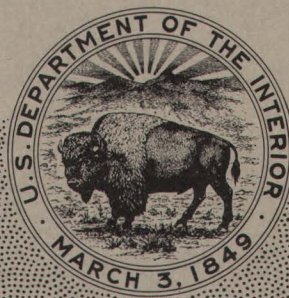


GEOLOGICAL SURVEY CIRCULAR 635



Stratigraphic Sections and
Chemical Analyses of
Phosphatic Rocks of Permian
And Mississippian Age in
Weber County, Utah

Stratigraphic Sections and Chemical Analyses of Phosphatic Rocks of Permian And Mississippian Age in Weber County, Utah

By E. M. Schell and K. P. Moore

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United States Department of the Interior

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STRATIGRAPHIC SECTIONS AND CHEMICAL ANALYSES OF PHOSPHATIC ROCKS OF PERMIAN AND MISSISSIPPIAN AGE IN WEBER COUNTY, UTAH

By E. M. SCHELL and K. P. MOORE

ABSTRACT

Stratigraphic sections and chemical analyses of phosphatic rocks from five trench localities in Weber County, Utah, are presented. Four of the trenches are in Mississippian rocks, and one is in Permian rocks. Of the Mississippian rocks, the highest grade phosphatic interval is at the Wheat Grass Creek locality. Here the phosphatic rocks are 14.9 feet thick, and a 5.8-foot-thick zone has an average of 22.1 percent P_2O_5 . Three localities of Mississippian rocks have 1.1 or less feet of phosphate rock that contains 24+ percent P_2O_5 . The Permian Park City Formation and related strata, where measured in Hardy Hollow, are 675 feet thick and consist of a 10.9-foot-thick phosphatic interval in the Grandeur Member of the Park City; the Meade Peak Phosphatic Shale Tongue of the Phosphoria Formation is 171 feet thick, but it is cut by numerous faults.

INTRODUCTION

This report presents stratigraphic sections and chemical analyses of phosphatic rocks from five trench localities in Weber County, Utah. The localities are from 6 to 25 miles east of Ogden, Utah in the Ogden River drainage system (fig. 1).

Four trenches (CP-35, CP-36, CP-38, CP-44) are in the upper part of the Lodgepole Limestone and the basal part of the Deseret and Humbug Formations, all of Mississippian age. The highest grade phosphatic rocks of the Mississippian are at the Wheat Grass Creek locality (CP-44). The phosphatic rocks there are 14.9 feet thick, and a 5.8-foot zone contains an average of 22.1 percent P_2O_5 . The three other localities of Mississippian rocks have 1.1 or less feet of phosphate rock that contains 24+ percent P_2O_5 . The phosphatic intervals in the Mississippian rocks are considered to be one phosphatic zone. Because of facies changes, the phosphatic intervals are assigned to three mappable formations. A discussion of the details

of the Mississippian stratigraphy is beyond the scope of this report.

One trench (CP-37) is in the Park City Formation and related strata of Permian age. Where measured in Hardy Hollow, the Park City and related strata are 675 feet thick and contain a 10.9-foot-thick phosphatic interval in the Grandeur Member of the Park City Formation. The Meade Peak Phosphatic Shale Tongue of the Phosphoria Formation is 171 feet thick, but it is cut by numerous faults.

The field study is part of a geologic program of the Conservation Division, U.S. Geological Survey, begun in 1964, to support mineral land classification of phosphate withdrawals on Federal lands. Trenching and sampling of the phosphatic intervals were done in August 1964 and July 1966 to augment geologic mapping projects in the general area. This report supplements stratigraphic and analytical data of previous investigators (Blackwelder, 1910; Cheney and others, 1953; Cheney, 1957; Mullens and Laraway, 1964; Schell and Gere, 1964; Mullens, 1969). The manner of investigation was similar to the procedure described by McKelvey, Davidson, O'Malley, and Smith (1953, p. 1-6). The analytical data and condensed descriptions of the rocks are presented for each trench, and detailed descriptions of the rocks exposed in the trenches follow the analytical data. No interpretation of the data is presented except for interpretation of some of the faulting in the Hardy Hollow trench (CP-37).

PERSONNEL AND ACKNOWLEDGMENTS

Field studies and geologic mapping in the northwest quarter of the Morgan 15-minute quadrangle by R. J. Hite specifically outlined for the first time the topographic expression of

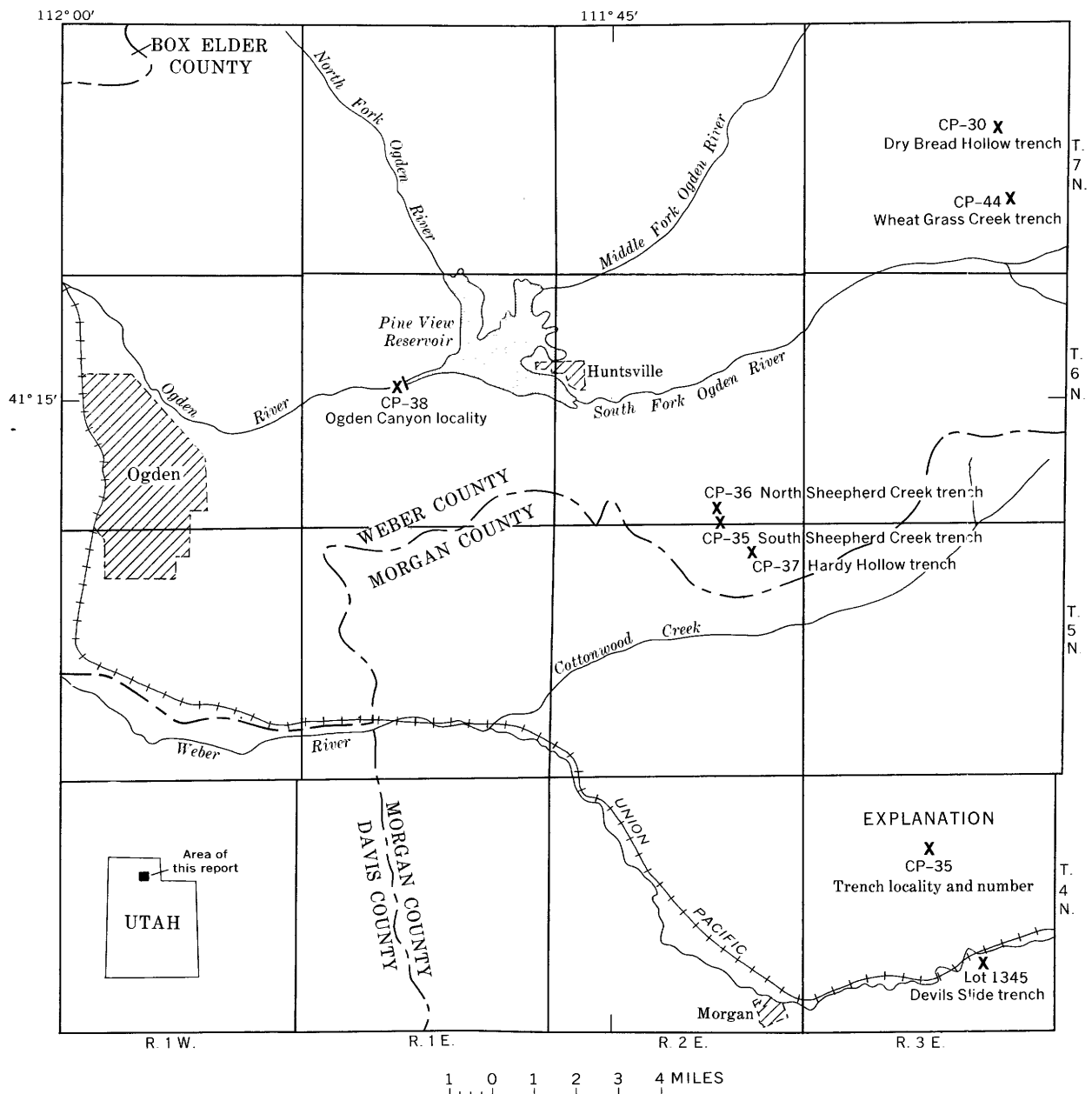


FIGURE 1.—Trench localities in Weber and Morgan Counties, Utah.

the phosphatic rocks from which three trench localities were selected. Field studies and geologic mapping in the Causey Dam quadrangle by T. E. Mullens (1969) delineated phosphatic rocks of Mississippian age. R. J. Hite and T. E. Mullens also participated in sampling and describing one trench each in Shepherd Creek (CP-35) and Wheat Grass Creek (CP-44). R. K. Stewart and Byron Walke did the hand

trenching in the North and South Shepherd Creeks localities in 1964; Lynn Walker and S. A. Wilbur did the hand trenching at the Wheat Grass Creek locality in 1966. E. M. Schell described and sampled the stratigraphic sections, and K. P. Moore made the chemical analyses. Permission by the land owners to trench and to sample the rocks is gratefully acknowledged.

PREVIOUS WORK

The Mississippian phosphatic rocks of the general area were first described by Blackwelder (1910, p. 547-550). Cheney (1957, p. 37) published a measured section of the Ogden Canyon (CP-38) locality but considered the P_2O_5 content too low to warrant sampling. Mullens (1969) showed the outcrop pattern of the Humbug Formation in the Causey Dam quadrangle and gave a synopsis of the data from the Wheat Grass Creek (CP-44) locality.

Preliminary data on the Permian phosphate deposits in the Hardy Hollow area were presented by Blackwelder (1910, p. 547-548, fig. 44). Blackwelder published a few analyses of phosphate rock float and the general outcrop pattern of the Park City Formation. The two nearest trench sections of the Park City Formation and related strata to the Hardy Hollow (CP-37) locality are the Devils Slide and Dry Bread Hollow localities (fig. 1). The Devils Slide locality is about 12 miles southeast in sec. 26, T. 4 N., R. 3 E. A stratigraphic section and chemical analyses of the phosphatic rocks in the Devils Slide locality were published by Cheney, Smart, Waring, and Warner (1953, p. 11-17). The geology of the Devils Slide area was mapped by Mullens and Laraway (1964). The Dry Bread Hollow locality is about 11 miles northeast of the Hardy Hollow locality. Geologic and trench data of the Dry Bread Hollow area were presented by Blackwelder (1910, p. 548-550, fig. 44) and, more recently, by Schell and Gere (1964) and Mullens (1969).

FIELD AND LABORATORY PROCEDURES

Three of the trenches, CP-35, CP-36, and CP-44, were hand excavated to a maximum depth of about 8 feet. The uppermost beds of the phosphatic interval at these localities were not sampled because of excessive overburden. The Hardy Hollow trench (CP-37) was bulldozed to a maximum depth of about 15 feet. Little additional excavation was necessary at the Ogden Canyon trench (CP-38) because the phosphatic interval is well exposed in an abandoned roadcut. Although well exposed, the rocks sampled at Ogden Canyon are overturned in a sharp fold. All the trenches described and sampled are in the weathered zone; therefore, the thickness and the analyses may not be representative of the units at depth. In general,

weathered phosphatic rock is slightly enriched in P_2O_5 as compared to underlying unweathered phosphatic rock (Cheney, 1957, p. 33-35). At the Hardy Hollow (CP-37) locality numerous fault zones and some repetition of beds were noted in the trenched intervals. No data on the thickness of strata deleted by faulting are available, and the interpretation of repetition of beds is the sole responsibility of the senior author.

Separate numerical designations were made for lithologic units and channel samples. Except in the units low in P_2O_5 content, a channel sample rarely exceeded 2 feet in thickness. At least one chip sample was collected from each bed, and the samples were later studied under a binocular microscope to supplement or modify the field descriptions.

Rock names and adjectives and the terms for hardness and thickness of bedding are similar to those described by Sheldon (1963, p. 57). Color names and numerical designations are from the Munsell color charts. The Wentworth scale for size classification was used for sandstone, phosphorite, limestone, and dolomite.

Channel samples, which averaged about 10 pounds, were crushed in the field to minus $\frac{1}{8}$ -inch mesh by a jaw crusher. A Jones splitter was used to obtain two splits of about half a pint each. One split was stored for future use, and one split was forwarded to the laboratory for analyses.

The methods of P_2O_5 and acid-insoluble analyses are similar to those described by Hoffman and Lundell (1938). Interpretation of chemical data of phosphatic rocks was presented by McKelvey, Davidson, O'Malley, and Smith (1953, p. 3-4).

REFERENCES CITED

- Blackwelder, Eliot, 1910, Phosphate deposits east of Ogden, Utah: U.S. Geol. Survey Bull. 430-H, p. 536-551.
- Cheney, T. M., 1957, Phosphate in Utah and an analysis of the stratigraphy of the Park City and the Phosphoria formations, Utah—a preliminary report: Utah Geol. and Mineralog. Survey Bull. 59, 54 p.
- Cheney, T. M., Smart, R. A., Waring, R. G., and Warner, M. A., 1953, Stratigraphic sections of the Phosphoria formation in Utah, 1949-51: U.S. Geol. Survey Circ. 306, 40 p.
- Hoffman, J. I., and Lundell, G. E. F., 1938, Analysis of phosphate rock: U.S. Natl. Bur. Standards Jour.

Research, v. 20, no. 5, Research Paper 1095, p. 607-626.

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, Pt. 1: U.S. Geol. Survey Circ. 208. 49 p.

Mullens, T. E., 1969, Geologic map of the Causey Dam quadrangle, Weber County, Utah: U.S. Geol. Survey Geol. Quad. Map GQ-790.

Mullens, T. E., and Laraway, W. H., 1964, Geology of the Devils Slide quadrangle, Morgan and Summit Counties, Utah: U.S. Geol. Survey Mineral Inv. Field Studies Map MF-290.

Schell, E. M., and Gere, W. C., 1964, Preliminary report on the phosphate deposits and stratigraphy of Permian rocks in Dry Bread Hollow, Weber County, Utah: U.S. Geol. Survey open-file report, 36 p.

Sheldon, R. P., 1963, Physical stratigraphy and mineral resources of Permian rocks in western Wyoming: U.S. Geol. Survey Prof. Paper 313-B, p. 49-273.

STRATIGRAPHIC SECTIONS AND ANALYSES

SOUTH SHEEPHERD CREEK, CP-35

Trench CP-35 is at South Shepherd Creek, SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 6 N., R. 2 E., Salt Lake meridian, Weber County, Utah. The phosphatic section near the top of the Lodgepole Limestone was sampled and described in a hand-excavated trench by E. M. Schell and R. J. Hite. Chemical analyses were by K. P. Moore.

Abstract section of only the upper part of Lodgepole Limestone, CP-35

Sample	Unit	Thickness (ft)	Rock description	Cumulative thickness (ft)	Chemical analyses (percent)					Thickness × percent P ₂ O ₅ (cumulative)						
					P ₂ O ₅	V ₂ O ₅	Cr ₂ O ₃	Acid insoluble	Ignition loss							
Top of trench																
CP-35-5	M-11b	3.1	Mudstone, slightly phosphatic	3.1	2.61	0.12	0.06	63.18	11.72	8.09						
4	M-11a	2.8	Mudstone, calcareous, slightly phosphatic	5.9	4.23	.26	.04	50.99	14.25	19.93						
3	M-10	.3	Phosphorite	6.2	7.47	.11	.01	26.22	21.55	{ 22.17 27.40						
3	M-9	.7	Mudstone, calcareous	6.9												
2	M-8	.1	Phosphorite, calcareous	7.0	4.33	.25	.06	58.76	10.03	{ 27.83 31.73						
2	M-7	.9	Mudstone, silty	7.9												
1	M-6	.2	Phosphorite	8.1	27.79	.05	.02	6.44	9.53	{ 37.29 42.85 51.19 53.97 67.86						
1	M-5	.2	Mudstone	8.3												
1	M-4	.3	Phosphorite	8.6												
1	M-3	.1	Mudstone, phosphatic	8.7												
1	M-2	.5	Phosphorite	9.2												
Base of trench																
	M-1	7.0	Dolomite, cherty	16.2												

Detailed description of only the upper part of Lodgepole Limestone, CP-35

Unit	Rock description	Thickness (ft)	Cumulative thickness (ft)
Top of trench			
M-11b	Mudstone, slightly phosphatic, calcareous, silty, soft; upper part is moderate brown (7.5YR 4/4), lower part is grayish brown (5YR 3/2); indistinct bedding; contains calcite pods. Basal contact is sharp	3.1	3.1
11a	Mudstone, slightly phosphatic, calcareous, silty, soft; upper 2.4 ft is pale brown (10YR 5/2), lower 0.4 ft is moderate yellowish brown (10YR 4/5); indistinct bedding; contains calcite pods. Basal contact is sharp	2.8	5.9
10	Phosphorite, very dark gray (2.5Y 3/0), very coarse to fine-pelletal, calcareous, hard, thin-bedded; contains a 0.01-ft-thick mudstone layer 0.1 ft above base. Basal contact is sharp	.3	6.2
9	Mudstone, moderate-brown (5YR 4/4), calcareous, soft; indistinct bedding, highly weathered; contains calcite veinlets and small pods. Basal contact is sharp	.7	6.9
8	Phosphorite, fine- to medium-pelletal, very calcareous, hard; single bed. Basal contact is sharp	.1	7.0
7	Mudstone, dark-grayish-brown (10YR 3/2), silty soft, laminated; lower 0.1 ft contains phosphorite pellets. Basal contact is sharp	.9	7.9
6	Phosphorite, dark-gray (2.5Y 4/0), very coarse to fine-pelletal, calcareous, hard, thick-bedded; contains reworked dolomite pebbles. Basal contact is sharp	.2	8.1

Detailed description of only the upper part of Lodgepole Limestone, CP-35—Continued

Unit	Rock description	Thickness (ft)	Cumulative thickness (ft)
M-5	Mudstone, grayish-brown (10YR 4/3), slightly phosphatic, slightly calcareous, soft; indistinct bedding, highly weathered; contains a 0.05-ft-thick fine- to coarse-pelletal phosphorite layer. Basal contact is sharp	.2	8.3
4	Phosphorite, dark-gray (2.5YR 4/0), fine- to coarse-pelletal and oolitic, calcareous, hard, thick-bedded. Most oolites consist of calcite and a phosphatic outer rim. Basal contact is sharp	.3	8.6
3	Mudstone, grayish-brown (7.5YR 4/2), phosphatic, calcareous, soft; indistinct bedding; contains fine to coarse pellets of phosphorite. Basal contact is sharp	.1	8.7
2	Phosphorite, gray (N 5/0), pelletal and oolitic (fine to 5 mm), calcareous, hard, thick-bedded. Some oolites contain a calcite center and a phosphorite rim. Sharp irregular basal contact contains dolomite pebbles from unit below	.5	9.2
Base of trench			
1	Dolomite, gray (2.5Y 5/0), fine- to medium-grained, cherty, hard, massive; contains irregular lenses and pods of dark-gray chert, and gastropods and erinoids (?). Forms ledge. Base not exposed	7.0	16.2

NORTH SHEEPHERD CREEK, CP-36

Trench CP-36 is at North Shepherd Creek, NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 6 N., R. 2 E., Salt Lake meridian, Weber County, Utah. The phosphatic

section near the top of the Lodgepole Limestone was sampled and described in a hand-excavated trench by E. M. Schell. Chemical analyses were by K. P. Moore.

Abstract section of only the upper part of Lodgepole Limestone, CP-36

Sample	Unit	Thickness (ft)	Rock description	Cumulative thickness (ft)	Chemical analyses (percent)					Thickness × percent P ₂ O ₅ (cumulative)
					P ₂ O ₅	V ₂ O ₅	Cr ₂ O ₃	Acid insoluble	Ignition loss	
	M-10	16.0	Concealed, overlain by limestone ledge							
			Top of trench							
	M-9	5.0	Mudstone, calcareous	5.0						
CP-36-5	M-8	.3	Phosphorite, calcareous	5.3	2.54	0.4	0.01	17.90	30.46	0.76
5	M-7	1.1	Limestone, argillaceous	6.4						
4	M-6	.1	Phosphorite	6.5	5.06	.18	.05	56.53	14.76	4.05
4	M-5	.9	Mudstone, calcareous	7.4						
3	M-4	.4	Phosphorite and mudstone	7.8	25.13	.05	.02	8.45	11.58	18.65
2	M-3	.7	Phosphorite and mudstone	8.5	25.44	.02	.01	4.11	14.38	36.45
1	M-2	.4	Phosphorite	8.9	26.29	.01	.01	5.23	11.69	46.95
			Base of trench							
	M-1	15.0	Dolomite, cherty							

Detailed description of only the upper part of Lodgepole Limestone, CP-36

Unit	Rock description	Thick- ness (ft)	Cumulative thick- ness (ft)
M-10	Concealed, probably mudstone. Overlain by dark-gray massive limestone ledge	16.0	—
	Top of trench		
9	Mudstone, dark-yellowish-brown (10YR 4/2), very calcareous, soft; indistinct bedding. Contains two phosphorite beds about 0.1 ft thick about 0.6 and 3.5 ft above base; phosphorite is pale brown (10YR 5/2), fine to coarse pelletal, argillaceous, calcareous, and hard. Basal contact is sharp	5.0	5.0
8	Phosphorite, light-brownish-gray (5YR 5/1), fine-pelletal to very coarse pelletal and oolitic, hard, thick-bedded; matrix dolomitic. Basal contact is sharp	.3	5.3
7	Limestone, grayish-brown (2.5Y 5/2), very argillaceous, soft, thick-bedded; contains calcite veinlets. Basal contact is sharp	1.1	6.4
6	Phosphorite, gray (N 6/0), fine- to medium-pelletal, hard; matrix dolomitic; contains calcite veinlets; single bed. Basal contact is sharp	.1	6.5
5	Mudstone, pale-brown (10YR 5/2), calcareous, soft; indistinct bedding, laminated in part. Basal contact is sharp	.9	7.4
4	Phosphorite and mudstone. Upper 0.3 ft is phosphorite, dark-grey (N 4/0), fine-pelletal to very coarse pelletal and oolitic, hard, thick-		

Detailed description of only the upper part of Lodgepole Limestone, CP-36—Continued

Unit	Rock description	Thick- ness (ft)	Cumulative thick- ness (ft)
	bedded; matrix dolomitic; oolites contain a calcite core. Lower 0.1 ft is mudstone, grayish-brown (10YR 4/3), soft, fissile; contains fine to very coarse pellets of phosphorite. Basal contact is sharp	.4	7.8
M-3	Phosphorite and mudstone. Upper 0.6 ft is phosphorite, gray (N 5/0), fine-pelletal to very coarse pelletal and oolitic, hard, thick-bedded; matrix dolomitic; oolites contain a calcite core. Basal 0.1 ft is mudstone, moderate-yellowish-brown (10YR 5/4), phosphatic, soft; indistinct bedding, highly weathered; contains fine to coarse pellets of phosphorite. Basal contact is sharp	.7	8.5
2	Phosphorite, dark-gray (N 4/10), pelletal, calcareous, fossiliferous, hard, thick-bedded; contains oolites and nodules ranging from fine to 10 mm in diameter. Upper part contains reworked phosphorite nodules and calcite-filled phosphorite oolites. Lower part contains reworked dolomite pebbles. Basal contact is sharp and irregular	.4	8.9
	Base of trench		
1	Dolomite, gray (2.5Y 5/0), fine- to medium-grained, cherty, hard, massive; contains dark-gray chert pods and lenses. Forms ledge	15.0	—

HARDY HOLLOW, UTAH, CP-37

Trench CP-37 is in Hardy Hollow, lot 9, sec. 2, T. 5 N., R. 2 E., Salt Lake meridian, Weber County, Utah. The Meade Peak Phosphatic Shale Tongue of the Phosphoria Formation and the phosphate zone of the Grandeur Member of

the Park City Formation was described and sampled on the ridge between Hardy Hollow and Shepherd Creek by E. M. Schell in bulldozer trenches; the remaining interval was described by E. M. Schell along a Brunton and tape traverse. Chemical analyses were by K. P. Moore.

Abstract section, CP-37

Sample	Unit	Thickness (ft)	Rock description	Cumulative thickness (ft)	Chemical analyses (percent)					Thickness × percent P ₂ O ₅ (cumulative)
					P ₂ O ₅	V ₂ O ₅	Cr ₂ O ₃	Acid insoluble	Ignition loss	
DINWOODY FORMATION—BASAL UNIT ONLY										
	D-1	5.0+	Limestone, silty	5.0						
PARK CITY FORMATION AND RELATED STRATA Rex Chert Tongue of Phosphoria Formation										
	P-83	43.0	Chert, carbonatic	43.0						
Franson Member of Park City Formation										
	P-82	34.0	Limestone	77.0						
	P-81	7.0	Dolomite	84.0						
	P-80	120.0	Limestone	204.0						
			Top of trench							
	P-79	80.0	Dolomite	284.0						
Meade Peak Phosphatic Shale Tongue of Phosphoria Formation										
CP-37-66	P-78	2.8	Phosphorite; top of unit is faulted; P-77 and P-78 range from 5.5 ft thick to about 13 ft thick	286.8	28.59	0.06	0.11	13.74	5.64	80.05
65	P-77	2.7	Phosphorite	289.5	28.80	.06	.13	12.37	6.23	157.81
64	P-76	4.0	Fault zone	293.5	9.51	.03	.03	61.97		195.85
63	P-75	5.0	Fault zone	298.5	12.36	.03	.06	44.68		257.65
62	P-74	6.0	Sandstone, calcareous	304.5	2.40			46.44		272.05
61	P-73	5.0	Sandstone, similar to unit P-74	309.5	1.68			61.98	13.33	280.45
60	P-72	5.0	Sandstone, similar to unit P-74	314.5	0			10.98		280.45
59	P-71	5.0	Sandstone, similar to unit P-74	319.5	0			28.23		280.45
58	P-70	5.0	Sandstone, similar to unit P-74	324.5	.08			68.53		280.85
57	P-69	5.0	Sandstone, similar to unit P-74	329.5	0			64.03		280.85
56	P-68	5.0	Fault zone	334.5	0	.02	.01	64.71		280.85
55	P-67	5.0	Fault zone, similar to unit P-68	339.5	0	.04	.01	89.28		280.85
54	P-66	5.0	Fault zone, similar to unit P-68	344.5	2.77	.03	.01	84.28		294.70
53	P-65	3.0	Fault zone, similar to unit P-68	347.5	4.57	.05	.04	53.21		308.41
52	P-64	2.8	Chert	350.3	4.43	.03	.02	84.08		320.81
51	P-63	3.0	Siltstone	353.3	4.91	.03	.03	80.65		335.54
50	P-62	5.0	Siltstone, similar to unit P-63	358.3	5.41	.04	.02	80.92		362.59
49	P-61	5.0	Siltstone, similar to unit P-63	363.3	4.39	.04	.07	78.79		384.54
48	P-60	5.0	Siltstone, similar to unit P-63	368.3	0	.10	.07	91.72		384.54
47	P-59	4.0	Siltstone	372.3	1.44			88.94		390.30
46	P-58	4.5	Siltstone, similar to unit P-59	376.8	.59			87.22		392.95
45	P-57	5.0	Fault zone	381.8	0	.11	.02	89.96		392.95
44	P-56	2.3	Siltstone	384.1	.01			89.01		392.97
43	P-55	1.8	Siltstone, dolomitic	385.9	0			57.87		392.97
42	P-54	.6	Chert, silty	386.5	0			74.77		392.97
41	P-53	5.0	Siltstone	391.5	0			76.26		392.97
40	P-52	5.0	Siltstone, similar to unit P-53	396.5	1.26			82.29		399.27
39	P-51	.5	Phosphorite, siliceous	397.0	27.28	.03	.14	17.99	5.78	412.91
38	P-50	2.2	Siltstone, micaceous	399.2	.01	.08	.03	86.72	4.74	412.93
37	P-49	2.0	Siltstone, dolomitic	401.2	.90	.04	.04	66.71	13.15	414.73
36	P-48	1.7	Mudstone and phosphorite, interbedded	402.9	16.51	.04	.16	40.19	6.78	442.79
35	P-47	1.7	Mudstone and phosphorite, similar to unit P-48	404.6	10.85	.03	.12	42.33	13.02	461.23
34	P-46	3.0	Dolomite, argillaceous, silty	407.6	4.69	.04	.12	54.93	12.88	475.30
33	P-45	2.5	Dolomite, similar to unit P-46	410.1	0	.04	.03	65.99	14.22	475.30
32	P-44	2.5	Dolomite, similar to unit P-46	412.6	6.00	.04	.17	42.87	15.54	490.30

Abstract section, CP-37—Continued

Sample	Unit	Thickness (ft)	Rock description	Cumulative thickness (ft)	Chemical analyses (percent)					Thickness × percent P ₂ O ₅ (cumulative)
					P ₂ O ₅	V ₂ O ₅	Cr ₂ O ₃	Acid insoluble	Ignition loss	
PARK CITY FORMATION AND RELATED STRATA—Continued										
Meade Park Phosphatic Shale Tongue of Phosphoria Formation—Continued										
CP-37-31	P-43	2.5	Dolomite, similar to unit P-46	415.1	2.90	.04	.20	41.62	18.86	497.55
30	P-42	2.5	Dolomite, similar to unit P-46	417.6	6.74	.03	.19	41.76	16.62	514.40
29	P-41	2.5	Dolomite, similar to unit P-46	420.1	7.20	.04	.14	53.56	10.58	532.40
28	P-40	2.5	Dolomite, similar to unit P-46	422.6	0	.01	.05	25.68	32.02	532.40
27	P-39	2.5	Dolomite, similar to unit P-46	425.1	0	.004	.01	24.05	35.77	532.40
26	P-38	2.5	Dolomite, similar to unit P-46	427.6	0	.02	.04	37.42	27.06	532.40
25	P-37	1.4	Chert, carbonatic	429.0	0	.007	.006	63.79		532.40
24	P-36	1.5	Dolomite, argillaceous	430.5	0	.004	.006	20.69	36.91	532.40
23	P-35	1.4	Fault zone	431.9	0	.06	.08	69.74		532.40
22	P-34	1.8	Mudstone, silty	433.7	0	.10	.14	73.53	7.68	532.40
21	P-33	1.5	Siltstone, argillaceous	435.2	6.34	.08	.08	69.56	6.03	541.91
20	P-32	.5	Mudstone, silty	435.7	8.98	.08	.14	55.76	7.04	546.40
19	P-31	1.8	Dolomite	437.5	.02	.01	.01	13.64	39.38	546.43
18	P-30	1.9	Dolomite, similar to unit P-31	439.4	.02	.01	.01	11.64	41.37	546.46
17	P-29	.7	Siltstone	440.1	4.78	.04	.04	65.72	7.74	549.80
16	P-28	.7	Mudstone, phosphatic, silty	440.8	14.93	.04	.17	46.86	6.86	560.25
15	P-27	.5	Phosphorite	441.3	32.31	.02	.09	7.53	5.09	576.40
14	P-26	2.3	Siltstone, phosphatic	443.6	17.04	.04	.16	35.92	8.81	615.59
13	P-25	2.2	Siltstone, similar to unit P-26	445.8	13.72	.03	.13	40.55	9.55	645.77
12	P-24	2.5	Mudstone, phosphatic, silty	448.3	12.80	.05	.27	45.78	8.80	677.77
11	P-23	2.5	Mudstone, similar to unit P-24	450.8	12.77	.04	.16	49.21	7.26	*699.69
	(29.5)		Faulted and folded zone							
	P-22	2.0	Chert	452.8						
CP-37-10	P-21	1.2	Siltstone, phosphatic, argillaceous	454.0	15.85	.05	.25	42.91	7.27	19.02
9	P-20	.4	Phosphorite	454.4	28.35	.02	.05	18.01	3.65	30.36
8	P-19	.2	Siltstone, phosphatic	454.6	12.85	.004	.04	58.21	2.97	*32.93
	P-18	.4	Fault zone	455.0						
Grandeur Member of Park City Formation										
	P-17	20.0	Dolomite	475.0						
	P-16	17.0	Dolomite	492.0						
			Base of trench							
	P-15	121.0	Dolomite, limestone, and chert float	613.0						
			Top of trench							
	P-14	2.0	Chert	615.0						
	P-13	2.4	Dolomite	617.4						
CP-37-7	P-12	2.0	Phosphorite	619.4	27.90	.05	.06	9.97	8.58	55.80
6	P-11	2.0	Phosphorite, similar to unit P-12	621.4	26.77	.06	.07	7.35	8.83	109.34
5	P-10	2.0	Phosphorite, similar to unit P-12	623.4	25.80	.06	.07	7.59	11.18	160.94
4	P-9	.4	Phosphorite	623.8	17.34	.02	.03	8.85	20.25	167.87
3	P-8	2.0	Phosphorite	625.8	26.88	.03	.04	8.97	8.89	221.63
2	P-7	1.2	Siltstone, dolomitic	627.0	1.38	.01	.01	66.68	13.49	223.28
1	P-6	1.3	Phosphorite	628.3	21.19	.03	.05	13.42	13.48	*250.82
	P-5	3.0	Fault zone	631.3						
	P-4	2.5	Dolomite	633.8						
	P-3	2.0	Limestone	635.8						
	P-2	4.2	Limestone	640.0						
			Base of trench							
	P-1	35.0	Limestone and dolomite, mostly float	675.0						
			Contact with Weber Quartzite below							

*Cumulative data incomplete. Computations start with zero after interruption.

Detailed description, CP-37

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
DINWOODY FORMATION—BASAL UNIT ONLY			
D-1	Limestone, light-brownish-gray (5YR 6/1), very fine grained, silty, hard, thick-bedded; contains gastropods and bioclastic debris	5.0+	5.0
PARK CITY FORMATION AND RELATED STRATA Rex Chert Tongue of Phosphoria Formation			
P-83	Chert, medium-light-gray (N 6/0), spicular, carbonatic, hard, massive, brecciated, concretionary; grades into a cherty limestone in upper part of unit	43.0	43.0
Franson Member of Park City Formation			
P-82	Limestone, very light gray (N 8/0), very fine grained, hard, massive; contains abundant bioclastic debris; contains fine-grained, sandy dolomite near middle of unit	34.0	77.0
81	Dolomite, medium-light-gray (N 6/0), very fine grained, hard; indistinct bedding; contains some light-gray spicular chert beds	7.0	84.0
80	Limestone, light-gray (N 7/0), fine- to coarse-grained, hard, massive; brecciated and cemented by calcite; includes chert and dolomite float; exposures are poor; ledge former in part	120.0	204.0
	Top of trench		
P-79	Dolomite, dark-grayish-brown (2.5Y 4/2), very fine grained, silty, hard, thin-bedded to massive, brecciated; contains sparse phosphorite pellets and chert pods and lenses; contains several small gouge zones	80.0	284.0
Meade Peak Phosphatic Shale Tongue of Phosphoria Formation			
P-78	Phosphorite, very dark gray (N 3/0), fine- to medium-pelletal, silty, calcareous, argillaceous, medium-hard, thin- to thick-bedded, brecciated; top of unit is faulted; this unit combined with the underlying unit was measured as 5.5 ft thick on north wall of trench; these two units are about 10 ft thick on south wall of trench, whereas they are about 13 ft thick north of the north wall	2.8	286.8
77	Phosphorite, similar to unit P-78; has sharp contact with unit below	2.7	289.5
76	Fault zone, variegated; dominant colors are dark red (10YR 3/6), pale brown (2.5Y 6/2), and light brownish gray (10YR 5/1); unit consists mainly of sandstone and phosphorite fragments in an unconsolidated sand matrix	4.0	293.5
75	Fault zone, similar to unit P-76; has gradational contact with unit below	5.0	298.5
74	Sandstone, yellowish-gray (10YR 7/1), fine- to coarse-grained, subangular to subrounded, calcareous, hard, thick-bedded to massive; contains argillaceous material, bioclastic debris, and sparse phosphorite pellets; upper part is brecciated and iron stained	6.0	304.5
73	Sandstone, similar to unit P-74	5.0	309.5
72	Sandstone, similar to unit P-74	5.0	314.5
71	Sandstone, similar to unit P-74	5.0	319.5
70	Sandstone, similar to unit P-74	5.0	324.5
69	Sandstone, similar to unit P-74; basal part is brecciated and iron stained and contains some cherty beds; has gradational contact with unit below	5.0	329.5
68	Fault zone, dark-red (10R 3/6) to reddish-yellow (5YR 6/8) to pale-yellowish-orange (10YR 8/6); consists of argillaceous calcareous sandstone and chert fragments; upper part consists of gouge containing spicular chert fragments	5.0	334.5
67	Fault zone, similar to unit P-68	5.0	339.5
66	Fault zone, similar to unit P-68	5.0	344.5
65	Fault zone, similar to unit P-68; primarily gouge containing chert fragments; has gradational contact with unit below	3.0	347.5
64	Chert, brownish-gray (5YR 4/1), silty, spicular, hard, thick-bedded; contains phosphorite pellets; highly fractured and stained dark red (10R 3/6); chip sample contains a gastropod; has gradational contact with unit below	2.8	350.3

Detailed description, CP-37—Continued

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
PARK CITY FORMATION AND RELATED STRATA—Continued Meade Peak Phosphatic Shale Tongue of Phosphoria Formation—Continued			
P-63	Siltstone, weak-red (10R 5/3) to dark-brownish-gray (5YR 3/2), siliceous, hard, thin-bedded; contains numerous chert beds about 0.2 ft thick; this unit and underlying unit are highly fractured	3.0	353.3
62	Siltstone, similar to unit P-63	5.0	358.3
61	Siltstone, similar to unit P-63	5.0	363.3
60	Siltstone, similar to unit P-63; has gradational contact with unit below	5.0	368.3
59	Siltstone, light-yellowish-brown (10YR 6/4), slightly calcareous, hard, thick-bedded, laminated in part	4.0	372.3
58	Siltstone, similar to unit P-59; contains a 0.4-ft-thick brecciated chert bed 2 feet below top of unit; has gradational contact with unit below	4.5	376.8
57	Fault zone, moderate-yellowish-brown (10YR 5/4) stained to yellowish-red (5YR 5/6); consists of brecciated siliceous slightly calcareous siltstone fragments; has sharp contact with unit below	5.0	381.8
56	Siltstone, very pale brown (10YR 7/2), hard, thick-bedded; contains slight iron oxide staining; contains a 0.1-ft-thick phosphorite bed at upper contact; has sharp contact with unit below	2.3	384.1
55	Siltstone, pale-brown (10YR 6/2), dolomitic, argillaceous, siliceous in part, medium-hard, thick-bedded; has sharp contact with unit below	1.8	385.9
54	Chert, light-brown (2.5YR 6/4), calcareous, silty, hard, thick-bedded; has sharp contact with unit below	.6	386.5
53	Siltstone, pale-brown (10YR 5/2) to brownish-black (10YR 2/1), medium-hard, thick-bedded; colors are light because of weathering	5.0	391.5
52	Siltstone, similar to unit P-53; has gradational contact with unit below	5.0	396.5
51	Phosphorite, very dark gray (N 3/0), fine- to coarse-pelletal, siliceous, slightly silty and calcareous, hard, thick-bedded; has sharp contact with unit below	.5	397.0
50	Siltstone, moderate-yellowish-brown (10YR 5/4), micaceous, medium-hard, thick-bedded; has sharp contact with unit below	2.2	399.2
49	Siltstone, pale-brown (10YR 5/3), dolomitic, slightly calcareous, medium-hard, thick-bedded; has sharp contact with unit below	2.0	401.2
48	Mudstone and phosphorite, interbedded. Mudstone, pale-brown (5YR 5/2), phosphatic, silty, calcareous, medium-hard, thin-bedded. Phosphorite, grayish-brown (7.5Y 4/2), fine- to coarse-pelletal, argillaceous, silty, medium-hard, thin-bedded; contains calcite-filled chert pods	1.7	402.9
47	Mudstone and phosphorite, similar to unit P-48; has sharp contact with unit below	1.7	404.6
46	Dolomite, dark-yellowish-brown (10YR 4/2), very fine grained, argillaceous, silty, medium-hard, thick-bedded; contains sparse phosphorite pellets, calcite and chert pods, and numerous small gouge zones; contains a less than 0.1-ft-thick phosphorite bed near base	3.0	407.6
45	Dolomite, similar to unit P-46	2.5	410.1
44	Dolomite, similar to unit P-46; contains a 0.1-ft-thick phosphorite bed near base	2.5	412.6
43	Dolomite, similar to unit P-46; contains a 0.1-ft-thick phosphorite bed near base	2.5	415.1
42	Dolomite, similar to unit P-46; contains a 0.1-ft-thick phosphorite bed near middle	2.5	417.6
41	Dolomite, similar to unit P-46	2.5	420.1
40	Dolomite, similar to unit P-46	2.5	422.6
39	Dolomite, similar to unit P-46	2.5	425.1
38	Dolomite, similar to unit P-46; has sharp contact with unit below	2.5	427.6
37	Chert, very dark gray (N 3/0) to medium-gray (N 6/0), calcareous, hard, brecciated, nodular; indistinct bedding; contains calcite rods; has sharp contact with unit below	1.4	429.0

Detailed description, CP-37—Continued

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
PARK CITY FORMATION AND RELATED STRATA—Continued Meade Peak Phosphatic Shale Tongue of Phosphoria Formation— Continued			
P-36	Dolomite, pale-brown (2.5Y 6/2), very fine grained, argillaceous, medium-hard, brecciated; indistinct bedding; contains sparse chert nodules; has indistinct contact with unit below.....	1.5	430.5
35	Fault zone, light-yellowish brown (10YR 4/2); consists of calcareous soft unconsolidated mudstone; has indistinct contact with unit below.....	1.4	431.9
34	Mudstone, brownish-black (10YR 2/1) (weathers moderate yellowish brown (10YR 4/4)), slightly calcareous, silty, soft, fissile; contains sparse chert pods; has sharp contact with unit below.....	1.8	433.7
33	Siltstone, pale-brown (2.5YR 5/2), argillaceous, slightly calcareous, soft, thick-bedded; contains fine to coarse phosphorite pellets and irregular phosphorite lenses; has gradational contact with unit below.....	1.5	435.2
32	Mudstone, pale-brown (2.5Y 6/2), slightly calcareous, silty, soft, thick-bedded; contains phosphorite that ranges from finely pelletal to nodules as much as 1 in. in diameter; has sharp contact with unit below.....	.5	435.7
31	Dolomite, grayish-brown (2.5Y 5/2), very fine grained, slightly argillaceous, medium-hard, massive.....	1.8	437.5
30	Dolomite, similar to unit P-31; has gradational contact with unit below.....	1.9	439.4
29	Siltstone, light-yellowish-brown (10YR 6/4), slightly calcareous and argillaceous, medium-hard, thick-bedded; contains fine to medium phosphorite pellets and numerous calcite-lined chert geodes; has gradational contact with unit below.....	.7	440.1
28	Mudstone, dark-yellowish-brown (10YR 4/2), phosphatic, slightly calcareous, silty, medium-hard, thin- to thick-bedded; contains fine to coarse phosphorite pellets and several thin phosphorite beds; has gradational contact with unit below.....	.7	440.8
27	Phosphorite, very dark gray (N 3/0), fine- to coarse-pelletal, slightly calcareous and silty, medium-hard, thick-bedded; contains sparse phosphorite nodules; has sharp contact with unit below.....	.5	441.3
26	Siltstone, grayish-brown (10YR 4/3), phosphatic, slightly argillaceous and calcareous, medium-hard, thin-bedded; contains fine to medium phosphorite pellets, and chert nodules.....	2.3	443.6
25	Siltstone, similar to unit P-26; has gradational contact with unit below.....	2.2	445.8
24	Mudstone, grayish-brown (7.5YR 4/2), phosphatic, slightly calcareous, silty, soft, thin-bedded, brecciated; contains fine to coarse phosphorite pellets, and chert concretions.....	2.5	448.3
23	Mudstone, similar to unit P-24; has indistinct contact with unit below.....	2.5	450.8
	Faulted and folded zone; contains several fault gouge zones and highly concorted zones; consists primarily of dolomite rubble and some chert and phosphorite rubble. Interval measured with Jacob staff set at 30°. Attitude of beds above and below unit interval is nearly parallel.....	(29.5)	---
P-22	Chert, very dark gray (N 3/0), hard, massive, brecciated; has sharp contact with unit below.....	2.0	452.8
21	Siltstone, light-brownish-gray (10YR 5/1), phosphatic, argillaceous, soft; indistinct bedding; contains fine to coarse phosphorite pellets; contains a 0.1-ft-thick phosphorite bed in upper part; upper half is stained pale red (10R 6/2); has sharp contact with unit below.....	1.2	454.0
20	Phosphorite, medium-gray (N 5/0), fine-pelletal to nodules as much as 5 mm in diameter, slightly calcareous and argillaceous, hard, thick-bedded; contains abundant phosphatic bioclastic debris; has sharp contact with unit below.....	.4	454.4

Detailed description, CP-37—Continued

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
PARK CITY FORMATION AND RELATED STRATA—Continued Meade Peak Phosphatic Shale Tongue of Phosphoria Formation— Continued			
P-19	Siltstone, very pale brown (10YR 7/2), phosphatic, argillaceous, medium-hard, thick-bedded; contains phosphorite consisting of fine to coarse pellets, sparse reworked nodules, laminae, and phosphatic bioclastic debris; has sharp contact with unit below.....	.2	454.6
18	Fault zone, weak-yellowish-orange (10YR 7/6); consists of gouge and fragments of dolomite and siltstone; appears to be a near-bedding-plane fault.....	.4	455.0
Grandeur Member of Park City Formation			
P-17	Dolomite, light-brownish-gray (10YR 5/1), very fine grained, hard, thick-bedded to massive; fracture is conchoidal; contains brachiopods (orbiculoids).....	27.0	475.0
16	Dolomite, brownish-gray (10YR 4/1), very fine grained, hard, thick-bedded to massive; fracture is conchoidal; contains small calcite pods, dark-gray chert pods and lenses, and sparse very fine phosphatic debris; contains brachiopods (orbiculoids). Similar to unit P-17.....	17.0	492.0
	Base of trench.....		
P-15	Dolomite, limestone, and chert float; dark-gray (weathers light gray).....	121.00	613.0
	Top of trench.....		
P-14	Chert, dark-gray (N 4/0), hard, massive, brecciated, possibly lenticular; contains calcareous pods; has sharp contact with unit below.....	2.0	615.0
13	Dolomite, pale-brown (7.5YR 6/2), very fine grained, hard, thick-bedded; contains chert pods; has gradational contact with unit below.....	2.4	617.4
12	Phosphorite, light-brownish-gray (10YR 6/1), fine- to coarse-pelletal, slightly calcareous and silty, hard, thin- to thick-bedded; contains calcite veinlets.....	2.0	619.4
11	Phosphorite, similar to unit P-12.....	2.0	621.4
10	Phosphorite, similar to unit P-12; has sharp contact with unit below.....	2.0	623.4
9	Phosphorite, light-brownish-gray (10YR 6/1), fine-pelletal, calcareous, slightly argillaceous, hard, thick-bedded; has sharp contact with unit below.....	.4	623.8
8	Phosphorite, dark-gray (N 4/0), fine- to medium-pelletal, slightly calcareous, medium-hard, thin- to thick-bedded; has gradational contact with unit below.....	2.0	625.8
7	Siltstone, strong-brown (7.5YR 5/6) dolomitic, medium-hard, thick-bedded; contains sparse dark grains; has gradational contact with unit below.....	1.2	627.0
6	Phosphorite, medium-gray (N 5/0), fine- to coarse-pelletal, calcareous, slightly silty and argillaceous, medium-hard, thin- to thick-bedded; has sharp contact with unit below.....	1.3	628.3
5	Fault zone; consists of a limestone breccia, light-red (2.5YR 6/1) to moderate-orange (7.5YR 6/6), very fine grained, argillaceous, medium-hard, thick-bedded; upper and lower parts are in place and only partially brecciated; appears to be a near-bedding-plane fault.....	3.0	631.3
4	Dolomite, light-brownish-gray (10YR 5/1), very fine grained, slightly argillaceous, hard, massive; has sharp contact with unit below.....	2.5	633.8
3	Limestone, moderate-orange (7.5YR 6/6), very fine grained, slightly argillaceous, medium-hard, thick-bedded; unit may be faulted; has sharp contact with unit below.....	2.0	635.8
2	Limestone, pale-brown (2.5Y 6/2), very fine grained, hard, massive; contains calcite veinlets and sparse phosphatic bioclastic debris.....	4.2	640.0
	Base of trench.....		
P-1	Limestone and dolomite, mostly float; light-gray (N 7/0), very fine grained, hard, thick-bedded to massive; contains cherty carbonate rock beds.....	35.0	675.0
	Contact with Weber Quartzite below.....		

OGDEN CANYON, CP-38

Trench CP-38 is in Ogden Canyon, NW¼-SW¼ sec. 16, T. 6 N., R. 1 E., Salt Lake meridian, Weber County, Utah. The phosphatic shale member of the Deseret Limestone and adjacent

rocks was described and sampled by E. M. Schell in an old roadcut on the north side of Ogden Canyon. The section is overturned, and the surrounding area is highly folded and faulted. The description is from stratigraphic top to base. Chemical analyses were by K. P. Moore.

Abstract section of only the phosphatic shale member of the Deseret Limestone and adjacent rocks, CP-38

Sample	Unit	Thickness (ft)	Rock description	Cumulative thickness (ft)	Chemical analyses (percent)				
					P ₂ O ₅	V ₂ O ₅	Cr ₂ O ₃	Acid insoluble	Ignition loss
CP-38-1	M-15	4.0+	Limestone	4.0					
	M-14	3.3	Limestone, argillaceous, siliceous	7.3	4.12	0.10	0.04	30.08	27.12
	2	.2	Phosphorite	7.5	24.71	.02	.02	6.56	13.46
	3	1.9	Limestone, argillaceous, siliceous	9.4	2.35	.04	.01	30.44	27.95
	4	.94	Limestone and phosphorite, interbedded	10.34	8.57	.06	.04	27.71	24.94
	5	1.81	Limestone and phosphorite, interbedded	12.15	11.17	.03	.03	30.42	19.99
	6	1.29	Limestone and phosphorite, interbedded	13.44	3.55	.02	.02	14.58	35.31
	7	.8	Limestone, argillaceous	14.24	0	.01	.02	34.75	29.98
	8	1.0	Phosphorite, argillaceous, calcareous	15.24	17.76	.08	.10	21.76	19.88
	9	1.3	Limestone, argillaceous	16.54	0	.02	.01	39.21	25.45
	10	1.8	Limestone, argillaceous	18.34	0	.03	.02	41.70	27.94
	M-4	2.0	Mudstone and phosphorite, interbedded	20.34	13.87	.08	.10	30.60	18.07
	M-3	.8	Limestone, siliceous	21.14					
	M-2	.2	Limestone, argillaceous	21.34					
	M-1	10.0+	Limestone	31.34					

Detailed description of only the phosphatic shale member of the Deseret Limestone and adjacent rocks, CP-38

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
M-15	Limestone, black (N 2/0), very fine grained, hard, massive; contains calcite veinlets	4.0+	4.0
14	Limestone, black (N 2/0), very fine grained, argillaceous, siliceous, sooty, hard, fissile to thin-bedded; contains phosphorite pellets	3.3	7.3
13	Phosphorite, black (N 2/0), fine- to coarse-pelletal, calcareous, hard, thin-bedded	.2	7.5
12	Limestone, black (N 2/0), very fine grained, argillaceous, siliceous, sooty, hard, massive	1.9	9.4
11	Limestone and phosphorite, interbedded. Limestone, black (N 2/0), very fine grained, argillaceous, hard, fissile to thick-bedded. Phosphorite, black (N 2/0), fine- to coarse-pelletal, calcareous, hard, thin-bedded. From top to base, unit consists of the following sequence:		
	Limestone, fissile	0.07	
	Phosphorite	.05	
	Limestone, thick-bedded	.33	
	Limestone, fissile	.05	
	Limestone, thick-bedded	.32	
	Limestone, fissile	.12	
	Total, unit M-11	0.94	10.34
10	Limestone and phosphorite, interbedded. Limestone black (N 2/0), very fine grained, phosphatic, fissile to thin-bedded; some beds are argillaceous and fissile, others are hard single beds. Phosphorite, black (N 2/0), fine- to coarse-pelletal, calcareous, hard, thin-bedded. Unit consists of the following sequence from top to base:		
	Phosphorite	0.07	
	Limestone, fissile	.02	
	Limestone, thin-bedded	.10	
	Limestone, fissile	.04	
	Phosphorite	.09	
	Limestone, fissile	.02	
	Phosphorite	.08	
	Limestone, thin-bedded	.18	
	Phosphorite	.05	
	Limestone, fissile	.02	
	Limestone, thin-bedded	.15	

Detailed description of only the phosphatic shale member of the Deseret Limestone and adjacent rocks, CP-38
—Continued

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
	Phosphorite	.12	
	Limestone, fissile	.30	
	Phosphorite	.15	
	Limestone, fissile	.12	
	Limestone, thin-bedded	.22	
	Limestone, fissile	.02	
	Phosphorite	.06	
	Total, unit M-10	1.81	12.15
M-9	Limestone and phosphorite, interbedded; similar to unit M-10. Unit consists of the following sequence from top to base:		
	Limestone, fissile	0.18	
	Limestone, thin-bedded	.80	
	Limestone, fissile	.12	
	Phosphorite	.15	
	Limestone, fissile	.04	
	Total, unit M-9	1.29	13.44
8	Limestone, black (N 2/0), very fine grained, argillaceous, sooty, hard, thin-bedded; fracture is platy	.8	14.24
7	Phosphorite, black (N 2/0), fine- to coarse-pelletal, argillaceous, calcareous, sooty, fissile; weathered rock is soft, unweathered rock is hard; contains limestone laminae and a 0.3-ft-thick limestone bed 0.1 ft below top	1.0	15.24
6	Limestone, black (N 2/0), very fine grained, argillaceous, hard, massive	1.3	16.54
5	Limestone, dark-yellowish-brown (10YR 4/2), very fine grained, argillaceous, hard, massive; contains a 0.2-ft-thick fissile limestone bed at top	1.8	18.34
4	Mudstone and phosphorite, interbedded. Mudstone, black (N 2/0), calcareous, phosphatic, soft, fissile. Phosphorite, fine- to coarse-pelletal; consists of laminae less than 0.1 ft thick	2.0	20.34
3	Limestone, black (N 2/0), sublithographic, siliceous, hard, thick-bedded	.8	21.14
2	Limestone, brownish-gray (5YR 4/1), very fine grained, argillaceous, soft, fissile	.2	21.34
1	Limestone, dark-gray, very fine grained, hard, massive; contains chert pods and lenses	10.0+	31.34

WHEAT GRASS CREEK, CP-44

Trench CP-44 is at Wheat Grass Creek, SE¼NW¼NE¼ sec. 26, T. 7N., R. 3 E., Salt Lake meridian, Weber County, Utah. The phos-

phatic section at the base of the Humbug Formation was sampled and described by E. M. Schell and T. E. Mullens in a hand-excavated trench. Chemical analyses were by K. P. Moore.

Abstract section, CP-44

Sample	Unit	Thickness (ft)	Rock description	Cumulative thickness (ft)	Chemical analyses (percent)				Thickness × percent P ₂ O ₅ (cumulative)
					P ₂ O ₅	V ₂ O ₅	Cr ₂ O ₃	Acid insoluble	
Humbug Formation—basal part only									
	M-15		Limestone						
			Top of trench						
CP-44-14	M-14	5.5	Mudstone, dolomitic	5.5	3.83	0.11	0.09	50.09	21.06
13	M-13	1.1	Phosphorite, argillaceous, calcareous	6.6	18.34	.09	.03	15.84	41.23
12	M-12	.6	Mudstone and phosphorite	7.3	15.03	.19	.13	33.63	50.25
11	M-11	.3	Phosphorite, calcareous	7.6	23.50	.06	.03	8.62	57.30
10	M-10	1.5	Limestone and mudstone	9.1	4.68	.08	.03	24.54	64.32
9	M-9	.1	Phosphorite, dolomitic	9.2	19.72	.05	.03	11.96	66.29
8	M-8	.5	Phosphorite, argillaceous	9.7	15.86	.15	.11	33.06	74.22
7	M-7	.6	Phosphorite, calcareous	10.3	24.20	.09	.05	13.98	88.74
6	M-6	.7	Phosphorite and mudstone	11.0	21.65	.14	.09	21.54	103.89
5	M-5	.6	Phosphorite	11.6	27.74	.09	.06	6.34	120.53
4	M-4	.9	Phosphorite and mudstone	12.5	19.44	.16	.08	24.88	138.03
3	M-3	1.5	Phosphorite	14.0	28.69	.05	.04	4.12	181.06
2	M-2	.4	Mudstone, phosphatic, calcareous	14.4	13.54	.11	.24	37.23	186.48
1	M-1	.5	Clay and mudstone (fault zone)	14.9	12.20	.12	.36	28.90	192.58
Lodgepole Limestone									
		3.0+	Limestone, sandy						
			Base of trench						

Detailed description, CP-44

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
Humbug Formation—basal part only			
M-15	Limestone, very dark gray (N 3/0), very fine grained, hard, massive; contains sparse chert nodules about 1 in. long		
	Top of trench		
14	Mudstone, brownish-gray (5YR 4/1), dolomitic, soft, thin- to thick-bedded, concretionary, hackly- to shaly-weathering; contains a 0.2-ft-thick phosphatic mudstone 0.4 ft above base; has gradational basal contact	5.5	5.5
13	Phosphorite, brownish-gray (5YR 4/1), fine-pelletal, argillaceous, calcareous, soft, thin- to thick-bedded; contains hard poorly formed very fine grained dolomitic argillaceous concretions	1.1	6.6
12	Mudstone and phosphorite, interbedded. Mudstone, black (N 2/0), slightly calcareous, soft, fissile to thin-bedded; appears to be non-phosphatic. Phosphorite, black (N 2/0), fine- to medium-pelletal, calcareous, argillaceous, soft, thin-bedded; contains sparse phosphorite nodules. Has sharp basal contact	.6	7.3
11	Phosphorite, black (N 2/0), fine- to coarse-pelletal, calcareous, hard, thin-bedded; contains some shaly interbeds; has gradational basal contact	.3	7.6
10	Limestone and mudstone. Bulk of unit made up of massive very fine grained limestone concretions as much as 0.9 ft in diameter. Mudstone, dark-grayish-brown (10YR 3/2), thin-bedded to fissile. Upper part of unit contains a 0.05-ft-thick phosphatic mudstone. Has sharp basal contact	1.5	9.1
9	Phosphorite, brownish-gray (10YR 4/1), fine-pelletal, dolomitic, hard, thin-bedded; has gradational basal contact	.1	9.2
8	Phosphorite, brownish-black (5YR 2/1), fine- to very coarse-pelletal, argillaceous, slightly calcareous, soft, thin-bedded; has gradational basal contact	.5	9.7
7	Phosphorite, brownish-black (5YR 2/1), fine- to coarse-pelletal and some very coarse pelletal,		

Detailed description, CP-44—Continued

Unit	Rock description	Thick- ness (ft)	Cumu- lative thick- ness (ft)
Humbug Formation—basal part only—Continued			
	calcareous, medium-hard, thin- to thick-bedded; contains sparse nodules of phosphatic limestone; has gradational basal contact	.6	10.3
M-6	Phosphorite and mudstone, brownish-black (5YR 2/1), medium-hard, thin-bedded. Phosphorite, fine- to medium-pelletal, calcareous. Mudstone, fine-pelletal, slightly calcareous and phosphatic. Has gradational basal contact	.7	11.0
5	Phosphorite, black (N 2/1), very coarse to fine-pelletal, slightly calcareous, medium-hard, thin-bedded; contains thin phosphatic limestone beds and four mudstone laminae; has gradational basal contact	.6	11.6
4	Phosphorite and mudstone, brownish-black (5YR 2/1), thin-bedded. Phosphorite, very coarse to fine-pelletal, slightly calcareous, soft to medium-hard. Mudstone, phosphatic and slightly calcareous, soft. Basal contact is gradational	.9	12.5
3	Phosphorite, brownish-black (5YR 2/1), very coarse to fine-pelletal, slightly calcareous and argillaceous, medium-hard, massive; contains nodules as much as 0.2 ft in diameter near middle and top; basal contact is gradational	1.5	14.0
2	Mudstone, very dark gray (N 6/0), phosphatic, calcareous, soft, fissile to platy; has gradational basal contact	.4	14.4
1	Clay and mudstone, reddish-brown, dark-brown, and medium- to light-gray, phosphatic, slightly calcareous, soft, shaly-weathering. Unit appears to be a fault zone that locally crushes underlying bed	.5	14.9
Lodgepole Limestone			
	Limestone, light-brownish-gray (5YR 6/1), very fine grained, sandy, hard, massive; contains thin irregular chert beds, and fossil spines and hash. Base not exposed		
	Base of trench		

