. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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>	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—top not exposed										
--	Dinwoody-Phosphoria contact covered, approximate thickness of covered interval--	--	10.0	--	--	10.0	--	--	--	--
E-25	Dolomite, sandy -----	--	1.0	--	--	11.0	--	--	--	--
E-24	Dolomite-----	--	.5	--	--	11.5	--	--	--	--
E-23	Sandstone, dolomitic -----	--	.6	--	--	12.1	--	--	--	--
E-22	Mudstone, dolomitic -----	--	3.3	--	--	15.4	--	--	--	--
E-21	Mudstone, dolomitic -----	--	3.8	--	--	19.2	--	--	--	--
E-20	Dolomite, argillaceous -----	--	7.4	--	--	26.6	--	--	--	--
E-19	Covered interval -----	--	5.3	--	--	31.9	--	--	--	--
E-18	Sandstone, phosphatic and chert -----	--	1.4	--	--	33.3	--	--	--	--
E-17	Sandstone, cherty-----	--	2.3	--	--	35.6	--	--	--	--
E-16	Covered interval-----	--	2.9	--	--	38.5	--	--	--	--
E-15	Sandstone -----	--	4.1	--	--	42.6	--	--	--	--
E-14	Sandstone -----	--	8.5	--	--	51.1	--	--	--	--
E-13	Sandstone -----	--	4.3	--	--	55.4	--	--	--	--
E-12	Sandstone -----	--	15.2	--	--	70.6	--	--	--	--
E-11	Sandstone, cherty, and sandy chert -----	--	8.1	--	--	78.7	--	--	--	--
E-10	Chert, sandy -----	--	9.0	--	--	87.7	--	--	--	--
E- 9	Chert -----	--	7.9	--	--	95.6	--	--	--	--
E- 8	Chert -----	--	8.2	--	--	103.8	--	--	--	--
E- 7	Chert -----	--	.6	--	--	104.4	--	--	--	--
E- 6	Chert -----	--	8.5	--	--	112.9	--	--	--	--
E- 5	Chert -----	--	8.5	--	--	121.4	--	--	--	--
E- 4	Chert -----	--	3.7	--	--	125.1	--	--	--	--
E- 3	Chert -----	--	3.2	--	--	128.3	--	--	--	--
E- 2	Chert -----	742-ERC	3.5	0.7	93.8	131.8	--	0.000	0.000	--
E- 1	Chert -----	741-ERC	1.3	.8	90.4	133.1	--	.002	.001	--
D member of Phosphoria formation										
D- 8	Mudstone -----	740-ERC	1.0	0.5	87.6	1.0	0.50	0.002	0.001	0.001
D- 7	Mudstone -----	739-ERC	1.3	1.2	86.3	2.3	2.06	.001	.002	.004

OFFICIAL USE ONLY

Lazyman Hill, Mont., lot 1319

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)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
D- 6	Carbonate rock -----	738-ERC	0.9	1.5	17.0	3.2	3.41	0.002	0.003	0.006
D- 5	Phosphate rock, argillaceous -----	737-ERC	1.2	28.0	19.2	4.4	37.01	.008	.010	.018
D- 4	Phosphate rock -----	736-ERC	.9	33.7	7.6	5.3	67.34	.008	.011	.028
D- 3	Mudstone, phosphatic -----	735-ERC	.6	10.4	49.4	5.9	73.58	.006	.006	.032
D- 2	Mudstone, phosphatic, and argillaceous phosphate rock -----	734-ERC	1.2	6.2	63.4	7.1	81.02	.005	.004	.037
D- 1	Mudstone, phosphatic, phosphate rock, and phosphatic chert -----	733-ERC	1.4	15.6	42.0	8.5	102.86	.006	.007	.046

C member of Phosphoria formation

C-16	Chert-----	749-WJG	6.1	0.5	93.2	6.1	--	0.001	0.001	--
C-15	Chert-----	--	2.0	--	--	8.1	--	--	--	--
C-14	Quartzite -----	--	6.1	--	--	14.2	--	--	--	--
C-13	Limestone, dolomitic, argillaceous and calcareous sandstone -----	--	4.5	--	--	18.7	--	--	--	--
C-12	Sandstone, calcareous -----	--	8.5	--	--	27.2	--	--	--	--
C-11	Sandstone, calcareous -----	--	6.2	--	--	33.4	--	--	--	--
C-10	Sandstone, calcareous -----	--	7.7	--	--	41.1	--	--	--	--
C- 9	Dolomite and cherty sandstone -----	--	2.7	--	--	43.8	--	--	--	--
C- 8	Sandstone, cherty and dolomite -----	--	2.8	--	--	46.6	--	--	--	--
C- 7	Sandstone -----	--	2.0	--	--	48.6	--	--	--	--
C- 6	Dolomite-----	--	1.2	--	--	49.8	--	--	--	--
C- 5	Quartzite, calcareous -----	--	2.3	--	--	52.1	--	--	--	--
C- 4	Chert, dolomitic -----	--	3.9	--	--	56.0	--	--	--	--
C- 3	Dolomite and calcareous sandstone -----	--	3.6	--	--	59.6	--	--	--	--
C- 2	Sandstone, cherty, sandstone, and sandy phosphate rock -----	--	3.5	--	--	63.1	--	--	--	--
C- 1	Chert-----	748-BKR	4.2	0.6	91.0	67.3	--	.000	.001	--

B member of Phosphoria formation

B- 2	Mudstone, phosphatic and chert -----	747-BKR	1.2	8.5	61.8	1.2	--	0.004	0.003	--
B- 1	Phosphate rock -----	746-BKR	1.5	27.9	19.3	2.7	--	.005	.007	--

A member of Phosphoria formation

A-26	Carbonate rock, argillaceous -----	745-BKR	0.7	1.7	20.3	0.7	--	0.001	0.001	--
A-25	Carbonate rock -----	--	6.5	--	--	7.2	--	--	--	--
A-24	Carbonate rock -----	--	8.2	--	--	15.4	--	--	--	--
A-23	Carbonate rock -----	--	3.2	--	--	18.6	--	--	--	--
A-22	Carbonate rock -----	--	8.6	--	--	27.2	--	--	--	--



A-21	Carbonate rock -----	--	4.6	--	--	31.8	--	--	--	--
A-20	Sandstone, carbonatic -----	--	11.2	--	--	43.0	--	--	--	--
A-19	Carbonate rock -----	--	1.5	--	--	44.5	--	--	--	--
A-18	Carbonate rock -----	--	2.5	--	--	47.0	--	--	--	--
A-17	Carbonate rock -----	--	3.7	--	--	50.7	--	--	--	--
A-16	Carbonate rock -----	--	4.7	--	--	55.4	--	--	--	--
A-15	Carbonate rock -----	--	3.7	--	--	59.1	--	--	--	--
A-14	Sandstone, carbonatic -----	--	2.6	--	--	61.7	--	--	--	--
A-13	Mudstone -----	--	4.8	--	--	66.5	--	--	--	--
A-12	Sandstone, carbonatic -----	--	7.0	--	--	73.5	--	--	--	--
A-11	Sandstone -----	--	2.5	--	--	76.0	--	--	--	--
A-10	Mudstone -----	--	3.3	--	--	79.3	--	--	--	--
A- 9	Sandstone, carbonatic -----	--	12.0	--	--	91.3	--	--	--	--
A- 8	Sandstone, carbonatic -----	--	16.1	--	--	107.4	--	--	--	--
A- 7	Carbonate rock -----	--	1.0	--	--	108.4	--	--	--	--
A- 6	Covered interval -----	--	2.3	--	--	110.7	--	--	--	--
A- 5	Sandstone, carbonatic -----	--	3.7	--	--	114.4	--	--	--	--
A- 4	Covered interval -----	--	4.5	--	--	118.9	--	--	--	--
A- 3	Carbonate rock -----	--	5.5	--	--	124.4	--	--	--	--
A- 2	Covered interval -----	--	4.3	--	--	128.7	--	--	--	--
A- 1	Sandstone, carbonatic -----	--	7.9	--	--	136.6	--	--	--	--
Quadrant formation—top bed only										
Cq-1	Sandstone breccia -----	--	24.0	--	--	24.0	--	--	--	--

Alpine Creek, Mont., lot 1307

B and D members of Phosphoria formation sampled and A, C, and most of E members described in southeast-facing slope at head of Alpine Creek, N $\frac{1}{2}$  sec. 26, T. 10 S., R. 2 W., Madison County, Mont., on gently dipping east limb of Ruby Valley syncline. Beds C-10 through E-1 measured and sampled in hand trench, all others from natural exposure. Beds strike N. 5° E. and dip 8° W. Section measured by E. R. Cressman, W. H. Wilson, and R. L. Jones and sampled by W. J. Garmoe and J. L. Elliott in August 1949. Samples analyzed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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>	Uranium content (percent)		Thickness x percent chem. U (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
E member of Phosphoria formation—top not exposed										
--	Dinwoody-Phosphoria contact covered, estimated thickness of covered interval --	--	10.	--	--	10.0	--	--	--	--
E-12	Sandstone, dolomitic; fos. col. no. 11689 <sup>1</sup> --	--	4.9	--	--	14.9	--	--	--	--
E-11	Dolomite; fos. col. no. 11688 -----	--	4.2	--	--	19.1	--	--	--	--
E-10	Covered interval -----	--	2.0	--	--	21.1	--	--	--	--
E-9	Sandstone, dolomitic; fos. col. no. 11687 --	--	3.0	--	--	24.1	--	--	--	--
E-8	Sandstone -----	--	14.0	--	--	38.1	--	--	--	--
E-7	Sandstone -----	--	4.8	--	--	42.9	--	--	--	--
E-6	Sandstone and sandy chert -----	--	8.0	--	--	50.9	--	--	--	--
E-5	Chert, argillaceous -----	--	36.5	--	--	87.4	--	--	--	--
E-4	Chert -----	--	11.5	--	--	98.9	--	--	--	--
E-3	Covered interval -----	--	9.5	--	--	108.4	--	--	--	--
E-2	Chert -----	--	5.9	--	--	114.3	--	--	--	--
E-1	Chert -----	3394-WHW	2.4	0.9	90.6	116.7	--	0.001	0.001	--
D member of Phosphoria formation										
D-4	Phosphate rock, argillaceous and phosphate rock -----	3393-WHW	1.1	30.5	13.7	1.1	33.55	0.009	0.009	0.010
D-3	Mudstone -----	3392-WHW	1.8	4.6	64.6	2.9	41.83	.004	.003	.015
D-2	Carbonate rock, argillaceous -----	3391-WHW	1.0	2.6	29.4	3.9	44.43	.002	.002	.017
D-1	Mudstone, phosphatic -----	3390-WHW	.5	12.1	52.5	4.4	50.48	.005	.004	.019
C member of Phosphoria formation										
C-10	Chert -----	3389-WHW	1.0	5.6	79.9	1.0	--	0.003	0.003	--
C-9	Chert and sandstone -----	--	4.3	--	--	5.3	--	--	--	--
C-8	Sandstone, dolomitic -----	--	6.7	--	--	12.0	--	--	--	--
C-7	Dolomite -----	--	3.0	--	--	15.0	--	--	--	--
C-6	Dolomite, sandy -----	--	5.2	--	--	20.2	--	--	--	--
C-5	Dolomite -----	--	3.6	--	--	23.8	--	--	--	--
C-4	Sandstone, dolomitic -----	--	6.8	--	--	30.6	--	--	--	--



C- 3	Chert -----	--	3.2	--	--	33.8	--	--	--	--
C- 2	Sandstone, dolomitic -----	--	2.2	--	--	36.0	--	--	--	--
C- 1	Sandstone, dolomitic and dolomite -----	--	1.7	--	--	37.7	--	--	--	--

B member of Phosphoria formation

B- 3	Sandstone -----	3388-WHW	2.3	1.4	90.0	2.3	3.22	0.000	0.001	0.002
B- 2	Sandstone, phosphatic and conglomerate; fos. col. no. 11686 -----	3387-WHW	.9	8.3	53.7	3.2	10.69	.002	.002	.004
B- 1	Phosphate rock, sandy, conglomeratic; fos. col. no. 11685 -----	3386-WHW	1.1	26.6	19.1	4.3	39.95	.007	.006	.011

A member of Phosphoria formation

A-16	Dolomite -----	--	2.9	--	--	2.9	--	--	--	--
A-15	Dolomite -----	--	2.9	--	--	5.8	--	--	--	--
A-14	Dolomite -----	--	3.3	--	--	9.1	--	--	--	--
A-13	Dolomite -----	--	3.8	--	--	12.9	--	--	--	--
A-12	Dolomite -----	--	0.8	--	--	13.7	--	--	--	--
A-11	Dolomite -----	--	2.2	--	--	15.9	--	--	--	--
A-10	Dolomite, argillaceous -----	--	2.8	--	--	18.7	--	--	--	--
A- 9	Sandstone, dolomitic -----	--	0.8	--	--	19.5	--	--	--	--
A- 8	Dolomite, sandy -----	--	0.9	--	--	20.4	--	--	--	--
A- 7	Dolomite, argillaceous -----	--	1.7	--	--	22.1	--	--	--	--
A- 6	Sandstone, dolomitic -----	--	2.4	--	--	24.5	--	--	--	--
A- 5	Dolomite breccia -----	--	2.0	--	--	26.5	--	--	--	--
A- 4	Dolomite -----	--	2.8	--	--	29.3	--	--	--	--
A- 3	Dolomite breccia, sandy -----	--	2.6	--	--	31.9	--	--	--	--
A- 2	Dolomite -----	--	15.5	--	--	47.4	--	--	--	--
A- 1	Dolomite, sandy -----	--	0.3	--	--	47.7	--	--	--	--

Quadrant formation—top bed only

Cq-1	Sandstone -----	--	5.4	--	--	5.4	--	--	--	--
------	-----------------	----	-----	----	----	-----	----	----	----	----

<sup>1</sup> Fossil collection made by W. R. Record, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Sliderock Mountain, Mont., lot 1301

Phosphoria formation measured and B and D members sampled on Sliderock Mountain, N $\frac{1}{2}$  sec. 25, T. 10 S., R. 4 W., Madison County, Mont., on overturned west limb of Ruby Valley syncline. Thrust-faulting was recognized in lower formations up slope from the Phosphoria outcrop. Average strike is about N-S and dip about 40° W. A and C members measured from natural exposure and B and D members sampled from hand trenches on spur between heads of South and Middle Forks of Fawn Creek. E member measured from natural exposure in gully at head of Middle Fork of Fawn Creek. Section measured by C. W. Tandy and E. R. Cressman and sampled by R. F. Gosman and W. J. Garmoe in August 1949. Samples analysed by U. S. Bureau of Mines laboratory, Albany, Oreg.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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>	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
Dinwoody formation—basal bed only										
Td-1	Mudstone, calcareous -----	--	22.0	--	--	22.0	--	--	--	---
E member of Phosphoria formation										
E- 7	Sandstone, contains glauconite -----	--	2.7	--	--	2.7	--	--	--	---
E- 6	Chert, sandy, calcareous-----	--	30.2	--	--	32.9	--	--	--	---
E- 5	Sandstone -----	--	2.9	--	--	35.8	---	--	--	- --
E- 4	Chert and dolomitic chert-----	--	7.2	--	--	43.0	--	--	--	--
E- 3	Sandstone, cherty-----	--	3.5	--	--	46.5	--	--	--	--
E- 2	Chert-----	--	4.8	--	--	51.3	--	--	--	--
E- 1	Chert and mudstone -----	--	60.0	--	--	111.3	--	--	--	--
D member of Phosphoria formation—base not exposed										
D-12	Chert-----	692-CWT	6.0	1.0	87.5	6.0	6.00	0.001	--	0.006
D-11	Mudstone and phosphate rock-----	691-CWT	3.8	7.3	51.7	9.8	33.74	.005	0.004	.025
D-10	Phosphate rock, argillaceous dolomitic-----	690-CWT	.5	12.0	22.5	10.3	39.74	.005	.005	.028
D- 9	Mudstone, carbonatic-----	689-CWT	.6	2.9	53.3	10.9	41.48	.004	--	.030
D- 8	Phosphate rock, dolomitic-----	688-CWT	.9	22.6	18.3	11.8	61.82	.008	.008	.037
D- 7	Dolomite-----	687-CWT	.6	4.8	8.3	12.4	64.70	.003	--	.039
D- 6	Mudstone and phosphate rock-----	686-ERC	1.0	12.2	37.1	13.4	76.90	.007	.006	.046
D- 5	Phosphate rock, calcareous-----	685-ERC	2.4	23.4	14.5	15.8	133.06	.009	.009	.068
D- 4	Phosphate rock and argillaceous phosphate rock-----	684-ERC	.7	21.6	20.4	16.5	148.18	.010	.008	.074
D- 3	Dolomite; fos. col. no. 11672-----	683-ERC	2.4	.8	12.7	18.9	150.10	.001	--	.077
D- 2	Mudstone, phosphatic-----	682-ERC	1.5	10.2	42.0	20.4	165.40	.006	.006	.086
D- 1	Mudstone, phosphate rock, and phosphatic mudstone-----	681-ERC	1.6	13.6	40.7	22.0	187.16	.007	.006	.097
	Fault and shear zones, especially at the base of beds D-2, 5, 6, and 12 make thickness and stratigraphic sequence questionable.									



C member of Phosphoria formation— top not exposed

	D-C contact not exposed, covered interval of about five feet may include faults.									
--	Covered interval-----	--	5.0	--	--	5.0	--	---	--	--
C-19	Sandstone, dolomitic-----	--	2.6	--	--	7.6	--	---	--	--
C-18	Sandstone-----	--	12.5	--	--	20.1	--	---	--	--
C-17	Chert-----	--	2.2	--	--	22.3	--	---	--	--
C-16	Dolomite-----	--	5.0	--	--	27.3	--	---	--	--
C-15	Dolomite-----	--	6.0	--	--	33.3	--	---	--	--
C-14	Dolomite-----	--	2.4	--	--	35.7	--	---	--	--
C-13	Dolomite-----	--	5.8	--	--	41.5	--	---	--	--
C-12	Dolomite-----	--	14.2	--	--	55.7	--	---	--	--
C-11	Dolomite-----	--	8.7	--	--	64.4	--	---	--	--
C-10	Covered interval-----	--	5.5	--	--	69.9	--	---	--	--
C- 9	Chert and sandstone-----	--	2.7	--	--	72.6	--	---	--	--
C- 8	Sandstone, cherty-----	--	2.4	--	--	75.0	--	---	--	--
C- 7	Chert and sandstone-----	--	1.5	--	--	76.5	--	---	--	--
C- 6	Sandstone, cherty-----	--	1.1	--	--	77.6	--	---	--	--
C- 5	Chert-----	--	8.7	--	--	86.3	--	---	--	--
C- 4	Sandstone-----	--	3.0	--	--	89.3	--	---	--	--
C- 3	Sandstone-----	--	.3	--	--	89.6	--	---	--	--
C- 2	Chert-----	--	11.8	--	--	101.4	--	---	--	--
C- 1	Chert-----	--	1.6	--	--	103.0	--	---	--	--

B member of Phosphoria formation—base not exposed

B- 7	Phosphate rock, argillaceous and mudstone-----	699-CWT	0.7	14.3	53.0	0.7	10.01	0.005	0.005	0.004
B- 6	Mudstone and phosphatic mudstone-----	698-CWT	.8	5.7	72.7	1.5	14.57	.003	--	.006
B- 5	Sandstone and phosphate rock-----	697-CWT	1.1	18.0	45.5	2.6	34.37	.006	.007	.012
B- 4	Phosphate rock, argillaceous-----	696-CWT	1.3	26.7	20.2	3.9	69.08	.009	.008	.024
B- 3	Sandstone and phosphate rock-----	695-CWT	.7	14.2	60.0	4.6	79.02	.005	.005	.028
B- 2	Phosphate rock, sandy-----	694-CWT	.5	26.2	26.0	5.1	92.12	.008	.008	.032
B- 1	Phosphate rock-----	693-CWT	1.0	34.6	5.0	6.1	126.72	.011	.010	.043

A member of Phosphoria formation—top not exposed

--	Covered interval-----	--	35.0	--	--	35.0	--	--	--	--
A-14	Dolomite-----	--	17.0	--	--	52.0	--	--	--	--
	Bed A-14 is highly fractured and brecciated.									
A-13	Mudstone, calcareous, dolomitic-----	--	.8	--	--	52.8	--	--	--	--
A-12	Dolomite-----	--	2.0	--	--	54.8	--	--	--	--
A-11	Sandstone, calcareous, dolomitic-----	--	1.7	--	--	56.5	--	--	--	--

<sup>1</sup> Fossil collection made by W. R. Record, Paleontology and Stratigraphy Branch, U. S. Geological Survey.

Sliderock Mountain—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)	Uranium content (percent)		Thickness x percent eU (cumulative)
				P <sub>2</sub> O <sub>5</sub>	Acid insoluble			eU	Chem. U	
A-10	Dolomite, calcareous -----	--	4.7	--	--	56.5	--	--	--	--
A-9	Limestone -----	--	1.0	--	--	62.2	--	--	--	--
A-8	Dolomite; fos. col. no. 11671 -----	--	12.0	--	--	74.2	--	--	--	--
A-7	Dolomite-----	--	4.4	--	--	78.6	--	--	--	--
A-6	Sandstone, calcareous -----	--	5.2	--	--	83.8	--	--	--	--
A-5	Dolomite-----	--	1.2	--	--	85.0	--	--	--	--
A-4	Dolomite, calcareous -----	--	1.2	--	--	86.2	--	--	--	--
A-3	Sandstone, calcareous -----	--	5.8	--	--	92.0	--	--	--	--
A-2	Dolomite-----	--	6.7	--	--	98.7	--	--	--	--
A-1	Dolomite-----	--	6.8	--	--	105.5	--	--	--	--

Quadrant formation—top bed only

Cq-1	Sandstone, calcareous -----	--	--	--	--	--	--	--	--	--
------	-----------------------------	----	----	----	----	----	----	----	----	----

Taylor Creek, Idaho, lot 1342

B member of Phosphoria formation measured and sampled from natural exposure on the east side of Taylor Creek valley, NE $\frac{1}{4}$  sec. 19, T. 14 N., R. 41 E., Clark County, Idaho, by R. F. Gosman in September 1950. Beds strike N. 80° W. and dip 11° S. 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.

Samples analyzed for eU and chem. U by the U. S. Geological Survey laboratory, Geochemistry and Petrology Branch.

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)	Uranium content (percent)		Thickness x percent eU (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			eU	Chem. U	
B member of Phosphoria formation													
B-3	Phosphate rock -----	5562-RFG	3.5	30.2	0.68	0.77	5.39	11.4	3.5	105.70	0.013	0.015	0.046
B-2	Phosphate rock, calcareous -----	5563-RFG	.75	17.0	.62	1.35	1.97	13.6	4.25	118.45	.006	.005	.050
B-1	Phosphate rock -----	5564-RFG	1.5	31.3	.73	.83	3.31	12.6	5.75	165.40	.010	.011	.065
A member of Phosphoria formation—top beds only													
A-2	Sandstone-----	5565-RFG	1.6	4.5	--	--	--	85.5	1.6	--	0.002	--	--
A-1	Chert -----	--	--	--	--	--	--	--	--	--	--	--	--

II mount 17

OFFICIAL USE ONLY

OFFICIAL USE ONLY