5. SOILS

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This report describes the soils of the Lost Lake, West Glacier Lake, and East Glacier Lake watersheds of GLEES and presents the methods used in conducting both the field and laboratory work. In addition, general statements about the nature of the mapping units used in making the soil maps are provided.

Appendix D presents the soil map unit descriptions. The pedon descriptions for representative soil pedons of the Glacier Lakes and Lost Lake watersheds are listed in Appendix E. Included in tabular form in this chapter are the physical and chemical characterization data for these soil pedons. The soils map is presented in figure 5.1.

Methods and Definitions

Soil Survey Methods

Field procedures appropriate for making an Order 3 soil survey were used in conducting the soil mapping (USDA, SCS 1984). These guidelines were exceeded in several respects, so that the finished soil maps approach those produced in an Order 2 soil survey. A detailed geology map (Rochette 1987) of the survey area permitted increased resolution of critical locations of mafic intrusive rock types and thus allowed design of soil mapping units that recognized their presence.

Map unit composition was determined by transecting selected delineations of the mapping units. The information from these transects provided estimates of the proportional amounts of the named components of the map units, as well as the soil and land types that are included in most delineations of a given map unit. The boundaries of each mapping unit were observed throughout much of their length. Notes on soil morphological characteristics and landform setting were recorded.

Representative pedon descriptions were chosen following mapping in most cases so that the variability in morphological characteristics for a given soil type could be considered. Pedons selected to be representative of the major soils in the map units were described in de-

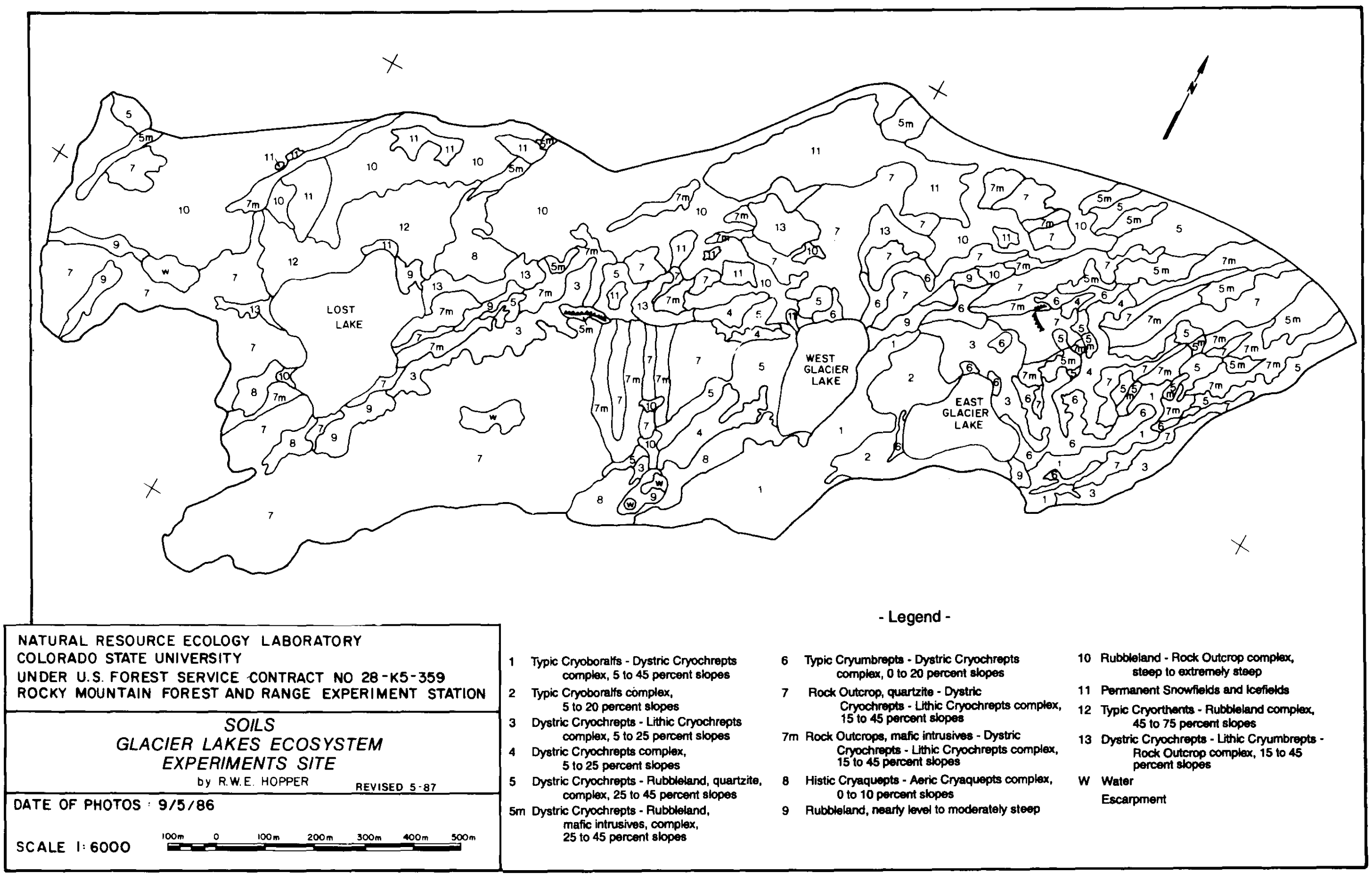

Figure 5.1.—Soils map of GLEES.

tail (USDA, SCS 1981) and sampled for physical and chemical laboratory characterization. Pedons of major soils and inclusions were classified in accordance with *Soil Taxonomy* (Soil Survey Staff 1975).

Laboratory Analyses

Soil samples were analyzed utilizing facilities of the Agronomy Department, Colorado State University, using accepted standard analytical procedures. These analyses included the following:

1) Particle size distribution in the fine-earth fraction was determined using the Bouyoucos hydrometer method (Day 1965).
2) Unbuffered, neutral salt, extraction of exchangeable bases and exchange acidity followed the NH_4Cl and KCl extraction methods (Arberg 1985).
3) Buffered (pH 8.2) extraction of exchange acidity followed the $BaCl_2$-triethanolamine extraction method (Arberg 1985).
4) pH was determined in water and 0.01*M* $CaCl_2$ (Arberg 1985). Determinations for mineral material were conducted at a soil-to-liquid ratio of 1:1. Determinations for organic soil material were conducted at 1:5 dilution.
5) Organic carbon contents were determined by a wet oxidation and diffusion method (Snyder and Trofymow 1984).

The results of these analyses appear in tables 5.1 and 5.2.

Table 5.1.—pH-transect data at GLEES.

Map unit no.	Component subgroup classif.	Hor.	Upper depth (cm)	Lower depth (cm)	pH (0.01M $CaCl_2$)	pH (water)	Elev. (m)	Slope (%)
			pH Transect no. 1					
5	Ochrept	A	0	4	4.36	4.77	3386	50
		Bw	4	27	4.23	4.88		
5	Ochrept	A	0	5	4.54	5.16	3378	44
		Bw	5	18	4.12	4.77		
5	Ochrept	A	0	6	4.22	4.87	3374	47
		Bw	6	23	4.19	4.43		
5	Ochrept	A	0	5	4.29	4.84	3365	47
		Bw	5	21	4.01	4.74		
5	Ochrept	A	0	6	3.49	4.16	3356	22
		Bw	6	25	3.65	4.24		
7m	Ochrept	A&BA	0	6	3.73	4.23	3353	24
		Bw	6	32	3.60	4.17		
			pH transect no. 1					
6	Umbrept	A&BA	0	19	3.83	4.36	3348	7
		Bw	19	39	3.83	4.35		
6	Ochrept	A	0	5	4.03	4.50	3346	10
		Bw	5	29	3.86	4.35		
5	Ochrept	A	0	4	4.22	4.61	3345	10
		Bw	4	22	3.77	4.30		
4	Ochrept	A	0	4	4.08	4.57	3343	25
		E&EB	4	22	3.55	4.23		
		Bw	22	31	3.52	4.10		
7	Ochrept	A	0	4	4.34	4.88	3340	33
		BE	4	29	3.97	4.45		
7	Ochrept	A	0	3	4.22	4.70	3334	34
		Bw	3	26	3.97	4.44		
5		Quartzite rock outcrop					3330	52
5	Ochrept	A	0	6	3.91	4.47	3307	12
		Bw	6	22	3.97	4.54		
5	Ochrept	BA	0	10	4.01	4.67	3305	8
		BEb	10	26	3.98	4.69		
4	Ochrept	Oi&A	3	9	4.00	4.70	3302	24
		EB	9	34	3.69	4.25		
6	Ochrept	A&EB	0	17	3.94	4.39	3299	13
		Bw	17	29	3.69	4.06		
6	Umbrept	A	0	19	3.82	4.25	3296	13
		Bw	19	35	3.82	4.38		

Map unit no.	Component subgroup classif.	Hor.	Upper depth (cm)	Lower depth (cm)	pH (0.01M $CaCl_2$)	pH (water)	Elev. (m)	Slope (%)
			pH transect no. 1					
4	Ochrept	Oi&Oa	11	0	4.39	4.80	3292	16
		Bw	0	25	4.55	5.02		
6	Aquept	A	0	8	3.85	4.30	3290	2
		Bw	8	31	3.69	4.31		
			pH transect no. 2					
7	Ochrept	A&E	0	9	3.89	4.54	3340	35
		Bw	9	22	3.86	4.70		
7	Ochrept	A	0	12	4.08	4.95	3328	36
		BE	12	28	4.08	4.88		
5	Ochrept	A	0	7	4.14	4.96	3316	29
		BE	7	21	4.09	5.01		
5	Ochrept	A/B	0	11	4.00	4.75	3310	22
		BE	11	28	3.97	4.83		
5	Ochrept	A	0	4	4.04	4.67	3305	23
		BE	4	25	3.97	4.86		
4	Ochrept	Oi&O	6	0	4.32	5.46	3300	16
		E	0	8	3.95	4.66		
		BE	8	25	3.97	4.83		
8	Umbrept	A	0	26	3.90	4.72	3290	10
		E	26	33	3.85	4.89		
8	Aquept	Oa	21	0	3.80	4.65	3280	3
		Bg	0	15	3.90	4.93		
			pH transect no. 3					
1	Umbrept	Oa	6	0	4.72	5.27	3292	30
		Bw	0	21	4.27	5.09		
1	Boralf	Oi&Oa	5	0	4.49	5.18	3295	30
		EB&Bt	0	21	3.51	4.20		
1	Boralf	Oi&O	15	0	4.76	5.25	3298	26
		E&EB	0	15	4.00	4.65		
1	Ochrept	Oi&Oa	5	0	4.70	5.26	3299	30
		A&EB	0	22	3.71	4.39		
1	Boralf	A	0	8	3.69	4.35	3301	10
		E	8	22	3.59	4.36		
1	Ochrept	Oi&O	12	0	5.66	6.17	3307	35
		E	0	19	4.43	5.09		
1	Boralf	Oi&O	5	0	4.40	4.99	3310	9
		E	5	17	3.73	4.42		

TABLE 5.2.—Physical and chemical characterization data for representative soil pedons at GLEES.

Pedon Number and Classification	Sample No.	Horizon	Upper Horizon Depth (cm)	Lower Horizon Depth (cm)	(%) Sand	(%) Silt	(%) Clay (<2mm)	(%) Sand (clay free)	(%) Silt (clay free)	Exchangeable Bases (meq/100 gm) Ca	Mg	Na	K	Exchange Acidity (meq/100 gm) Al	H	Total	Cation Exchange Capacity (unbuffered, meq/100 gm)	(%) Base Saturation (unbuffered, meq/100 gm)	pH Water	pH 0.01M CaCl2	(pH 8.2 buffered) (meq/100 gm) Cation Exchange Capacity	Exchange Acidity	(%) Base Saturation	(%) Organic Carbon
GLACIER LAKES WATERSHED																								
WYGL001	WYGL0011	Oi & Oa	2	0	—	—	—	—	—	22.58	2.52	0.03	0.55	0.03	0.67	0.97	26.64	96.36	3.35	3.99	81.35	55.68	31.56	>24.00
	WYGL0012	E	0	3	31.5	37.1	31.5	45.9	54.1	1.18	0.29	0.05	0.19	8.36	2.10	10.46	12.18	14.06	3.62	3.09	25.43	23.72	6.73	3.15
Typic Cryoboralf	WYGL0013	2E9	3	11	52.7	32.5	14.8	61.9	38.1	0.32	0.20	0.03	0.08	5.93	3.00	8.93	9.56	6.64	3.69	3.00	15.34	14.71	4.14	1.14
	WYGL0014	2Bt	11	31	60.8	24.4	14.8	71.3	28.7	0.74	0.68	0.02	0.04	6.45	3.49	9.94	11.41	12.92	3.73	3.01	16.67	15.19	8.95	0.50
	WYGL0015	2BC1	31	66	44.5	34.6	20.9	56.3	43.7	0.77	0.55	0.01	0.03	5.53	4.12	9.65	11.01	12.35	3.85	3.10	16.10	14.74	8.44	0.36
	WYGL0016	2BC2	66	100	57.1	26.2	16.7	68.5	31.5	0.34	0.27	0.00	0.02	3.42	1.11	4.53	5.17	12.37	3.92	3.19	9.95	9.31	6.43	0.18
WYGL002	WYGL0021	Oi & Oa	2	0	—	—	—	—	—	18.51	2.51	0.03	0.42	0.07	0.22	0.30	21.76	98.64	4.30	4.05	56.13	34.67	38.24	14.05
	WYGL0022	E	0	8	63.1	24.2	12.7	72.3	27.7	1.92	0.50	0.00	0.06	1.56	1.04	2.60	5.08	48.78	3.62	3.37	10.68	8.20	23.21	2.85
Typic Cryoboralf	WYGL0023	EB	8	16	59.1	28.2	12.7	67.7	32.3	1.04	0.34	0.00	0.03	1.66	1.39	3.05	4.47	31.72	3.65	3.32	8.62	7.20	16.44	0.46
	WYGL0024	BE	16	25	53.0	30.3	16.7	63.6	36.4	0.84	0.33	0.00	0.03	2.77	0.77	3.54	4.75	25.41	3.60	3.25	11.93	10.72	10.12	1.68
	WYGL0025	Bt	25	47	57.0	24.3	18.8	70.1	29.9	0.63	0.28	0.00	0.03	3.55	1.48	5.03	5.98	15.77	3.64	3.20	14.69	13.74	6.42	0.54
	WYGL0026	BC1	47	61	55.1	28.2	16.7	66.2	33.8	0.26	0.13	0.02	0.03	2.51	0.89	3.40	3.85	11.71	3.70	3.30	7.34	6.89	6.14	0.32
	WYGL0027	BC2	61	73	55.2	28.2	16.7	66.2	33.8	0.12	0.08	0.01	0.02	2.10	0.82	2.92	3.15	7.37	3.81	3.40	7.12	6.89	3.26	0.24
	WYGL0028	BC3	73	101	59.2	24.1	16.7	71.0	29.0	0.12	0.07	0.00	0.02	2.03	0.85	2.88	3.09	6.89	3.84	3.42	7.95	7.73	2.68	0.18
WYGL003	WYGL0031	A	0	2	44.4	32.6	23.0	57.6	42.4	6.80	1.90	0.02	0.26	0.00	0.10	0.10	9.08	98.87	5.50	5.05	15.45	6.47	58.10	2.57
	WYGL0032	2Bw	2	30	77.3	10.1	12.6	88.5	11.5	1.62	0.73	0.03	0.07	0.33	0.32	0.64	3.08	79.14	4.94	4.23	7.48	5.04	32.63	0.33
Dystric Cryochrept	WYGL0033	2BC	24	47	64.5	24.2	11.4	72.7	27.3	0.75	0.44	0.01	0.02	1.17	0.49	1.66	2.89	42.58	4.45	3.78	6.27	5.04	19.58	0.24
	WYGL0034	3C	46	59	44.3	42.3	13.4	51.1	48.9	0.61	0.36	0.02	0.02	1.24	0.53	1.77	2.79	36.42	4.71	3.69	8.62	7.60	11.79	0.27
WYGL004	WYGL0041	A	0	3	49.7	28.6	21.7	63.5	36.5	4.51	1.00	0.02	0.11	1.41	0.58	1.99	7.64	73.92	4.48	3.90	20.76	15.11	27.22	2.36
	WYGL0042	CA	3	24	41.7	36.6	21.6	53.3	46.7	3.08	0.76	0.03	0.08	2.33	0.87	3.19	7.15	55.29	4.39	3.73	17.58	13.63	22.48	1.86
Typic Cryorthent	WYGL0043	C1	24	46	51.9	28.5	19.6	64.5	35.5	2.79	0.69	0.02	0.06	2.73	0.99	3.72	7.28	48.91	4.38	3.68	12.91	9.35	27.59	1.04
	WYGL0044	C2	46	64	62.2	20.3	17.5	75.4	24.6	2.01	0.48	0.03	0.04	2.01	1.24	3.25	5.80	43.97	4.30	3.61	18.85	16.30	13.52	0.77
WYGL005	WYGL0051	Oi & Oa	3	0	—	—	—	—	—	40.38	3.33	0.05	0.59	0.03	0.39	0.42	44.77	99.07	4.74	4.29	83.87	39.51	52.88	21.82
	WYGL0052	E	0	9	56.2	30.3	13.4	65.0	35.0	1.69	0.30	0.02	0.11	2.48	1.17	3.64	5.75	36.67	3.81	3.22	4.72	2.61	44.70	0.91
Typic Cryorthent	WYGL0053	BE	9	17	62.4	24.2	13.4	72.1	27.9	0.73	0.20	0.01	0.04	2.22	1.56	3.79	4.76	20.39	3.53	3.10	6.92	5.95	14.01	0.53
	WYGL0054	Bw	17	43	54.4	30.2	15.4	64.3	35.7	0.25	0.14	0.01	0.03	2.64	0.00	1.90	2.32	18.39	3.75	3.10	7.13	6.70	5.99	0.37
	WYGL0055	BC1	43	64	52.2	28.3	19.5	64.8	35.2	0.34	0.21	0.00	0.03	4.07	2.18	6.25	6.82	8.43	3.82	3.20	8.90	8.33	6.46	0.33
	WYGL0056	BC2	74	105	54.2	28.3	17.5	65.7	34.3	0.22	0.28	0.02	0.04	4.18	0.00	3.18	3.75	15.16	4.49	3.64	8.75	8.18	6.50	0.20
WYGL006	WYGL0061	A	0	5	41.0	39.0	20.0	51.0	49.0	10.59	2.04	0.03	0.40	0.12	3.19	3.31	16.35	79.79	4.68	4.20	33.09	20.04	39.43	6.93
	WYGL0062	E	5	9	43.8	38.6	17.6	53.2	46.8	5.54	1.12	0.05	0.11	0.97	0.58	1.55	8.36	81.43	4.10	3.70	15.28	8.47	44.57	1.67
Dystric Cryochrept	WYGL0063	BE	9	13	54.0	28.5	17.6	65.5	34.5	6.18	1.18	0.02	0.05	0.80	1.39	2.20	9.64	77.20	4.02	3.73	14.95	7.51	49.76	1.65
	WYGL0064	Bw	13	23	45.4	32.9	21.8	58.0	42.0	9.61	1.93	0.07	0.05	1.24	0.32	1.55	13.21	88.24	4.45	3.87	22.40	10.74	52.05	0.91
	WYGL0065	BC	23	41	50.4	36.3	13.4	58.1	41.9	2.67	0.58	0.01	0.03	0.00	0.67	0.67	3.96	83.13	4.05	3.65	6.34	3.05	51.90	0.44
	WYGL0066	C1	41	74	56.5	34.1	9.3	62.4	37.6	1.41	0.30	0.00	0.02	0.37	0.31	0.68	2.41	71.70	4.01	3.68	3.77	2.04	45.80	0.18
	WYGL0067	C2	74	101	58.6	32.1	9.3	64.6	35.4	1.43	0.28	0.03	0.02	0.33	0.00	0.00	1.76	100.00	4.09	3.70	3.60	1.84	48.84	0.25
WYGL007	WYGL0071	Oi & Oa	4	0	—	—	—	—	—	39.25	3.58	0.03	0.45	0.00	0.31	0.31	43.62	99.29	4.62	4.10	88.26	44.95	49.07	>24.00
	WYGL0072	E	0	10	32.9	39.1	28.0	45.7	54.3	4.06	0.79	0.03	0.10	4.87	0.62	5.50	10.48	47.55	4.20	3.45	19.52	14.54	25.53	1.78
Dystric Cryochrept	WYGL0073	BE	10	26	39.3	36.8	23.8	51.6	48.4	2.19	0.50	0.03	0.09	4.64	1.33	5.97	8.79	32.07	4.11	3.30	17.60	14.78	16.02	1.44
	WYGL0074	B	26	55	47.4	30.8	21.8	60.6	39.4	1.09	0.25	0.02	0.06	5.10	1.08	6.19	7.60	18.59	3.99	3.35	20.81	19.39	6.79	1.36
	WYGL0075	BC1	55	85	51.7	28.6	19.7	64.4	35.6	0.46	0.09	0.02	0.05	2.86	0.77	3.64	4.25	14.43	4.27	3.65	19.17	18.55	3.20	1.14
	WYGL0076	BC2	85	106	51.7	26.6	21.7	66.1	33.9	0.42	0.10	0.07	0.05	2.47	3.02	5.49	6.14	10.47	4.12	3.64	16.91	16.27	3.90	1.24
WYGL008	WYGL0081	A	0	21	41.4	38.9	19.7	51.5	48.5	6.53	1.61	0.00	0.19	0.60	0.38	0.97	9.31	89.55	4.60	4.13	18.39	10.06	45.31	2.05
	WYGL0082	AC	21	51	39.6	40.8	19.7	49.3	50.7	6.42	1.51	0.02	0.04	1.17	0.57	1.74	9.73	82.15	4.39	3.99	13.61	5.61	58.74	0.62
Typic Cryorthent	WYGL0083	C1	51	73	52.1	36.4	11.4	58.9	41.1	4.84	1.13	0.03	0.03	0.26	0.78	1.04	7.07	85.26	4.75	4.20	10.04	4.02	60.00	0.16
	WYGL0084	2C2	73	92	64.5	26.2	9.3	71.1	28.9	3.07	0.73	0.01	0.02	0.14	0.59	0.74	4.57	83.92	5.32	4.40	6.23	2.40	61.58	0.11
WYGL009	WYGL0091	A	0	8	40.0	47.7	12.3	45.6	54.4	2.39	0.45	0.05	0.11	4.97	1.36	6.22	9.21	32.46	3.89	3.40	31.48	28.49	9.50	6.03
	WYGL0092	Bw	8	45	44.7	34.9	20.4	56.2	43.8	0.36	0.05	0.01	0.06	3.57	1.30	4.87	5.35	9.08	3.89	3.50	18.63	18.14	2.61	1.90
Typic Cryumbrept	WYGL0093	BC	45	84	53.3	28.5	18.2	65.2	34.8	0.15	0.03	0.05	0.02	2.74	0.85	3.59	3.85	6.59	4.05	3.60	15.46	15.21	1.64	0.39
	WYGL0094	2C	84	110	26.8	51.0	22.3	34.4	65.6	1.46	0.31	0.02	0.04	5.36	0.52	5.89	7.72	23.72	4.29	3.59	15.59	13.76	11.74	0.23
	WYGL0095*	BC	45	84	67.9	20.1	11.9	77.1	22.9	0.28	0.04	0.03	0.03	1.78	0.23	2.01	2.39	16.02	3.70	3.51	8.77	8.39	4.37	1.13

TABLE 5.2.—(Continued)

Pedon Number and Classification	Sample No.	Horizon	Upper Horizon Depth (cm)	Lower Horizon Depth (cm)	(%) Sand	(%) Silt	(%) Clay (<2mm)	(%) Sand (clay free)	(%) Silt (clay free)	Exchangeable Bases (meq/100 gm) Ca	Mg	Na	K	Exchange Acidity (meq/100 gm) Al	H	Total	Cation Exchange Capacity (unbuffered, meq/100 gm)	(%) Base Saturation (unbuffered, meq/100 gm)	pH Water	pH 0.01M CaCl2	(pH 8.2 buffered) (meq/100 gm) Cation Exchange Capacity	Exchange Acidity	(%) Base Saturation	(%) Organic Carbon
WYGL010	WYGL0101	A	0	9	28.1	46.6	25.3	37.6	62.4	4.70	1.18	0.10	0.20	5.51	1.89	7.39	13.57	45.51	3.83	-3.49	39.61	33.43	15.60	7.46
	WYGL0102	B	9	30	30.8	44.1	25.0	41.1	58.9	1.10	0.20	0.05	0.06	6.54	0.56	7.11	8.52	16.54	3.90	3.35	27.00	25.59	5.22	2.38
Typic Cryumbrept	WYGL0103	BC	30	59	24.7	39.8	35.5	38.3	61.7	1.25	0.22	0.04	0.05	5.98	0.76	6.74	8.29	18.73	3.92	3.09	25.32	23.76	6.14	1.74
	WYGL0104	2C1	59	91	74.0	16.1	9.9	82.1	17.9	0.23	0.05	0.01	0.02	1.03	2.14	3.17	3.48	8.99	4.10	3.70	5.65	5.34	5.54	0.26
	WYGL0105	2C2	91	108	60.3	26.3	13.4	659.7	30.3	0.32	0.04	0.02	0.01	0.89	0.13	1.02	1.41	27.53	4.10	3.60	4.90	4.51	7.94	0.19
WYGL011	WYGL0111	A1	0	11	40.1	37.6	22.2	51.6	48.4	7.77	1.62	0.12	0.21	1.54	0.64	2.18	11.90	81.67	4.68	4.00	32.31	22.59	30.08	5.61
	WYGL0112	2A2	11	45	18.0	53.0	28.9	25.4	74.6	4.24	1.01	0.04	0.10	5.30	1.51	6.92	12.20	44.14	4.37	3.73	34.84	29.46	15.46	3.73
Humic Cryaquept	WYGL0113	2AC	45	59	17.8	42.6	39.7	29.3	70.5	2.95	0.77	0.03	0.07	6.80	2.20	9.01	12.83	29.78	4.32	3.70	34.49	30.68	11.07	1.92
	WYGL0114	2C	58	95	36.7	26.9	36.4	57.7	42.3	2.46	0.71	0.04	0.06	4.10	1.57	5.67	8.94	36.60	4.32	3.70	23.79	20.52	13.76	1.05
WYGL012	WYGL0121	Oi & Oa	4	0	—	—	—	—	—	30.30	3.07	0.02	0.46	0.04	0.31	0.35	34.21	98.97	4.70	4.20	76.68	42.82	44.16	19.63
	WYGL0122	B	0	19	37.9	29.4	32.8	56.3	43.7	12.14	3.29	0.02	0.15	5.43	0.91	6.34	21.93	71.10	3.89	3.44	38.47	22.88	40.53	3.48
Dystric Cryochrept	WYGL0123	BC	19	33	32.5	36.2	21.2	47.3	52.7	10.57	5.27	0.01	0.03	18.77	2.76	21.53	37.42	42.46	3.89	3.30	47.97	32.08	33.13	0.97
	WYGL0124	C	33	55	40.3	28.1	31.6	58.9	41.1	11.89	6.84	0.03	0.03	19.53	4.69	24.22	43.02	43.69	3.89	3.29	34.80	16.01	54.00	0.49
	WYGL0125	Cr	55	72	32.0	28.0	40.1	53.3	46.7	13.93	8.02	0.01	0.06	21.79	2.00	23.79	45.81	48.07	3.99	3.31	57.10	35.08	38.56	0.21
	WYGL0126*	C	33	55	43.6	27.5	28.9	61.3	38.7	9.45	5.10	0.00	0.03	16.70	2.43	19.13	33.72	43.26	3.90	3.30	40.13	25.54	36.53	0.45
WYGL013	WYGL0131	Oe	13	0	—	—	—	—	—	14.23	2.90	0.06	0.21	0.27	0.32	0.59	17.99	96.71	4.83	4.32	48.31	30.92	36.01	14.30
Histic Cryaquept	WYGL0132	C1	0	36	55.9	24.5	19.7	69.6	30.4	3.68	0.90	0.03	0.07	1.16	0.47	1.64	6.32	74.04	4.50	3.91	15.10	10.42	30.98	1.94
WYGL014	WYGL0141	Oa	5	0	—	—	—	—	—	13.37	2.49	0.21	0.52	3.31	1.70	5.01	21.59	76.79	3.73	3.40	75.28	58.70	22.03	20.72
Distric Cryochrept	WYGL0142	B	0	32	23.0	44.1	32.9	34.3	65.7	0.97	0.17	0.07	0.05	7.45	2.70	10.15	11.41	11.08	3.71	3.42	32.34	31.08	3.91	3.31
	WYGL0143	BC	32	74	25.4	41.8	32.7	37.8	62.2	0.73	0.13	0.00	0.05	7.40	1.13	8.54	9.46	9.75	3.90	3.56	26.55	25.63	3.47	2.59
WYGL015	WYGL0151	A	0	7	32.3	45.6	22.1	41.4	58.6	25.15	3.45	0.05	0.53	0.04	0.06	0.10	29.28	99.65	4.90	4.61	43.35	14.17	67.32	4.89
	WYGL0152	2BA	7	15	19.9	49.7	30.3	28.6	71.4	6.34	1.30	0.09	0.09	4.09	0.03	4.12	11.95	65.50	4.20	3.82	22.23	14.41	35.19	1.76
Distric Cryochrept	WYGL0153	2Bw	15	33	19.5	47.9	32.6	28.9	71.1	1.28	0.36	0.05	0.05	6.36	1.08	7.44	9.18	18.94	4.00	3.59	19.49	17.75	8.92	0.96
	WYGL0154	2BC	33	55	21.8	49.8	28.3	30.5	69.5	0.28	0.26	0.03	0.02	7.71	0.30	8.01	8.60	6.90	3.97	3.55	19.99	19.39	2.97	0.71
	WYGL0155	2CB	55	83	24.4	49.7	26.2	32.6	67.4	0.94	0.36	0.05	0.03	6.02	0.61	6.64	8.01	17.17	4.00	3.62	17.64	16.26	7.80	0.55
	WYGL0156	3C	83	108	33.9	42.2	23.9	44.5	55.5	0.37	0.18	0.04	0.07	4.84	0.00	4.74	5.39	12.10	4.03	3.72	12.73	12.08	5.12	0.58
WYGL016	WYGL0161	Oi & Oa	4	0	—	—	—	—	—	44.38	2.64	0.21	0.78	1.58	0.98	2.56	50.58	94.94	3.62	3.39	112.72	64.70	42.60	>24.00
	WYGL0162	E	0	12	20.6	44.8	34.6	31.5	68.5	1.70	0.35	0.11	0.18	9.19	1.86	11.05	13.38	17.42	3.85	3.09	28.10	25.77	8.30	2.75
Typic Cryoboralf	WYGL0163	EB	12	33	20.8	42.6	36.6	32.8	67.2	0.98	0.27	0.04	0.13	10.03	1.08	11.10	12.52	11.33	3.51	3.20	26.18	24.76	5.42	2.40
	WYGL0164	BE	33	47	15.9	43.0	41.1	27.0	73.0	0.85	0.27	0.03	0.12	12.02	0.64	12.66	13.92	9.08	3.49	3.20	28.72	27.45	4.40	1.88
	WYGL0165	Bt	47	68	39.7	32.1	28.2	55.3	44.7	0.00	0.13	0.04	0.05	2.63	4.27	6.90	7.11	3.04	3.45	3.30	17.28	17.06	1.25	1.35
	WYGL0166	BC	68	102	42.6	29.6	27.8	59.0	41.0	0.00	0.06	0.02	0.03	2.96	0.34	3.30	3.42	3.48	3.60	3.41	10.37	10.25	1.15	0.51
LOST LAKE WATERSHED																								
Ochrept	WYLL0011	A	0	8	44.4	31.8	23.8	58.3	41.7	10.73	1.84	0.06	0.23	0.03	0.13	0.17	13.03	98.72	4.9	4.65	21.27	8.41	60.45	5.01
	WYLL0012	Bw	8	23	41	35.5	23.5	53.6	46.4	5.59	1.27	0.07	0.05	0.16	0.16	0.32	7.3	95.66	4.68	4.35	11.79	4.81	59.2	1.18
Umbrept	WYLL0021	A	0	11	62.9	17.4	19.6	78.3	21.7	1.32	0.3	0.03	0.13	2.79	1.31	4.1	5.9	30.4	3.82	3.5	22.31	20.51	8.04	5.95
	WYLL0022	AB	11	27	58.9	19.5	21.7	75.1	24.9	0.47	0.1	0.03	0.08	3.05	1.14	4.19	4.87	13.98	3.83	3.59	15.79	15.11	4.31	3.84
	WYLL0023	Bw	27	37	71.3	13.3	15.4	84.3	15.7	0.14	0.02	0.04	0.02	1.5	0.66	2.16	2.38	9.31	3.85	3.72	11.01	10.78	2.02	2.03
Umbrept	WYLL0031	A	0	18	30.6	36.7	32.7	45.5	54.5	1.99	0.37	0.11	0.1	7.51	2.04	9.55	12.12	21.14	3.7	3.43	41.87	39.31	6.12	7.94
	WYLL0032	AB	18	35	20.5	40.7	38.8	33.5	66.5	0.64	0.09	0.06	0.04	6.89	2.43	9.31	10.14	8.2	3.73	3.5	36.97	36.14	2.25	4.64
Orthent	WYLL0051	A	0	4	56.8	25.6	17.6	69	31	5.21	1.22	0.15	0.13	—	—	—	106.7	6.28	5.09	4.59	18.98	12.28	35.32	4.41
	WYLL0052	C	4	27	61.1	21.4	17.5	74	26	2.68	0.72	0.04	0.04	—	—	—	103.48	3.37	4.68	4.01	11.39	7.9	30.65	2.17
Orthent	WYLL0061	C	1	31	44.8	37.6	17.5	54.4	45.6	5.13	1.61	0.04	0.08	—	—	—	106.85	6.42	4.9	4.16	13.5	6.64	50.81	—

** — indicates a sample of contrasting material taken from the designated horizon*

Soil Map Units

The map units used in the soil map represent the kinds of soil in the Lost Lake and East and West Glacier Lakes survey areas. A unique set of mapping units was developed for the survey areas and is described in detail. Preceding the name of each map unit is the symbol that identifies that map unit on the map. Each map unit description includes general facts about the soil and a brief description of the soil profile.

The map units on the soil map represent areas on the landscape made up mostly of the soils for which the unit is named. Most of the delineations shown on the map are phases of soil families (Soil Survey Staff 1975; USDA, SCS 1983). No attempt was made to correlate the soils observed during this mapping effort with existing soil series. The soils described as occurring in either survey area were classified to the family level according to the soil classification system described in *Soil Taxonomy* (Soil Survey Staff 1975). The soil family is the lowest taxonomic level recognized in this classification system. Soils of one family discernably differ from soils of other families by texture, mineralogy, reaction class (pH), or soil temperature. The major characteristic separating soil families in the two areas reported here was the texture (relative amounts of sand, silt, and clay) of the fine-earth fraction (< 2mm particle-size fraction). Soils of one family can differ in the texture of the surface layer or in the underlying substratum and in slope, stoniness, or other characteristics that affect their use. On the basis of such differences the family may be divided into phases. The name of a phase commonly indicates a feature that affects use or management and assists in the identification of these soils in the field. For example, Typic Cryoboralfs-Dystric Cryochrepts complex, 5–45% slopes, identifies a particular combination of soil families occurring on a unique range of slopes. The absolute and proportionate extent of each mapping unit in its respective survey is given in table 5.3. Slight overlap of GLEES boundaries occurred when the soil units were mapped. The detailed soil mapping unit descriptions are given in Appendix D.

Most of the map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes, soil associations, or undifferentiated groups. The soil complex was the primary map unit type used in making the soil surveys reported here. A *soil complex* consists of two or more soils that are so intricately mixed or so small in extent that they cannot be shown separately on the soil map. Each map unit includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soils and thus could significantly affect use and management of the area delineated. These soils are described for each map unit.

Areas that have little or no soil material and support little or no vegetation are called *miscellaneous areas*. These areas are delineated on the soil map. Map units may be composed of one miscellaneous area type, e.g., Rubbleland, nearly level to moderately steep; or they may contain more than one type of area, e.g., Rubbleland-Rock Outcrop complex, steep to extremely steep. Miscellaneous areas may also be included with soil types in naming the dominant components of a map unit, e.g., Rock Outcrop, quartzite-Dystric Cryochrepts-Lithic Cryochrepts complex, 15–45% slopes. In the latter example a phase of the miscellaneous area has been recognized.

Table 5.3.—Map units and their extents within the GLEES soil survey area. Total area reflects area of soil survey rather than area of GLEES listed in Chapter 1.

Map Symbol	Mapping unit name	Total area (hectares)	Percent of area
1	Typic Cryoboralfs-Dystric Cryochrepts complex, 5-45% slopes	8.1	5
2	Typic Cryoboralfs complex, 5–20% slopes	4.9	3
3	Dystric Cryochrepts-Lithic Cryochrepts complex, 5-25% slopes	6.5	4
4	Dystric Cryochrepts complex, 5–25% slopes	4.9	3
5	Dystric Cryochrepts-Rubbleland, quartzite complex, 25-45% slopes	6.5	4
5m	Dystric Cryochrepts-Rubbleland, mafic intrusives complex, 25–45% slopes	4.9	3
6	Typic Cryumbrepts-Dystric Cryochrepts complex, 0–20% slopes	4.9	3
7	Rock Outcrop, quartzite-Dystric Cryochrepts-Lithic Cryochrepts complex, 15–45% slopes	52.1	32
7m	Rock Outcrop, mafic intrusives-Dystric Cryochrepts-Lithic Cryochrepts complex, 15–45% slopes	6.5	4
8	Histic Cryaquepts-Aeric Cryaquepts complex, 0-10% slopes	4.9	3
9	Rubbleland, nearly level to moderately steep	3.3	2
10	Rubbleland-Rock Outcrop complex, steep to extremely steep	29.3	18
11	Permanent Snowfields and Icefields	8.1	5
12	Typic Cryorthents-Rubbleland complex, 45–75% slopes	3.3	2
13	Dystric Cryochrepts-Lithic Cryumbrepts –Rock Outcrop complex, 15–45% slopes	3.3	2
W	Water	11.4	7
	Total	162.9	100

Representative Soil Pedons

In making a soil map, information obtained by observation in one area is extended to similar areas that have not necessarily been directly sampled or even observed. This process depends on careful selection of modal soil pedons that may be used to represent the soil morphological, physical, and chemical characteristics most often observed or most likely to be observed. Representative soil pedons were selected for each of the survey areas. Descriptions of these soil pedons are listed in Appendix E. In addition, physical and chemical characterization data for these soils are also included in table 5.2.

The textural classifications appearing in the pedon descriptions are based on the field hand-texture results and are modified according to the visual estimates of proportionate volumetric quantities of rock fragments. The relative amounts of sand, silt, and clay appearing in the tables of laboratory data were derived by the Bouyoucos hydrometer method as cited. Contrasting particle-size distributions within a soil profile were discerned by calculating relative amounts of sand and silt on a clay-free basis. This aids in overcoming the problem of discerning depositional rather than pedogenic redistribution of particle-size fractions by eliminating the potential confounding arising from differential translocation, accumulation, and loss of clay in the soil profile. Lithologic discontinuities noted in horizon designations for the representative profiles are based on the clay-free distributions of sand and silt.

General Description of the Survey Area

Local alpine glaciation has had a significant effect on the expressed geomorphology of the Snowy Range watersheds. However, the classical U-shaped valleys commonly associated with alpine glaciation do not occur. A main ridge along which Browns Peak (3573 m) and Medicine Bow Peak (3661 m) are located follows a SW-NE trend and forms the northern extent of the watershed. Since no steep-walled valleys existed, permanent snow and ice masses originating in nivation basins along the base of this ridge could have easily coalesced and then flowed in a southerly direction out from the ridge. The nivation basins, or cirques, now are the locations of East Glacier Lake (3282 m), West Glacier Lake (3276 m), and Lost Lake (3332 m). Each lake is located in a separate watershed.

In addition to the glacial influence, the contemporary landscape has been further shaped by nivation and by colluvial and alluvial processes. Evidence for eolian effects in some locations is provided by the clay-free, fine-earth particle size data appearing in table 5.2 and from Rochette (1987).

The bedrock lithologies of these watersheds are similar. They are primarily quartzite with 15–20% amphibolite (mafic) intrusions (Rochette 1987). The quartzite bedrock is extensively fractured in most locations. Soil material fills most or all of the voids formed by these fractures. This results in a prevalence of extremely stony, moderately deep (50–100 cm), and deep soils (> 100 cm) throughout the survey area. Shallow soils (< 50 cm) are usually limited to close association with rock outcrops.

One of the purposes of this soil investigation was to determine the relative potential sensitivity of the soils to acid deposition based on the pH and the base saturation of the soil material. It was felt that bedrock lithology could have a major effect on the sensitivity of these watersheds. Consequently, soil map units were designed to indicate bedrock lithology where appropriate.

The northern portion of the watersheds consists of a steep rock wall and talus slopes. Permanent snow and icefields occur along the upper portions of this wall. Soils in this area, where present, are minimally developed. Most of the soils in these higher elevations are Cryochrepts and Cryorthents. At lower elevations the forest vegetation types are associated with Cryochrepts on raised, well-drained positions. Open grass-sedge meadows are associated with Cryumbrepts. Glacial till occurs between West and East Glacier Lakes and along the SE perimeter of the watershed. Cryoboralfs are associated with these latter sites and generally support forest or krummholz vegetation.

The Cryoboralfs were found to express the lowest pH and base saturation values. Typical pH and base saturation (unbuffered, neutral salt method) profiles for selected Cryoboralfs appear in figure 5.2. Typical base saturation profiles for the Cryochrepts occurring in the watershed appear in figure 5.3. Pedon WYGL012 is a soil developed, at least in part, in residuum from mafic intrusive material. Pedon WYGL006 is a soil developed in colluvium and nivation debris derived from quartzite. The soil represented by Pedon WYGL007 is also developed in predominantly quartzite colluvium and nivation debris; however, mafic intrusives comprised a significant portion of the rock fragments of this soil and indicated a significant influence of mafic material in the soil. This influence probably accounts for the elevated base saturation values comparable with those of the soil developed in mafic intrusive residuum. Representative profiles for the major soil types occurring in the survey areas are compared with respect to base saturation in figure 5.4.

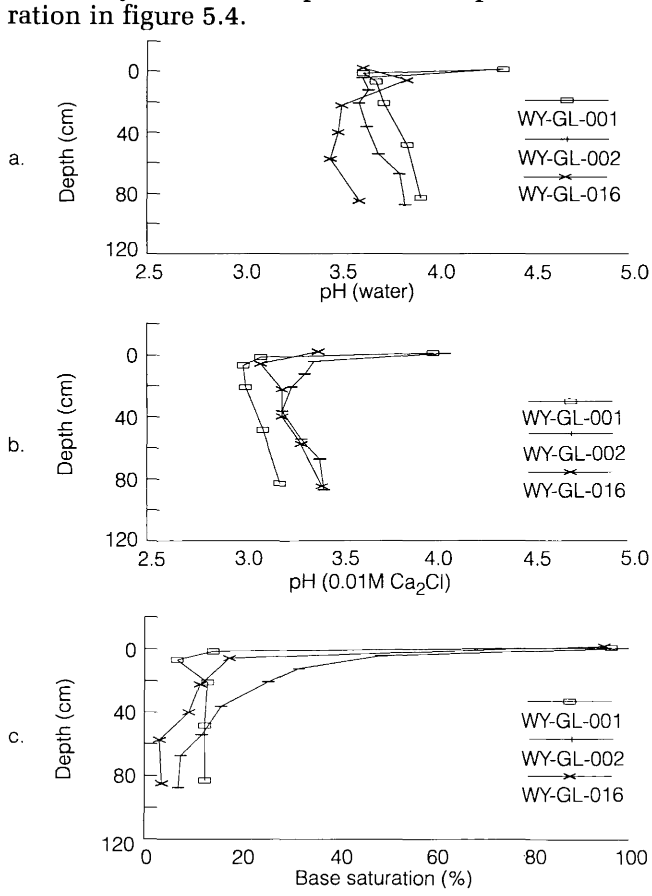

Figure 5.2.—pH and base saturation (neutral salt method) for selected Cryoboralfs in GLEES.

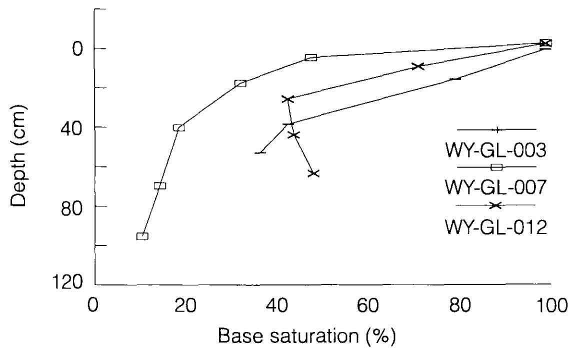

Figure 5.3.—Base saturation (neutral salt method) for selected Cryochrepts in GLEES.

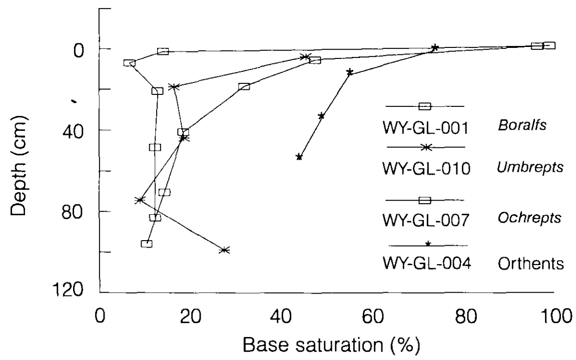

Figure 5.4.—A comparison of base saturation (neutral salt method) for selected pedons of the major soil types occurring in GLEES.

The Cryoboralfs occurring in the GLEES watersheds are generally poorly expressed. Typically only 2% or 3% clay separates the Cryoboralfs and Cryochrepts. Consistent separation of these soils in the field is difficult. Reliance on auxillary characteristics such as color and parent material is of some assistance. The color of the B-horizons is generally more red in the Cryoboralfs than the Cryochrepts. Further, the Cryoboralfs appear to be limited in extent to the distribution of glacial till. Cryochrepts primarily are developed in colluvium and nivation debris.

Three transects were run through the Glacier Lakes watersheds. The purpose of these transects was to observe variations in the pH of surface and near-surface soil material with slope position, elevation, and map unit. Systematic sampling of surface and upper subsoil horizons along these transects was performed for pH determination. Map unit, soil classification, horizon designation and depths, elevation, and slope data were recorded at each sampling site. These data appear in table 5.1. The data indicate that, in general, pH is reasonably constant for like horizon for similar soils within and between map units. Variations in pH occur between dissimilar soils regardless of map unit, slope, or elevation.

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