

COLUMNAR SECTION PHOSPHATIC SHALE MEMBER

U. S. Geological Survey
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THICK- IN BED NO.	THICK- IN FEET	COLOR Munsell	MODAL GRAIN SIZE	ROCK COMPOSITION	THICKNESS OF BEDDING IN FEET	ROCK NAME AND COLOR	QUARTZ-SILICATE MINERALS IDENTIFIED IN THIN SECTION	ACCESSORY MINERALS IDENTIFIED IN THIN SECTION	MINERALS IDENTIFIED BY X-RAY ANALYSIS	STRUCTURES	SPECIAL FEATURES
P-107	5.7	10YR 5/2	fine	Carbonate rock; light brownish gray	102	Carbonate rock; light brownish gray	qtz, mxl qtz, ab, musc	Fe ox, tit-leuc	apa, dol, cal, qtz, ortho, musc-ill, kaol	carb fossil frag	
P-106	0.3	10YR 5/2	fine	Phosphorite; brownish gray	96	Phosphorite; brownish gray	qtz, musc	Fe ox	apa, cal(?) , qtz, ortho musc-ill, kaol	apa pel	
P-104	0.5	10YR 5/2	fine	Quartz-silicate rock; grayish brown	95	Quartz-silicate rock; grayish brown	qtz, mxl qtz, microcl, musc, ill, kaol(?)	Fe ox, T, tit-leuc	apa, qtz, ortho, musc-ill, kaol		
P-103	0.5	10YR 5/2	fine	Quartz-silicate rock; grayish brown	94	Quartz-silicate rock; grayish brown	qtz, mxl qtz, musc, ill, kaol	Fe ox, tit, tit-leuc	apa, qtz, musc-ill, kaol		
P-102	3.2	10YR 5/2	fine	Quartz-silicate rock; light brownish gray	102	Quartz-silicate rock; light brownish gray	qtz, ortho, ab, musc	Fe ox, tit-leuc	dol, cal(?) , ortho, ab, musc-ill		
P-101	1.2	10YR 5/2	fine	Quartz-silicate rock; grayish brown	101	Quartz-silicate rock; grayish brown	qtz, ortho, ab, musc, ill, kaol	Fe ox, T, Z, tit	apa, cal(?) , ortho, ab, musc-ill, kaol		
P-100	0.4	10YR 5/2	fine	Phosphorite; brownish gray	99	Phosphorite; brownish gray	qtz, ortho, musc	Fe ox, Z(?)	qtz, ortho, ab (acid insol.)	some apa pel	
P-99	1.4	10YR 5/2	fine	Dolomite; light brownish gray	90	Dolomite; light brownish gray	qtz, mxl qtz, microcl, ortho(?) , ab, musc, biotite	Fe ox, T, Z, tit	dol, cal, qtz, ortho, ab, musc-ill, kaol(?)		
P-98	1.1	10YR 5/2	fine	Phosphorite; brownish gray	97	Phosphorite; brownish gray	qtz, ortho, musc	Fe ox	apa, cal	apa ool and pel	qtz, musc and ortho inclus in ool and pel
P-97	1.9	10YR 5/2	fine	Phosphorite; brownish black	96	Phosphorite; brownish black	qtz, musc	Fe ox, fluor	apa, qtz, musc-ill kaol	apa pel and ool	
P-96	0.7	10YR 5/2	fine	Phosphorite; brownish black	95	Phosphorite; brownish black	qtz, musc	Fe ox	incip, apa pel		
P-95	0.8	10YR 5/2	fine	Phosphorite; brownish black	94	Phosphorite; brownish black	qtz, musc	Fe ox	incip apa pel		
P-94	0.5	10YR 5/2	fine	Phosphorite; brownish black	93	Phosphorite; brownish black	qtz, musc	Fe ox	incip apa pel		
P-93	0.5	10YR 5/2	fine	Phosphorite; brownish gray	92	Phosphorite; brownish gray	qtz, musc	Fe ox	incip apa pel		
P-92	1.1	10YR 5/2	fine	Quartz-silicate rock; grayish brown	91	Quartz-silicate rock; grayish brown	qtz, ortho, ab, musc, ill	Fe ox, T	apa, dol, cal(?) , qtz, ortho, ab, musc-ill, kaol		
P-91	0.4	10YR 5/2	fine	Carbonate rock; light brownish gray	90	Carbonate rock; light brownish gray	qtz, ortho, microcl, musc	Fe ox	dol, cal, qtz, ortho, ab, musc-ill, kaol	carb fossil frag	
P-90	1.9	10YR 5/2	fine	Phosphorite; brownish gray	89	Phosphorite; brownish gray	qtz, musc	Fe ox	qtz, ortho (acid insol.)	incip apa pel	
P-89	0.7	10YR 5/2	fine	Phosphorite; brownish gray	88	Phosphorite; brownish gray	qtz, musc	Fe ox, fluor	apa, cal, qtz	apa pel	rel. much fluor, purple and colorless
P-88	0.6	10YR 5/2	fine	Phosphorite; brownish gray	87	Phosphorite; brownish gray	qtz, musc	Fe ox, T	apa pel		
P-87	0.6	10YR 5/2	fine	Phosphorite; brownish gray	86	Phosphorite; brownish gray	qtz, musc	Fe ox	apa pel		
P-86	0.5	10YR 5/2	fine	Phosphorite; dusky brown	85	Phosphorite; dusky brown	qtz, musc	Fe ox	apa pel		
P-85	0.9	10YR 5/2	fine	Phosphorite; dusky brown	84	Phosphorite; dusky brown	qtz	Fe ox, fluor	apa pel and ool		purple and colorless fluor
P-84	1.8	10YR 5/2	fine	Phosphorite; brownish gray	83	Phosphorite; brownish gray	qtz, ab, musc	Fe ox, fluor	qtz, ortho, ab(acid insol.)	apa fossil frag, apa pel	qtz-sil interbed, qtz inclus. in apa pel, purple and colorless fluor
P-83	1.0	10YR 5/2	fine	Phosphorite; brownish gray	82	Phosphorite; brownish gray	qtz, mxl qtz, musc	Fe ox, T, Z, tit	apa, qtz, kaol(?)	apa fossil frag	
P-82	1.7	10YR 5/2	fine	Carbonate rock; light brownish gray	81	Carbonate rock; light brownish gray	qtz, ab, microcl(?) , musc, biotite, kaol	Fe ox, T, Z	dol, cal, qtz, ortho, ab, musc-ill, kaol		
P-81	2.0	10YR 5/2	fine	Quartz-silicate rock; brownish gray	80	Quartz-silicate rock; brownish gray	qtz, microcl, musc	Fe ox	apa, dol, qtz, ortho, ab, musc-ill, kaol		phos interbed
P-80	1.0	10YR 5/2	fine	Quartz-silicate rock; brownish gray	79	Quartz-silicate rock; brownish gray	qtz, musc	Fe ox, tit	apa, dol, cal, qtz, musc-ill, kaol	apa pel, foram	carb and phos interbeds, apa pel replaced by carb
P-79	0.8	10YR 5/2	fine	Quartz-silicate rock; brownish gray	78	Quartz-silicate rock; brownish gray	qtz, musc, kaol	Fe ox	apa, dol, cal, qtz, ortho, musc-ill, kaol	carb fossil frag	carb interbed
P-78	0.4	10YR 5/2	fine	Phosphorite; brownish black	77	Phosphorite; brownish black	qtz	Fe ox	apa, musc-ill	apa pel	
P-77	2.1	10YR 5/2	fine	Carbonate rock; brownish gray	76	Carbonate rock; brownish gray	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	phos and qtz-sil interbeds, apa pel replaced by carb
P-76	1.6	10YR 5/2	fine	Limestone; light brownish gray	75	Limestone; light brownish gray	qtz, ortho, microcl, musc	Fe ox	dol, cal, qtz, ortho, musc-ill	cal shell frag	
P-75	0.6	10YR 5/2	fine	Quartz-silicate rock; grayish black	74	Quartz-silicate rock; grayish black	qtz, ab, musc	Fe ox	apa, dol, cal(?) , qtz, ortho, ab, musc-ill kaol	apa fossil frag	black opaque matrix
P-74	0.4	10YR 5/2	fine	Quartz-silicate rock; grayish black	73	Quartz-silicate rock; grayish black	qtz, ab, musc	Fe ox	dol, cal, qtz, ortho, ab, musc-ill		black opaque matrix
P-73	0.6	10YR 5/2	fine	Quartz-silicate rock; grayish black	72	Quartz-silicate rock; grayish black	qtz, musc	Fe ox	dol, qtz, ortho, ab, musc-ill		black opaque matrix
P-72	0.9	10YR 5/2	fine	Quartz-silicate rock; grayish black	71	Quartz-silicate rock; grayish black	qtz, musc	Fe ox	dol, qtz, ortho, ab, musc-ill, pyrite		black opaque matrix
P-71	1.0	10YR 5/2	fine	Quartz-silicate rock; grayish black	70	Quartz-silicate rock; grayish black	qtz, musc	Fe ox	qtz, ortho, ab, musc-ill (acid insol.)		phos interbed, black opaque matrix
P-70	1.1	10YR 5/2	fine	Limestone; light brownish gray	69	Limestone; light brownish gray	qtz, ortho, ab, musc	Fe ox, tit-leuc, T, Z	dol, cal, qtz, ortho, ab, musc-ill, kaol	rutilized(?) qtz, qtz with Z inclus	
P-69	1.5	10YR 5/2	fine	Quartz-silicate rock; brownish gray	68	Quartz-silicate rock; brownish gray	qtz, musc	Fe ox	apa, qtz, musc-ill, kaol	incip apa pel	phos interbed
P-68	1.4	10YR 5/2	fine	Quartz-silicate rock; brownish gray	67	Quartz-silicate rock; brownish gray	qtz, ortho, microcl, ab, musc	Fe ox, tit	apa(?) , dol, cal(?) , qtz, ortho, ab, musc-ill kaol		feld rel abundant
P-67	0.5	10YR 5/2	fine	Quartz-silicate rock; brownish gray	66	Quartz-silicate rock; brownish gray	qtz, ortho, microcl, musc, ill	Fe ox	apa, qtz, feld, musc-ill, kaol	carb fossil frag	
P-66	2.3	10YR 5/2	fine	Carbonate rock; light brownish gray	65	Carbonate rock; light brownish gray	qtz, ortho, microcl, musc	Fe ox, T	dol, cal, qtz, feld, musc-ill, kaol	carb fossil frag	
P-65	3.0	10YR 5/2	fine	Quartz-silicate rock; brownish gray	64	Quartz-silicate rock; brownish gray	qtz, musc	Fe ox	apa, cal, qtz, feld, musc-ill	incip apa pel	carb interbed
P-64	0.7	10YR 5/2	fine	Dolomite; light brownish gray	63	Dolomite; light brownish gray	qtz, mxl qtz, ortho, ab, musc	Fe ox, tit-leuc, T	dol, cal, qtz, feld, musc-ill		
P-63	2.0	10YR 5/2	fine	Quartz-silicate rock; brownish gray	62	Quartz-silicate rock; brownish gray	qtz, musc	Fe ox	apa, cal, qtz, feld, musc-ill	incip apa pel	
P-62	2.0	10YR 5/2	fine	Phosphorite; brownish gray	61	Phosphorite; brownish gray	qtz	Fe ox	apa, dol, cal, qtz, feld, musc-ill	incip apa pel	carb and qtz-sil interbeds
P-61	3.5	10YR 5/2	fine	Carbonate rock; brownish gray	60	Carbonate rock; brownish gray	qtz, mxl qtz, ortho, ab, musc	Fe ox, T, Z(?)	dol, cal, qtz, ortho, ab, musc-ill, kaol		
P-60	1.1	10YR 5/2	fine	Dolomite; brownish gray	59	Dolomite; brownish gray	qtz, mxl qtz, ab	Fe ox	apa, dol, cal, qtz, ortho, ab, musc-ill	incip apa pel	dol and qtz-sil interbeds
P-59	3.0	10YR 5/2	fine	Phosphorite; brownish gray	58	Phosphorite; brownish gray	qtz	Fe ox	apa, dol, qtz, musc-ill	incip apa pel	
P-58	1.6	10YR 5/2	fine	Dolomite; brownish black	57	Dolomite; brownish black	qtz, mxl qtz, musc	Fe ox, T, tit	apa, dol, cal, qtz, feld, musc-ill, kaol	apa pel	
P-57	1.6	10YR 5/2	fine	Quartz-silicate rock; brownish black	56	Quartz-silicate rock; brownish black	qtz, musc	Fe ox	qtz, ortho(acid insol.)	incip apa pel	
P-56	1.2	10YR 5/2	fine	Dolomite	55	Dolomite	qtz, mxl qtz	Fe ox	apa, dol, cal, qtz, ortho, ab, musc-ill		chart interbed
P-55	1.6	10YR 5/2	fine	Phosphorite; brownish black	54	Phosphorite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, musc-ill	apa pel	
P-54	1.3	10YR 5/2	fine	Dolomite; brownish gray	53	Dolomite; brownish gray	qtz	Fe ox	apa, dol, cal, qtz, feld, musc-ill, kaol	incip apa pel	dol and qtz-sil interbeds
P-53	2.5	10YR 5/2	fine	Quartz-silicate rock; brownish black	52	Quartz-silicate rock; brownish black	qtz, musc	Fe ox	qtz, ortho(acid insol.)	apa fossil frag	
P-52	0.7	10YR 5/2	fine	Dolomite	51	Dolomite	qtz, mxl qtz	Fe ox	apa, dol, cal, qtz, ortho, ab, musc-ill	incip apa pel	
P-51	0.3	10YR 5/2	fine	Phosphorite; brownish black	50	Phosphorite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, musc-ill	apa pel	
P-50	1.3	10YR 5/2	fine	Dolomite; brownish gray	49	Dolomite; brownish gray	qtz	Fe ox	apa, dol, cal, qtz, feld, musc-ill	incip apa pel	carb interbed
P-49	0.6	10YR 5/2	fine	Phosphorite; brownish black	48	Phosphorite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill, kaol	apa pel	
P-48	1.1	10YR 5/2	fine	Phosphorite; brownish black	47	Phosphorite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill(?)	apa pel	
P-47	1.1	10YR 5/2	fine	Dolomite; brownish gray	46	Dolomite; brownish gray	qtz, mxl qtz, ortho, musc	Fe ox, T	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-46	1.1	10YR 5/2	fine	Phosphorite; brownish black	45	Phosphorite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-45	0.8	10YR 5/2	fine	Carbonate rock; brownish black	44	Carbonate rock; brownish black	qtz, mxl qtz, ab, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-44	1.3	10YR 5/2	fine	Phosphorite; brownish black	43	Phosphorite; brownish black	qtz, mxl qtz	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-43	0.7	10YR 5/2	fine	Dolomite; brownish black	42	Dolomite; brownish black	qtz, musc, kaol(?)	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-42	2.0	10YR 5/2	fine	Dolomite; brownish black	41	Dolomite; brownish black	qtz, ortho, ab, musc	Fe ox	apa, dol, cal, qtz, ortho, ab, musc-ill	apa pel	
P-41	3.8	10YR 5/2	fine	Dolomite; brownish black	40	Dolomite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill, kaol	apa pel with qtz, carb inclus	
P-40	3.0	10YR 5/2	fine	Phosphorite; brownish black	39	Phosphorite; brownish black	qtz, musc	Fe ox, fluor	apa, qtz	apa pel with qtz, carb inclus	
P-39	0.6	10YR 5/2	fine	Quartz-silicate rock; brownish gray	38	Quartz-silicate rock; brownish gray	qtz, musc	Fe ox, fluor	apa, dol, cal, qtz, feld, musc-ill, kaol	apa pel	
P-38	1.8	10YR 5/2	fine	Quartz-silicate rock; light brownish gray	37	Quartz-silicate rock; light brownish gray	qtz, mxl qtz, microcl, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-37	0.6	10YR 5/2	fine	Quartz-silicate rock; brownish gray	36	Quartz-silicate rock; brownish gray	qtz, musc, feld	Fe ox	apa, dol, cal, qtz, feld, musc-ill, kaol	foram	apa interbed
P-36	0.9	10YR 5/2	fine	Dolomite; brownish gray	35	Dolomite; brownish gray	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill, kaol	apa pel	
P-35	0.4	10YR 5/2	fine	Dolomite; grayish brown	34	Dolomite; grayish brown	qtz, mxl qtz, ortho, musc, kaol(?)	Fe ox, tit-leuc	apa, dol, cal, qtz, ortho, ab, musc-ill, kaol	apa pel	
P-34	0.6	10YR 5/2	fine	Dolomite; dusky brown	33	Dolomite; dusky brown	qtz, ortho, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill, kaol	apa pel	
P-33	0.8	10YR 5/2	fine	Phosphorite; brownish gray	32	Phosphorite; brownish gray	qtz, ab, musc	Fe ox	apa, dol(?) , qtz, ortho	apa pel	
P-32	1.6	10YR 5/2	fine	Phosphorite; brownish gray	31	Phosphorite; brownish gray	qtz, musc	Fe ox	apa, qtz, ortho, musc-ill	incip apa pel	apa and dol interbeds
P-31	1.0	10YR 5/2	fine	Quartz-silicate rock; brownish black	30	Quartz-silicate rock; brownish black	qtz, ortho, ab, musc, ill	Fe ox	apa, dol, qtz, ortho, ab, musc-ill, kaol	incip apa pel	
P-30	0.9	10YR 5/2	fine	Quartz-silicate rock; brownish black	29	Quartz-silicate rock; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-29	0.8	10YR 5/2	fine	Black	28	Black	qtz, mxl qtz, ortho, microcl, kaol(?)	Fe ox, tit-leuc	apa, dol, cal, qtz, feld, musc-ill, kaol	apa pel	
P-28	1.7	10YR 5/2	fine	Dolomite; light brownish gray	27	Dolomite; light brownish gray	qtz, musc	Fe ox	apa, qtz	incip apa pel	dol interbed
P-27	1.2	10YR 5/2	fine	Phosphorite; brownish black	26	Phosphorite; brownish black	qtz, ortho, musc	Fe ox	qtz, ortho(acid insol.)	incip apa pel	
P-26	2.1	10YR 5/2	fine	Phosphorite; brownish black	25	Phosphorite; brownish black	qtz, mxl qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-25	0.3	10YR 5/2	fine	Phosphorite; brownish gray	24	Phosphorite; brownish gray	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-24	1.7	10YR 5/2	fine	Phosphorite; brownish black	23	Phosphorite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-23	1.7	10YR 5/2	fine	Phosphorite; dusky brown	22	Phosphorite; dusky brown	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-22	0.8	10YR 5/2	fine	Phosphorite; brownish black	21	Phosphorite; brownish black	qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa pel	
P-21	0.9	10YR 5/2	fine	Dolomite; brownish gray	20	Dolomite; brownish gray	qtz, mxl qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	apa fossil frag	dol interbed
P-20	1.2	10YR 5/2	fine	Phosphorite; brownish gray	19	Phosphorite; brownish gray	qtz, mxl qtz, musc	Fe ox	apa, dol, cal, qtz, feld, musc-ill	incip apa pel	chart interbed, anisotropic apa subheda in chart
P-19	1.1	10YR 5/2	fine	Dolomite; brownish gray	18	Dolomite; brownish gray	qtz, ortho, musc	Fe ox	apa, dol, cal, qtz, ortho, musc-ill	apa pel	
P-18	0.7	10YR 5/2	fine	Phosphorite; brownish gray	17	Phosphorite; brownish gray	qtz, mxl qtz, musc	Z, Fe ox	apa, dol, cal, qtz	apa pel	qtz inclus in apa pel
P-17	0.4	10YR 5/2	fine	Dolomite; brownish gray	16	Dolomite; brownish gray	qtz, mxl qtz, musc	Fe ox, fluor	apa, dol, cal, qtz, musc-ill, kaol	apa pel	phosphatite interbed, rel much fluor, qtz inclus in apa pel
P-16	2.3	10YR 5/2	fine	Dolomite; brownish black	15	Dolomite; brownish black	qtz, musc	Fe ox	apa, qtz, ortho	apa pel	qtz inclus in apa pel
P-15	1.3	10YR 5/2	fine	Quartz-silicate rock; brownish black	14	Quartz-silicate rock; brownish black	qtz, mxl qtz, musc, ill	Fe ox	apa, dol, qtz, musc-ill	apa pel	
P-14	0.5	10YR 5/2	fine	Dolomite; dusky brown	13	Dolomite; dusky brown	qtz	Fe ox	apa, dol, qtz, feld, musc-ill	apa pel	
P-13	0.9	10YR 5/2	fine	Phosphorite; brownish black	12	Phosphorite; brownish black	qtz	Fe ox	apa, qtz		
P-12	0.5	10YR 5/2	fine	Quartz-silicate rock; brownish black	11	Quartz-silicate rock; brownish black	qtz, musc, ill, plag	Fe ox	dol, cal, qtz, ortho		
P-11	0.7	1									