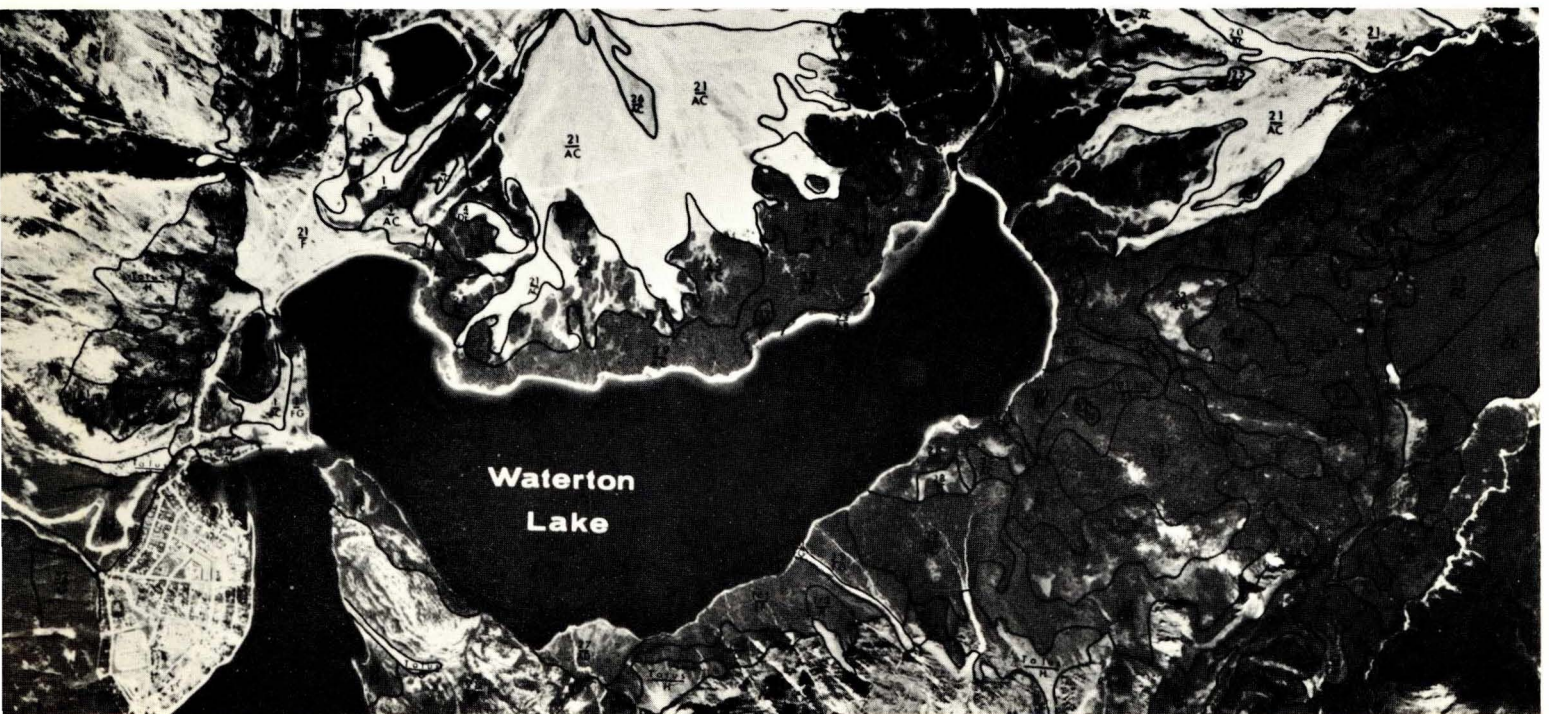
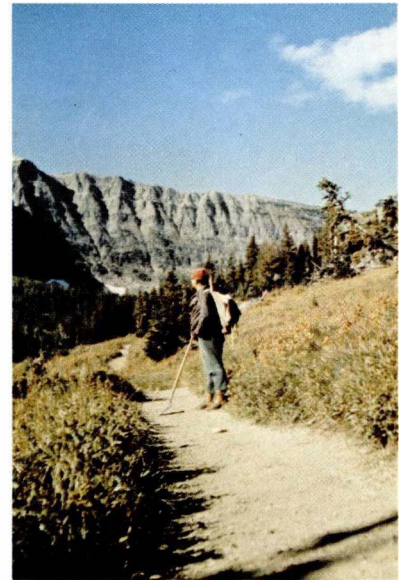
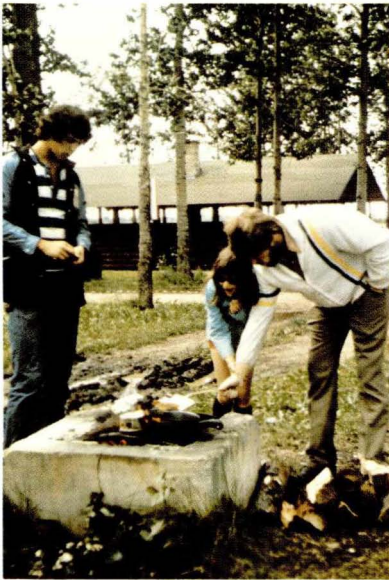
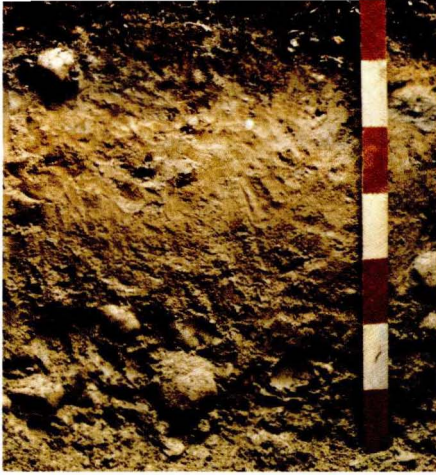


Waterton Lakes National Park

APPENDIX D



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S - 73 - 33

Information Report
NOR-X-65

May 1974

FORWARD

The body of this report includes very sketchy map unit and pedon descriptions to acquaint the reader with the basic concepts of the units. APPENDIX "D" provides rigorous detailed descriptions which characterize the morphology¹ of the type pedons in the map unit, and attempts to suggest the major variations from the type pedon which fall within the concept of the mapped unit. Major map units which have common boundaries with the unit under discussion are identified and landscape relationships assisting in the recognition of the boundaries are discussed. Differentiating criteria between similar mapping units are also provided.

Soil pedons are classified according to Canada Soil Survey Committee (1970)² and the approximate equivalent in the 7th Approximation (1960, 1964, 1967, 1968) is given. The map units are characterized by the taxonomic name of the typical pedon and occasionally by a second taxonomic name of a major associated pedon.

Vegetation description for the mapping units are interpreted from Lopoukhine³ unless otherwise noted. Vegetation reported as part of the pedon description was determined by on-site observations at the time of sampling. Some of the vegetation characterizing the grassland areas was taken from Stringer⁴ as noted throughout the text.

1. Morphological terminology conforms to Canada Soil Survey Committee. 1970. The System of Soil Classification for Canada. Canada Department of Agriculture, Ottawa.
2. Soil Survey Staff. 1960. Soil Classification, A Comprehensive System, 7th approximation (and supplements in 1964, 1967 and 1968). U.S. Government Printing Office, Washington, D.C., 265 pp.
3. Lopoukhine, N. 1970. Forest types and related vegetation of Waterton Lakes National Park, Alberta, 1968. Forest Management Institute Information Report FMR-X-28, Canadian Forestry Service, Ottawa (plus appendices 1 to 5).
4. Stringer, P.W. 1969. An ecological study of grasslands at low elevations in Banff, Jasper and Waterton Lakes National Parks. Ph.D. Thesis. Univ. of Alberta, Edmonton.

MAP UNIT NO. 1. (Orthic Dark Brown and Orthic Black Chernozemics)

The soils of this map unit are dominantly coarse textured with many gravel sized fragments. They have formed on calcareous gravelly outwash materials, derived mainly (if not entirely) from sedimentary materials from the nearby mountains. The fine gravels 2-5 mm. are comprised dominantly of red and green argillites and some sandstone and limestone. With increasing size there is a greater percentage of sandstones and limestones. There are no compact or impermeable layers and thus permeability is very rapid. These soils are well drained. Because of the complex slopes (knob and kettle) and associated changes in micro-climate and micro-environment there is a systematic change in the soils corresponding to changes in the slope position. Soils on the tops and steep sides of the knolls have very shallow Chernozemic Ah horizons, thus they are either Chernozems with shallow Ah horizons or Regosols. Soils within this same map unit on gentler slopes (generally less than 9%) or on the lower slopes and areas of moisture accumulation are generally Black Chernozems, rather than the Dark Brown Chernozems found on the upper part of the slopes. The Black Chernozems generally contain fewer coarse fragments and are finer textured. Geographically this map unit is located north of the townsite in the main Waterton Valley.

Associated Map Units

Map unit 4 is comprised of lithic soils on rocky knobs occurring as islands in map unit 1. Map unit 19 is found at the base of the knob and kettle topography of map unit 1, where finer textured alluvial terraces were deposited by the melting glaciers. Map unit 50 is comprised of Chernozemic soils developed on drumlinoid till features surrounded and partially covered by the outwash on which soils mapped as map unit 1 are found.

Competing Map Units and Differentiae

The coarse textured gravelly outwash materials on which the soils of map unit 1 are formed distinguish them from most other soils in the park. Map unit 7 differs because it has bedrock within 50 cm. of the surface. Soils of map unit 8 are finer textured and have very few gravel or cobble sized fragments which distinguish them from map unit 1. Map units 50, 58 and 67 are characterized by Chernozems but differ from map unit 1 by being developed on till. Map unit 38 may at times be similar to map unit 1 but differs by being formed on fan shaped landforms and generally located at higher elevations.

Vegetation

Vegetation characteristic of this map unit is typical of the drier prairies in Alberta. Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue),

Danthonia parryi (parry oat grass), and Lupinus sericeus (pursh's silky lupine) comprise the major flora. Potentilla fruticosa (shrubby cinque foil) is found dispersed throughout the map unit and comprises about 5% of the ground cover. Shrubby Populus tremuloides (trembling aspen) are found on lower slopes and on the north (lee) side of hills where snow collects and the wind is not as severe. Grasses growing on the lower slopes are noticeably higher and more luxuriant. Their better growth corresponds quite well with the change to Black Chernozems. The strong, fairly consistently south winds which blow down the Waterton valley combined with a limited rainfall control to a considerable degree the vegetation in map unit 1 and also the variation of the vegetation and soils within this map unit. Some relatively large areas of the topsoil from the lower slopes of this map unit have been mined.

The two major kinds of pedons found in this map unit are described below.

Pedon description (C106)

Classification: Orthic Dark Brown Chernozemic (Typic Cryoborall)

Described by: Gerald Coen.

Date: August 5, 1971.

Location: about $\frac{1}{4}$ mile north of trademen's dump, north of Blakiston Creek and West of Knight Lake (Fig.22).

Climate: semiarid continental.

Parent material: glacial outwash gravels and sands with occasional boulders, mostly below the ground surface.

Landform: outwash plain with some knobs and kettles.

Slope: 6% across pit, up to 40-50% in map unit.

Elevation: 4400 feet ASL.

Aspect: about 250 degrees.

Relief: estimated maximum 200 feet.

Estimated drainage: well drained.

Water table: probably never within the solum.

Vegetation: nearly 100% coverage with bluebunch fescue, rough fescue, parry out grass and pursh's silky lupine. Shrubby cinquefoil covers about 5% of the area and very stunted trembling aspen occupy the footslopes and kettles.

Notes: Soil temperature at 50 cm was 15 degrees C. There are not many large stones or boulders on the surface. The present land use is virgin prairie and erosion is relatively small.

- Ah 0 to 20 cm; dark grayish brown (10YR 4/2 d) and very dark grayish brown (10YR 3/2 m) gravelly coarse sandy loam; weak fine granular (fluffy); soft, very friable; plentiful very fine and fine roots; estimated coarse fragments 50%; diffuse, wavy boundary; 15 to 25 cm thick.
- Bm1 20 to 38 cm; brown to dark brown (7.5YR 4/2 d) and dark brown (7.5YR 3/2 m) gravelly coarse sandy loam; weak coarse subangular blocky; soft, very friable; plentiful very fine and fine roots; estimated coarse fragments 50%; diffuse, wavy boundary; 15 to 23 cm thick.
- Bm2 38 to 76 cm; brown (7.5YR 5/2 d) and brown to dark brown (7.5YR 4/2 m) gravelly coarse sandy loam; weak coarse subangular blocky; soft, very friable; plentiful fine and very fine roots; estimated coarse fragments 50%; diffuse, wavy boundary; 15 to 20 cm thick; (more gravels than Bm1).
- Ck 76 to 102+cm; reddish gray (5YR 5/2 d) and reddish brown (5YR 4/4 m) gravelly coarse sandy loam; single grain; loose; very few roots; weak effervescence; estimated coarse fragments 50%.

Pedon Description

Classification: Orthic Black Chernozemic (Typic Cryoboroll).

Described by: Zdenek Widtman and Gerald Coen.

Date: June 2, 1971.

Location: about 100 feet northwest of the tradesmen's dump, north of Blakiston Creek and west of Knight's Lake (Fig.22).

Climate: semiarid continental.

Parent Material: glacial outwash gravels and sands with occasional boulders, mostly below the ground surface.

Landform: outwash plain with some knob and kettle topography.

Slope: 4 - 6% across the pit and up to 15% in some places on these soils.

Relief: estimated maximum of the landform of 200 feet.

Elevation: about 4,400 feet ASL.

Aspect: about 150 degrees.

Estimated drainage: rapidly drained.

Water table: probably never within the pedon, except possibly on the bottom of kettles in the early spring of some years. The water table was below the solum in the kettles examined on June 2, 1971.

Vegetation: Dominantly covered with grasses and herbs such as Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), Danthonia parryi (parry oat grass), and Lupinus sericeus (pursh's silky lupine). Potentilla fruticosa (shrubby cinquefoil) covers a small amount of the area and very stunted Populus tremuloides (trembling aspen) are fairly common especially in the lee sides of hills where snow collects.

Notes: Soil temperature at 50 cm was 8.5 degrees C. Considerably fewer surface stones and boulders are likely to be found associated with the Black Chernozems than with the associated Dark Brown Chernozems. The present land use is largely virgin grassland although several areas have been mined for topsoil. Erosion is not a problem.

Ah 0 to 28 cm ; black (10YR 2/1 m) very dark gray (10YR 3.5/1 d) loam; weak fine to medium subangular blocky (granular?); friable; abundant very fine roots; less than 20% coarse fragments; diffuse, wavy boundary; 23 to 30 cm thick.

Bm 28 to 56 cm ; dark reddish brown (5YR 3/2 m) sandy loam; medium to coarse subangular blocky; friable; plentiful very fine roots; few very fine pores; less than 20% coarse fragments; diffuse, wavy boundary; 20 to 33 cm thick.

C 56 to 76 plus cm ; dark reddish brown (5YR 3/4 m) gravelly sandy loam; medium to coarse subangular blocky; friable; plentiful very fine roots; few very fine pores; greater than 20% coarse fragments.

MAP UNIT NO 4. (Lithic Orthic Brown Chernozemic)

The soils of this map unit are coarse textured with many gravel sized fragments as well as some stones and boulders. They have formed from a thin deposit of gravelly outwash material over bedrock. The underlying resistant bedrock controls the landform and occasionally is exposed at the surface. They are very similar to the Dark Brown Chernozem members of map unit 1 except that the solum is restricted in depth by bedrock. Map unit 4 is geographically located north and west of the lower Waterton Lake on the rocky knobs that are evident on the Blakeston fan and the adjacent outwash.

Associated Map Units

Map units associated with the Blakeston fan such as 21, 22 and 25 are found adjacent to the base of the rocky knobs upon which map unit 4 is located. Map unit 1 is also found on the more rolling topography where bedrock is not so close to the surface. Occasionally the mantle of outwash which covers till deposits in the area is not continuous and till is exposed to the surface adjacent to map unit 4, thus map unit 50 and map unit 4 may be found in juxtaposition.

Competing Map Units and Differentiae

Soils of map unit 1 differ from those of map unit 4 by being greater than 50 cm to bedrock. Other map units with dominantly lithic soils such as 90R and 91R differ chiefly in that they do not have the Chernozemic Ah associated with the prairie parts of the park.

Vegetation

Vegetation associated with this map unit is Gramineae (grasses). Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue) and Danthonia parryi (Parry oat grass) are the dominant species. Other herbs such as Lupinus sericeus (perennial lupine) and Erigeron glabellus var. pubescens (wild daisy) are found. Shrubs include Arctostaphylos uva ursi (kinnickinnick) and some Rosa acicularis (prickly rose). Selaginella densa (little clubmoss) is also found (Stringer, 1969).

Pedon Description (C230)

Classification: Lithic Brown Chernozemic (Typic Cryoboroll).

Described by: Gerald Coen.

Date: September 11, 1972.

Location: On the rocky knob west of the highway about three-quarters of a mile north of the park compound (Fig.22).

Climate: semiarid continental.

Parent Material: A shallow deposit of gravelly and flaggy outwash material.

Landform: Glacially contoured bedrock outcrop with a thin mantle of outwash material.

Slope: 7% in the vicinity of the pedon and ranging 5 to 40% on the landform.

Elevation: 4,300 feet ASL.

Relief: About 70 feet.

Aspect: 180 degrees.

Estimated Drainage: rapidly drained.

Water table: below the bedrock contact.

Vegetation: An occasional scrubby Pseudotsuga menziesii (Douglas fir) was noted on the landscape. Shrubs noted included Symphoricarpos occidentalis (western snowberry), Potentilla fruticosa (shrubby cinquefoil), Amelanchier alnifolia (saskatoon) and an occasional three to four foot tall Populus tremuloides (trembling aspen). Herbs noted included Lupinus argentus (perennial lupine), Campanula rotundifolia (common bluebell), Aster sp. (asters) and Chrysanthemum leucanthemum (ox-eye daisy). The dominant vegetative species was Gramineae (grasses) of which the Festuca sp. (fescues) were most common.

Notes: Rocks and flags were common both within the pedon and on the surface. The soil was in a virgin condition.

- Ah 0 to 9 cm ; dark reddish brown (5YR 3/3 m) and brown(10YR 5/3 d and rubbed) gravelly loam; weak medium granular; very friable; abundant fine roots; very few fine pores; no clay films; no effervescence; estimated coarse fragments 50%; clear wavy boundary; 5 to 18 cm thick.
- Bm 9 to 30 cm ; brown (7.5YR 4/4 m) gravelly loam, weak large subangular blocky; friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 50%; clear wavy boundary; 15 to 23 cm thick.
- C 30 to 38 cm ; reddish brown (5YR 4/3 m) gravelly sandy loam; massive; friable; few fine roots; few fine pores; no clay films; slight effervescence; estimated coarse fragments 50%; 0 to 13 cm thick.
- R The rock consists of an outcrop of resistant dolomite. Fresh fractures are gray and weathered surfaces are buff colored.

COMMENTS

A skiff of shallow unconsolidated mineral material covers most of this outcrop but in some cases is less than 10 cm thick while in the hollows it is greater than 10 cm thick resulting in lithic soils. Some of the soils do not have a C horizon and many do not have a Bm horizon. It is difficult to be sure whether the unconsolidated mineral debris covering these bedrock knobs is outwash or merely modified till and probably the answer to the question is only academic.

MAP UNIT NO. 8 (Orthic Dark Brown Chernozemic)

The soils of this map unit are medium to coarse textured with occasional areas of gravelly soils. The soils having the most extensive distribution have very few gravel sized stones within the solum and essentially no larger stones. On the east side of Crooked Creek there is an area of soils showing considerable slumping - where the ground surface has dropped 2 - 6 feet. This slumping prevents appreciable profile development and thus these slumped soils are Regosolic rather than Chernozemic as in the rest of the map unit. These silty and very fine sandy soils have been deposited around the base of drumlinoid like till knobs and over some gravelly (probably outwash) material near the base of the till knobs. Occasionally the gravels show through the mantle near the tops of rises and the gravels are buried deeper downslope and are below 6 feet in the kettles and swales. Vegetation is very poor on the gravelly areas and much improved in the silty and fine sandy material. These soils are very calcareous with the lime coming nearly to the surface near the tops of slopes and receding to 76 cm or so near the bottom of slopes. In some kettles lime has been removed to below 2.5 m (much below the mean water penetration depth) indicating that runoff is collecting and percolating downward eventually ending up in the Waterton River to the west. Most of the area would have little, if any, net percolation through the solum. Map unit 8 is geographically located east of the Waterton River in the vicinity of Crooked Creek.

Associated Map Units

Map unit 50 is found on the till areas upslope from map unit 8. Map unit 16 is found adjacent to the streams where profile development is impeded by occasional erosion and sedimentation.

Competing Map Units and Differentiae

Map unit 16 has soils which are very similar to the soils of map unit 8. The significant development of a Chernozemic Ah in map unit 8 and not in map unit 16, along with the association of map unit 8 with the outwash deposits whereas map unit 16 is associated with alluvium along the creek separates these two map units. The shallow depth to lime (20 to 38 cm) separates the soils of map unit 8 from most other fine sandy and silty soils.

Vegetation

Vegetation characteristic of this map unit has about 5% coverage by the shrub Potentilla fruticosa (shrubby cinquefoil) and about 100% coverage by the herb association comprised of Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), Danthonia parryi (parry oat grass) and Lupinus sericeus (Pursh's silky lupine).

Pedon Description (C135)

Classification: Orthic Dark Brown Chernozemic (Typic Cryoborall).

Described by: Z. Widtman, W. D. Holland and G. Coen.

Date: September 26, 1972.

Location: about $\frac{1}{2}$ mile west and $\frac{1}{4}$ mile south of where highway 5 crosses the park boundary towards Cardston (Fig.22).

Climate: semiarid continental.

Parent Material: highly calcareous, very fine sandy loam to silt loam outwash.

Landform: outwash plain.

Slope: about 12 to 14% across the pit and ranging from 0 to 15% complex slopes made up of knobs and kettles.

Elevation: about 4200 feet ASL.

Relief: about 50 feet.

Aspect: about 170 degrees for pit site.

Estimated drainage: well drained.

Water table: probably below the solum for most, if not all, the year.

Vegetation: some bluffs of scrubby Populus tremuloides (trembling aspen) are noted on north facing slope positions. Juniperus horizontalis (creeping juniper), Arctostaphylos uva-ursi (Kinnickinnick) Rosa sp. (roses) and one of the sages as well as Potentilla fruticosa (shrubby cinquefoil) are the major shrubs noted. The vegetation is completely dominated by the Festuca sp. (fescue grasses).

Notes: The soil temperature at 50 cm was 5 degrees C. There were very few stones or boulders on the surface. Considerable rodent activity results in bringing significant amounts of CaCO_3 rich soil to the surface. The soils are in a virgin condition.

Ah 0 to 10 cm ; very dark grayish brown (10YR 3/2 m) and dark grayish brown (10YR 3.5/2 d) silt loam, weak medium granular; very friable; few medium and plentiful fine and very fine roots; pores not visible; no clay films; estimated coarse fragments less than 5%; abrupt, smooth boundary; 8 to 13 cm thick.

- AB 10 to 15 cm ; brown 10YR 4/3 m) very fine sandy loam; weak large subangular blocky; very friable; few fine and plentiful very fine roots; no pores; no clay films; estimated coarse fragments less than 5%; clear, wavy boundary; 1.5 to 9 cm thick.
- Bm 15 to 33 cm ; dark yellowish brown (10YR 4/4 m) very fine sand; massive to weak medium subangular blocky; very friable; few fine, plentiful very fine roots; pores not visible; no clay films; estimated coarse fragments less than 2%; clear, wavy boundary; 15 to 30 cm thick.
- BC 33 to 48 cm; yellowish brown (10YR 5/4 m) very fine sand; weak medium subangular blocky; very friable; few fine roots; few very fine pores; no clay films; no coarse fragments; abrupt, irregular boundary; 10 to 15 cm thick.
- Cca 46 to 71 cm ; light gray(10YR 7/1 and 7/2 d) silt loam; massive; soft; few very fine roots; few, fine pores; no clay films; strong effervescence; diffuse, wavy boundary; 23 to 38 cm thick.
- Ck 71 to 104 plus cm ; light gray (10 YR 7/2 d) silt; massive; hard; no roots; no pores; no clay films; strong effervescence; no coarse fragments.

MAP UNIT NO. 11 (Orthic and Cumulic Regosols)

The soils of this map unit are dominantly coarse textured with varying amounts of gravel sized fragments and generally not many cobbles or boulders. They have formed from alluvium which is flooded once every year or two but not flooded so that it is scoured of the finer materials. Thus, it is generally covered with vegetation of varying ages but little profile development is observed. Buried layers of semidecomposed and decomposed L-H are evident in many pedons. The coarse texture of these soils is probably partly responsible for the lack of morphological evidence of poor drainage. When the water level drops in the river the soils very quickly drain and dry out. This map unit is found mainly on the flood plain of the Belly River.

Associated Map Units

Map units 20 and 15 are found in the flood plain of the river adjacent to map unit 11. In general map unit 20 will be between the water and map unit 11 and map unit 15 will be located between map unit 11 and other map units.

Competing Map Units and Differentiae

Map unit 20 is often coarser and is flooded so regularly and severely that it supports essentially no vegetation, and also often has no fines covering the coarse

fragments. Soils of map unit 15 are finer textured and do not have as active erosion and deposition. Map unit 17 differs because it has soils with more profile development (Orthic Dark Brown Chernozemic) and because of the more arid and stable conditions. Map unit 18 is found on more stable river alluvium positions and differs mainly because its soils have more profile development.

Vegetation

Vegetation characteristic of this map unit is dominated by Populus balsamifera (balsam poplar) and Picea glauca (white spruce) in thrifty mature stands 40 to 60 feet tall and providing 40 to 60% cover. The lower vegetation is usually dominated by a shrub association consisting of Spiraea lucida (white meadowsweet), Rubus parviflorus (thimbleberry) and Amelanchier alnifolia (saskatoon) and an herb association consisting of Thalictrum venulosum (veiny meadow-rue), Graminae (grasses), Epilobium angustifolium (fireweed) and Equisetum arvense (horsetail).

Pedon Description (C133)

Classification: Orthic Regosol (Typic Cryorthents).

Described by: W. D. Holland and Gerald Coen.

Date: September 24, 1972.

Location: about $\frac{1}{2}$ mile north along the trail east of the Belly River bridge and then west onto the flood plain (Fig.22).

Climate: semiarid continental.

Parent material: coarse alluvium with few boulders.

Landform; floodplain.

Slope: less than 2%.

Elevation: about 4500 feet ASL.

Relief: 1 to 3 feet.

Aspect: nil.

Estimated Drainage: well drained except when the river is in flood, when for a period the soils may be saturated.

Water table: within 4 to 5 feet most of the year and at or near the surface for periods in the spring.

Vegetation: Picea glauca (white spruce) and Populus balsamifera (balsam poplar) are found in about equal numbers. Many of the poplars are damaged and have broken tops. Shrubs include Salix sp. (willows), Cornus stolonifera (red osier dogwood), Symphoricarpos occidentalis (western snowberry) and Shepherdia canadensis. Herbs include Epilobium angustifolium (fireweed), Smilacina stellata (Solomon's seal), Aquilegia sp. (columbine), Solidago sp. (goldenrod) Vicia sp. (vetch) and a predominance of Graminae (grasses).

Notes: Soil temperature at 50 cm was 4 degrees C. Surface stones are variable but cobbles and boulders are not common. The soil is in virgin condition.

L-H Generally less than 1.5 cm of relatively undecomposed leaf litter, quite variable thickness.

C1 0 to 18 cm ; very dark grayish brown (10YR 3/2 m) silt loam; weak, very fine granular; very friable; abundant, fine and medium roots; few medium pores; estimated 5% coarse fragments; abrupt, smooth boundary; 15 to 20 cm thick.

C2 18 to 51 cm ; very dark grayish brown (10YR 3/2 m) (multicolored sands) gravelly coarse sandy loam; single grain; loose; few, fine roots; no evident pores; estimated 40% coarse fragments; clear, wavy boundary; 30 to 38 cm thick.

C3 51 to 76 cm ; gray (10YR 5/1 m) and grayish brown (10YR 5/2 m) coarse sand with few large faint mottles (sands are multicolored); single grain; loose; few, fine roots; estimated 10% coarse fragments; gradual, wavy boundary; 20 to 28 cm thick.

C4 76 to 102 plus cm ; grayish brown (10YR 5/2 m) gravelly coarse sand dominantly comprised of fragments of the red and green argillites; single grain; loose; few, fine roots; estimated 80% coarse fragments mostly gravel size.

COMMENTS

There is a 0.5cm thick layer of buried L-H between C1 and C2 at 18 cm. depth.

MAP UNIT NO. 12 (Orthic Regosol)

The soils of this map unit are medium textured surficial material for about the surface 50 cm and below that they are dense fine-textured till. Large coarse fragments are found at depth but few are exposed at or on the surface. The fine textures below 50 cm result in very slow percolation of water and a perched water table for appreciable portions of the year. These soils are of very limited areal extent, found only immediately

east of the Belly River and north of the U.S. border on longlineal landforms. The somewhat unique nature of these soils justifies their separation.

Associated Map Units

Map units 15, 41, 46, 190 and Bp are found in association with map unit 12. Map unit 15 is found on alluvial benches adjoining the lower slopes of map unit 12. Map unit 41 is found east of and up slope from map unit 12. Map unit 46 is found where a small stream dropped some of its sediment load as it abutted map unit 12. Map units 190 and Bp are located in depressions to the east of map unit 12.

Competing Map Units and Differentiae

The occurrence of the fine textured paleosol developed in dense till below the loam surficial deposit distinguishes map unit 12 from most of the other map units in the Park. Map unit 15 differs because of the lack of till with depth and because of its occurrence on river terrace alluvium. Map unit 41 has a loamy regosolic surficial deposit over till but differs by the lack of an Ah horizon (indicating active slopewash) and by the coarser textured, less dense nature of the calcareous underlying till. Map unit 57 is a Luvisol developed on till but generally does not have the fairly deep surficial deposit as does map unit 12. Also the till in map unit 57 is highly calcareous and less dense than in map unit 12.

Vegetation

Vegetation associated with this map unit is dominantly 40 - 60% cover with 40 to 60 foot tall Pinus contorta (lodgepole pine). Occasional patches of Populus tremuloides (trembling aspen) are also found on map unit 12. The shrub layer provides 25 to 30% cover with such species as Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose), Rubus parviflorus (thimbleberry) and Spiraea lucida (white meadowsweet). Herbs provide about 80% cover with such species as Gramineae (grasses), Hedysarum sulfurescens (yellow hedysarum), Heracleum lanatum, (cow parsnip) and Thalictrum venulosum (veiney meadow rue).

Pedon Description (C129 located close to N29)

Classification: Orthic Regosol (truncated Luvisolic paleosol as precursor in polygenetic history (Typic Cryorthent).

Described by: W. D. Holland and Gerald Coen.

Date: September 22, 1971.

Location: about $\frac{1}{2}$ mile south along the trail starting in Belly River campground and then east about 100 yards into the trees (Fig.22).

Climate: continental.

Parent Material: the soil appears to be polygenetic with a truncated Luvisolic paleosol (developed in till) acting as parent material for the lower part of the solum or C horizon. The top 28 cm may be loess or some similar type silty deposit.

Landform: north-south oriented elongated drumlinoid-like feature.

Slope: 5 to 7% in the vicinity of the pit and 3% across the pit.

Elevation: about 4620 feet ASL.

Relief: about 20 to 30 feet.

Aspect: 270 degrees.

Estimated drainage: surface drainage is fairly good but pedon characteristics indicate it is only moderately well drained.

Water table: probably has a perched water table for significant period of the year.

Vegetation: At the pedon the vegetation consisted of 40 to 60% forest cover comprised of Populus tremuloides (trembling aspen) and Pinus contorta (lodgepole pine), 40 to 60 feet tall, mature and overmature. there was a fair amount of regeneration by trembling aspen, Picea glauca (white spruce) and Pseudotsuga menziensis (Douglas fir). The understory vegetation included about 30% coverage by the shrub association of Rubus parvi florus (thimbleberry), Spirea lucida (white meadowsweet) and Berberis repens (creeping mahonia) and 70% coverage by the herb association of Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow-rue), Epilobium angustifolium (fireweed), and Gramineae (grasses) - taken from Lopoukhine, 1969 because snow prevented proper on the spot evaluation.

Notes: Soil temperature at 50 cm was 4 degrees C. Relatively few stones and boulders on the surface but several greater than 10 inches in diameter in the lower solum. The soil is virgin.

L-F 2.5 to 0 cm ; relatively undecomposed organic remains containing some yellow mycelia; abrupt, smooth boundary; 1.3 to 5 cm thick.

Ah 0 to 13 cm ; very dark grayish brown (10YR 3/2 m) varying to black (10YR 2/1 m) loam; weak medium granular structure; very friable; abundant coarse and few fine roots; soil was too wet to observe pores; there is evidence of earthworm activity; clear, wavy boundary; 5 to 20 cm thick.

C1 13 to 28 cm ; grayish brown (10YR 5/2 m) and dark gray to dark grayish brown (10YR 4/1 to 4/2 m) loam to silt loam; weak medium subangular blocky; very friable; plentiful coarse and medium roots; many fine pores; clear, wavy boundary; 8 to 20 cm thick.

- C2 28 to 43 cm ; grayish brown (10YR 5/2 m) silt loam matrix with light gray (10YR 7/2 m) ped surfaces and common medium distinct yellowish brown (10YR 5/6 m) mottles; moderate coarse platy with some subangular blocky tendency; firm, brittle; plentiful medium roots; many fine pores; clear, wavy boundary.
- IIABgb 43 to 51 cm; light brownish gray (10YR 6/2 m) clay loam matrix with light gray (10YR 7/1 m) ped coatings and many fine distinct dark yellowish brown (10YR 4/4 m) mottles; strong medium subangular blocky; firm; plentiful medium roots; many fine and very fine pores; clear, broken boundary.
- IIbtgb1 51 to 76 cm; brown (10YR 4/3 m) clay matrix with dark gray (10YR 4/1 m) ped surfaces and common medium faint dark yellowish brown (10YR 4/4 m) mottles; very coarse prismatic; firm; few medium and fine roots; few fine pores; continuous thick clay films; gradual, wavy boundary.
- IIbtgb2 76 to 109 cm ; brown (10YR 4/3 m) clay matrix with dark gray (10YR 4/1 m) ped surfaces and common medium faint dark yellowish brown (10YR 4/4 m) mottles; strong medium prismatic and strong coarse blocky; firm; very few medium roots; no visible pores (roots follow ped faces); continuous thick clay films; gradual, wavy boundary, (white mycelia were observed on ped faces).
- IIBCgb 109 to 117 plus cm ; brown (10YR 4/3 m) clay matrix with very dark grayish brown (10YR 3/2 m) ped surfaces and many medium distinct yellowish brown (10YR 5/6 m) mottles; massive; firm; few medium roots; few medium pores; many thick clay films; fine gravel sized pieces of black shale were observed in this horizon.

COMMENTS

This pedon, based on morphological evidence, appears to have a polygenetic origin. There appears to be a Regosol profile development in a silty surficial deposit over a partially truncated paleo-luvisol developed from till. The B region of the paleo-luvisol is extremely dense and compact. About $\frac{1}{2}$ dozen boulders from below 28 cm were essentially the only coarse fragments found in the pedon.

MAP UNIT NO. 14 (Rego Humic Gleysol)

The soils of this map unit are medium to fine textured with a few coarse fragments. They have formed on river floodplains and are associated with the depressional areas and ox-bows. Much of the area of map unit 14 has a water table within cms of the surface

for the entire season in some years. The water table on these very poorly drained Gleysol soils fluctuates with the level of the water in the nearby river. Mapunit 14 is geographically located in the Belly River floodplain.

Associated Map Units

Map units 15, 27, 42 and 101 are found in association with map unit 14. Map unit 15 is found on slightly elevated portions of the floodplain and is better drained than map unit 14. Where fairly coarse textured fans having Regosolic soils on them, encroach upon the floodplain map unit 27 adjoins map unit 14. Where these fans are finer textured and have a relatively well developed Ah horizon, map unit 42 adjoins map unit 14. Map unit 101 is occasionally found on the valley walls which define an upper limit of the floodplain where map unit 14 is found.

Competing Map Units and Differentiae

Map unit 11 differs from map unit 14 in that it is a very coarse and very variable textured part of the alluvial floodplain. Soils of map unit 11 do not show the gley and mottled characteristics of those of map unit 14 even though they are occasionally flooded. Soils of map unit 15 are the better drained counterparts of those of map unit 14. Map units 29, 31, 32 and 44 differ because of the fan-shaped landform upon which they are found. Soils of map unit 29 are better drained than are those of map unit 14 and are also more coarse textured. Soils of map units 31 and 32 are poorly and very poorly drained, but somewhat coarser textured than map unit 14. Soils of map unit 44 are much coarser textured and contain a large amount of cobble and boulder sized fragments.

Vegetation

Vegetation associated with this map unit is characterized by an abundance of Salix spp. (willows). Alnus tenuifolia (river alder) and a few Populus balsamifera (balsam poplar) are also associated with this map unit. Herbs such as Heracleum lanatum (cow-parsnip), Veratrum eschscholtzii (false hellebore) Carex spp. and Gramineae (grasses) are also associated with this map unit.

Pedon Description (C197)

Classification: Rego Gleysol (Typic Cryaque).

Described by: Gerald Coen.

Date: August 25, 1972.

Location: about $\frac{1}{4}$ mile north and $\frac{1}{4}$ mile east of where the Belly River crosses the southern boundary of the Park. (Fig.22).

Climate: continental.

Parent Material: fairly fine-textured floodplain alluvium.

Landform; river floodplain.

Slope: less than $\frac{1}{2}\%$ in the vicinity of the pedon and associated with the map unit.

Elevation: about 4500 feet ASL.

Relief: about five feet.

Aspect: none.

Estimated Drainage: very poorly drained.

Water table: 0 to 8 cm below the ground surface.

Vegetation: Salix spp (willows) provided almost 100% cover of about 10 foot tall trees. The odd Populus balsamifera (balsam poplar) and an occasional Picea glauca (white spruce) were noted. The only herb noticed was Caltha palustris (marsh marigold). An abundance of feather mosses were also noted adjacent to the clumps of willows.

Notes: The soil temperature at 50 cm was 11 degrees C. There were essentially no stones within the pedon or on the surface. The soil was in a virgin condition.

L-H 20 to 0 cm ; very dark gray (10YR 3/1 m) very well decomposed organic matter with islands or blotches of C horizon material within the organic horizon; common fine roots; clear irregular boundary; 15 to 23 cm thick.

A & Cg 0 to 5 cm ; very dark gray (10YR 3/1 m) and dark gray (5Y 4/1 m) loam with common medium, distinct, light olive brown (2.5Y 5/6 m) mottles; moderate large angular blocky; friable; few medium roots; pores not observed; no clay films; no effervescence; no coarse fragments; gradual irregular boundary; 1.5 to 10 cm thick.

Cg 5 to 50 cm ; gray (N 6/ m) silty clay loam with many medium distinct strong brown (7.5YR 5/8 m) mottles; massive; friable; few medium roots; very few fine pores; no clay films; no effervescence; no coarse fragments.

COMMENTS:

There appears to be very strong tonguing or mixing of some sort in the 0 to 5 cm depth region, hence, the horizon designation A & Cg There is an increase in clay and a decrease in mottles, but not gleying with depth.

MAP UNIT NO. 15 (Orthic and Cumulic Regosols)

The soils of this map unit are medium and fine textured with occasional cobbles and boulders within the first 100 cm. They have formed on somewhat stratified alluvial deposits along the floodplain of the Belly and Waterton Rivers. These soils are better drained than Gleysols but vary between Orthic Regosols and Gleyed Regosols. Because of the landscape position these soils receive runoff or groundwater so that they are saturated for varying portions of the year depending on the exact landscape position of the particular segment of the map unit. Geographically map unit 15 is located mainly on the floodplain of the Belly River and small areas north of Maskinonge Lake.

Associated Map Units

Map units 11, 14, 19, 32, 36, 42, 44 and 50 are found in association with map unit 15. Map unit 11 is found on associated gravelly river terraces. Map unit 14 is found in the depressional areas adjacent to or within map unit 15. In the more arid portions of the Park adjacent to Maskinonge Lake, map unit 19 may be found on some of the grassy, gravelly deposits. Map unit 32 is found on the depressional areas at the toe of fans where it may occasionally adjoin map unit 15. Where fans with well developed Luvisolic profiles abut the river terraces map unit 15 is sometimes found in association with map unit 36. On other fans which have Regosolic soils developed in a silty loam material map unit 42 may be found adjoining map unit 15. Where stony and cobbly poorly drained fans adjoin river terraces map unit 44 may abut map unit 15. North of Maskinonge Lake the floodplain of the Waterton River is constricted by grassy till soils and in this position map unit 50 adjoins map unit 15.

Competing Map Units and Differentiae

Map unit 15 differs from most other map units in the Park because it is characterized by soils which lack coarse fragments and which have relatively good structure in the Ah horizon. Its occurrence on river floodplains further serves to differentiate map unit 15 from most other competing map units. Map unit 11 is found on river floodplains but the very variable texture and abundance of coarse fragments of its soils allows relatively easy differentiation from map unit 15. Map unit 14 is also found on floodplains and it is the poorly drained associate to map unit 15. Map units 25 and 44 are found on fans associated with river floodplains but the soils of map unit 25 are considerably coarser in texture and the soils of map unit 44 contain a large component of coarse fragments and are very poorly

drained. Map unit 105 differs from map unit 15 mainly by its considerably finer textured soils and its association with more fan-like landforms than those of river terraces.

Vegetation

Vegetation characteristic of this map unit is dominated by shrubs and herbs. The major species include Salix spp. (willows) and Alnus tenuifolia (river alder). Herbs are dominated by the association consisting of Hercleum lanatum (cow parsnip), Veratrum eschcholtzii (false hellebore), Carex spp. (sedges) and Gramineae (grasses). Some areas have clumps of 40 to 60 foot tall Picea glauca (white spruce) and/or Populus spp. (trembling aspen and balsam poplar).

Pedon Description (C223)

Classification: Orthic Regosol (Typic Cryofluvent)

Described by: Gerald Coen.

Date: September 10, 1972.

Location: about $\frac{1}{4}$ of a mile north of the United States border and 100 yards west of the Belly River (Fig. 22).

Climate: Continental.

Parent Material: medium textured alluvium with few stones and boulders.

Landform: floodplain.

Slope: $\frac{1}{2}\%$ in the vicinity of the pedon and 0 to 2% on the landform.

Elevation: about 4,500 feet ASL .

Relief: about 4 feet.

Aspect: none

Estimated Drainage: moderately well drained.

Water table: greater than 30 inches (76 cm) at the time of sampling but probably near the surface for short periods in the spring.

Vegetation: the occasional clump of Populus tremuloides (trembling aspen) was noted. Also the odd clump of Salix spp (willows) was noted in the local depressions. The area where the pedon was sampled was dominantly vegetated by herbs including Achillea lanulosa (common wild yarrow), Thalictrum venulosum (veiny meadow-rue), Erigeron sp. (fleabane), Solidago decumbens (goldenrod) and Taraxacum officinale (dandelion). For much of the area 100% cover was provided by grasses, mainly Phleum pratense (timothy).

Notes: The soil temperature at 50 cm was 10 degrees C. There were very few stones on the surface or within the pedon. Ox-bows are a common feature on the landscape associated with this map unit. Soil was in a virgin condition.

- Ah1 0 to 13 cm ; very dark grayish brown (10YR 3/2 m) silt loam; moderate medium granular; very friable; abundant fine roots; few medium pores; no clay films; no effervescence; no coarse fragments; clear wavy boundary; 10 to 15 cm thick.
- Ah2 13 to 25 cm ; dark grayish brown (10YR 4/2 m) silt loam; moderate fine granular; very friable; plentiful fine roots; common medium pores; no clay films; no effervescence; no coarse fragments; gradual wavy boundary; 10 to 18 cm thick.
- C1 25 to 66 cm ; dark grayish brown (10YR 4/2 m) silt loam; weak fine granular to massive; friable; few fine roots; many very fine and common medium pores; no clay films; no effervescence; no coarse fragments; gradual wavy boundary; 36 to 43 cm thick.
- C2 66 to 97 plus cm ; grayish brown (10YR 5/2 m) silt loam; massive; friable; no roots observed; many fine and very fine pores; no clay films; no effervescence; no coarse fragments.

COMMENTS:

A very dark brown (10YR 2/2 m) Ahb horizon 1 cm thick was noted at 79 cm. It was too thin to properly describe or sample. There is considerable rodent and earthworm activity in the vicinity of the pedon and krotovnas were observed. Areas mapped as 15 include the moderately well drained soils described above plus imperfectly drained soils in close association. The poorly and very poorly drained soils found either as inclusions or as associates are mapped as 14.

MAP UNIT 16 (Rego Brown Chernozemic)

The soils of this map unit are very uniform, extensively sorted, silt loam in texture with very few coarse fragments. They have formed on light colored highly calcareous modern alluvial parent materials found in the floodplain of Crooked Creek. Flooding of these soils is erratic depending upon the location and elevation of the

particular segment of floodplain in question. Most areas are probably inundated at least once every two to three years. However, water recedes quickly enough that vegetation is not indicative of wet soils and no mottles are evident. These soils are in the direct path of the northerly valley winds resulting in high evapo-transpiration rates and exposure conditions. Geographically these soils are located on the floodplain of Crooked Creek east of the Waterton River and north of Maskanonge Lake.

Associated Map Units

Map units 1, 8, 17, 19, 31 and 50 are found in association with map unit 16. Map unit 1 adjoins map unit 16 where the flood plain of Crooked Creek meanders against the coarse outwash deposits in the area. Map unit 8 adjoins map unit 16 where the very fine sandy and silt deposits of the two map units merge. Map units 17 and 19 are found on gravelly river terraces whereas map unit 16 is found on similar but silty and very fine sandy terraces. Map unit 31 is a Gleysol found at somewhat lower elevations and generally associated with fans or widening of river terraces. Map unit 50 is found where the meandering floodplain of map unit 16 abuts a morainic or drumlinoidal landform.

Competing Map Units and Differentiae

The most distinctive characteristic of the soils in map unit 16 is the lack of coarse fragments and the very uniform texture of the well sorted CaCO_3 rich materials. Soils of map unit 15 differ from map unit 16 by a rich, black, finer textured Ah horizon and the lack of free carbonate within 76 cm. Soils of map unit 25 are somewhat coarser and more variable in texture showing evident stratification than those of map unit 16. The fan shaped landforms associated with map unit 25 also act as a separating criteria. Map unit 8 is very similar in soil material to map unit 16, however soils of map unit 8 have a reasonably well developed Chernozemic Ah horizon and a good Bm horizon development.

Vegetation

Vegetation associated with this map unit is characterized mainly by Salix spp. (willows) and occasionally Alnus tenuifolia (river alder). Better drained areas are characterized by Potentilla fruticosa (shrubby cinquefoil). Herbs include Heracleum lanatum (cow parsnip), Veratrum eschscholtzii (false hellebore), Carex spp. (sedges)

and Gramineae (grasses). The better drained areas have grass species such as Festuca idahoensis (bluebunch fescue) and Festuca scabrella (rough fescue) as well as Danthonia parryi (parry oat grass) and Lupinus sericeus (Pursh's silky lupine).

Pedon Description (C217)

Classification: Rego Brown Chernozemic (Calcic Cryoboroll).

Described by: Gerald Coen.

Date: September 8, 1972.

Location: On the south side of Crooked Creek about 100 yards west of where the creek crosses Highway 5 to Cardston (Fig.22).

Climate: semiarid continental.

Parent Material: highly calcareous well sorted very uniformly textured very fine sandy loam and silt loam pale colored alluvium.

Landform: stream floodplain.

Slope: about $\frac{1}{2}\%$ adjacent to the pedon and from 0 to 5% on the landform.

Elevation: 4,200 feet ASL.

Relief: from 2 to 4 feet.

Aspect: none.

Estimated drainage: moderately well drained.

Water table: probably near the surface for short periods during most years.

Vegetation: Salix spp. (willows) next to the stream channel and Potentilla fruticosa (shrubby cinquefoil) and Symphoricarpos occidentalis (western snowberry) on the slightly better drained areas. Herbs observed include Aster spp. Hedysarum sulphurescens (yellow hedysarum) and Erigeron perigrinus (fleabane). About 50% cover by grasses was observed.

Notes: The soil temperature at 50 cm. was 9.5 degrees C. There was essentially no stones within the pedon or on the surface. The soil was in a virgin condition, although it may have been pastured at one time by domestic cattle (according to retired warden Ken Gobel).

Ah 0 to 10 cm., very dark grayish brown (10YR 3/2 m) silt loam; strong medium granular; friable; plentiful fine roots; common fine pores; no clay films; slight effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 5 to 13 cm. thick.

- Ck1 10 to 40 cm , dark grayish brown (10YR 4/2 m) silt loam; massive; friable; plentiful fine roots; few fine pores; no clay films; moderate effervescence; estimated coarse fragments less than 2%; gradual wavy boundary; 25 to 33 cm thick.
- Ck2 40 to 100 plus cm ; dark grayish brown (2.5Y 4/2 m) silt loam; massive; friable; very few very fine roots; few fine pores; no clay films; strong effervescence; estimated coarse fragments less than 2%.

COMMENTS:

The depth of the Ah horizon varies somewhat throughout the area.

MAP UNIT NO. 17 (Orthic Dark Brown Chernozemic)

The soils of this map unit are coarse textured with many coarse fragments. Coarse fragments vary from abundant cobbles and boulders within the pedon in areas mapped along the Blakiston Creek to few cobbles and boulders on the east side of Knight's Lake. Parent materials are sometimes so stony that not all interstices are filled with fines. Percolation is so fast and water holding capacity so low that these soils are droughty. Exposure, plus landform allowing run-off, contribute to droughtiness. In some areas, such as along the Blakiston Creek, the Ah is so thin that it barely qualifies for a Chernozemic Ah while in other areas, such as the east side of Knight's Lake, it may be as deep as 25 cm. Map unit 17 is geographically located along the Blakiston Creek and east of Knight's Lake.

Associated Map Units

Map units 1, 11, 19, 20, 22, 32, 170 and 171 are found in association with map unit 17. Occasionally map unit 1 on kame-like deposits along the valley margins is associated with map unit 17. Map unit 11 is found on river terraces where active soil movement is taking place. Map unit 17 is quite stable. Map unit 19 is found in the slight depressions and where snow and moisture tend to accumulate. They have very similar parent materials. Map unit 20 is found in the bouldery, unvegetated stream courses associated with map unit 17. Map units 22 and 32 are found on fans, the former having similar profile characteristics and the latter being a Gleysol. Map unit 170 is characterized by Regosols developed on a sand dune parent material and map unit 171

occurs where relatively recent wind-blown material has covered map unit 17 resulting in a Regosol with a buried Paleo-Chernozem within 76 cm.

Competing Map Units and Differentiae

Map units 11, 15, and 19 are all formed on alluvial terraces but 11 is characterized by a stony Regosol, 15 by a fine textured Regosol, and 19 by a soil with a deep Chernozemic Ah and little, if any, Bm horizon. Map units 27 and 37 are found on fans and the soils have prominent L, F and H horizons. Map unit 42 is formed on river alluvium which was deposited from slow water and hence the soils are finer textured with essentially no stones. Map unit 50 is found on till.

Vegetation

Vegetation associated with this map unit is Gramineae (grasses). Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), and Danthonia parryi (Parry oat grass) are the dominant species. Other herbs such as Lupinus sericeus (perennial lupine) and Erigeron glabellus var pubescens (smooth fleabane) are found. Shrubs include Arctostaphylos uva-ursi (kinickinnick) and some Rosa acicularis (prickly rose). Selaginella densa (little club moss) is also found. (Stringer, 1969).

Pedon Description (C161)

Classification: Orthic Dark Brown Chernozemic (Typic Cryoboroll)

Described By: Gerald Coen.

Date: July 26, 1972.

Location: About 1 mile north of the YMCA Camp along the shore of Knight's Lake
(Fig. 22).

Climate: semiarid continental.

Parent Material: Coarse textured alluvium.

Landform: River terrace.

Slope: about $\frac{1}{2}\%$ in the vicinity of the pedon and 0 to 5% associated with the map unit.

Elevation: 4,195 feet ASL.

Relief: About 20 feet.

Estimated Drainage: well drained.

Water table: Deep, probably rarely within 5 feet (1.5 m) of the surface.

Vegetation: Short (about 12 inches (30 cm)) stands of sparse grasses mainly Festuca spp. (fescues).

Notes: At this site there were few cobble or boulder sized fragments either within the pedon or on the surface. There was, however, an abundance of gravels. The soil was in a virgin condition, although hay may have been harvested occasionally.

- Ah1 0 to 2.5 cm ; very dark grayish brown (10YR 3/2 m) and dark reddish brown (5YR 3/2 d) loam; moderate fine granular; friable; abundant fine roots; no pores; no clay films; no effervescence; coarse fragments not estimated; abrupt, smooth boundary; 1.5 to 7 cm thick.
- Ah2 2.5 to 25 cm ; very dark brown and brown (10YR 2/2 m and 7.5YR 4/2 d) grading to dark brown (7.5YR 3/2 m) with depth, gravelly sandy loam; moderate to coarse granular to weak subangular, blocky; very friable; many very fine and fine roots; no pores; no clay films; no effervescence; estimated coarse fragments 20%; clear, wavy boundary; 20 to 25 cm thick.
- Bm 25 to 66 cm ; dark yellowish brown (10YR 3/4 m) gravelly sandy loam; very weak fine subangular blocky; very friable; abundant very fine roots; no pores; no clay films; no effervescence; estimated coarse fragments 35%; abrupt, wavy boundary; 38 to 43 cm thick.
- Cca 66 to 80 cm ; brown to dark yellowish brown (10YR 5/3 to 5/4 m) very gravelly sand; single grain; loose; very few micro roots; pores unobserved; strong effervescence (Mainly from coatings on sand grains and gravels) ; estimated coarse fragments about 95 to 99%; abrupt, wavy boundary; 10 to 15 cm thick (A layer of stratified rocks, all gravel sized)
- Ck 80 to 100 plus cm ; light brown (7.5YR 6/4 m) gravelly loamy coarse sand; single grain; loose; no roots; pores unobserved; no clay films; strong effervescence; estimated coarse fragments 70%.

COMMENTS:

The pedons representing map unit 17 in the Blakiston Valley have many more cobble and boulder sized coarse fragments, both on the surface and within the solum. Surface stones are everywhere and often as many as one per square yard. The solums are shallower (about 25 to 38 cm) and the Ah horizons are 1.5 to 13 cm thick. Profile development on these soils is minimal but they have much in common with the description above.

MAP UNIT NO. 18 (Orthic Eutric Brunisol)

The soils of this map unit are coarse textured with many gravel and cobble sized coarse fragments. They have formed on variable coarse textured alluvial material associated with small terraces along rivers and streams. The soil development and landscape position suggest that these terraces are rarely flooded. Because of the lack of fine textured materials nutrients for good plant growth appear to be limiting. The areal extent of this map unit is very small within the Park. Map unit 18 is geographically located along Blakiston Brook in the west half of the Park.

Associated Map Units

Map units 17, 27, 38, 48, 52, 57, 64 and 141 are found associated with map unit 18. Map unit 17 is associated on very similar landscapes and landforms as map unit 18 but is generally in a somewhat more arid situation where only grasses proliferate. Map units 27, 38 and 48 are found associated with map unit 18 wherever fans encroach upon river terraces having Brunisolic soil development. Map units 52, 57 and 64 are found associated with map unit 18 where the stream course has wound its way through or adjacent to till moraines. Map unit 57 is found in the more easterly regions of the area where map unit 18 is mapped, whereas map unit 64 is found in the westerly regions and map unit 52 is found somewhere in between. Occasionally steep colluvial slopes encroach upon the river terraces and in these instances map unit 141 abuts map unit 18.

Competing Map Units and Differentiae

Map units 11, 17 and 19 are found on river terraces similar to those upon which map unit 18 is found. Map unit 11 differs because of the Regosolic profile development and its susceptibility to flooding. Soils of map units 17 and 19 have Chernozemic Ah horizons associated with grassland vegetation. Soils of map units 28 and 47 are similar in horizon development but differ in the fan-shaped landforms upon which they are developed. Map units 52 and 66 are characterized by Brunisolic soils but are developed on till which differentiates them from map unit 18. Map units 150 and 156 also contain some Brunisolic soils but the steep colluvial slopes provide an easy means of separation from map unit 18.

Vegetation

Vegetation associated with this map unit is characterized by 40 - 80% cover with 20 to 40 foot tall Pinus contorta (lodgepole pine). The understory vegetation is characterized by the association comprised of Rubus parviflorus (thimbleberry), Spirea lucida (white meadowsweet), and Berberis repens (creeping mahonia). The herb association is characterized by Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed) and Gramineae (grasses).

Pedon Description (C214)

Classification: Orthic Eutric Brunisol (Typic Cryochrept)

Described by: Gerald Coen.

Date: Sept. 7, 1972.

Location: Crandell Mountain campground.

Climate: semiarid continental.

Parent Material: coarse textured river alluvium.

Landform: river terrace, high enough to be seldom flooded.

Slope: about 2% in the vicinity of the pedon and ranges from 0-5% in the area.

Elevation: 4600 feet ASL.

Relief: about 15 feet.

Aspect: none.

Estimated Drainage: well drained.

Water table: probably occasionally within 3 feet (90 cm) of the surface.

Vegetation: about 40% cover with 15 foot tall Pinus contorta (lodgepole pine).

Understory species noted included shrubs such as Symphoricarpos occidentalis (western snowberry), Berberis repens (creeping mahonia), Shepherdia canadensis (Canadian buffaloberry), Rosa acicularis (prickly rose), Spiraea lucida (white meadowsweet), Arctostaphylos uva-ursi (kinnickinnick) and Juniperus communis (ground juniper). Herbs observed included Aster spp., Arnica cordifolia (heart leaved arnica), Hedysarum sulphurescens (yellow hedysarum), Galium boreale (northern bedstraw), and Goodyera oblongifolia (rattlesnake plantain). About 20% coverage was provided by Gramineae (grasses) and a few mosses were also observed.

Notes: The soil temperature at 50 cm was 10 degrees C. There were many stones on the surface and within the pedon. The soil was in a virgin condition.

- L-F 1.5 to 0 cm ; dark brown (7.5Y 3/2 m) partly decomposed coniferous needles; abrupt wavy boundary; 0 to 2.5 cm thick.
- Ah 0 to 5 cm ; brown (7.5YR 4/4 m) gravelly sandy loam; weak fine granular and moderate, medium subangular blocky; very friable; abundant medium and plentiful fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 30%; clear wavy boundary; 2.5 to 10 cm thick.
- Bm 5 to 36 cm ; brown (7.5 YR 5/4 m) gravelly sandy loam; weak medium subangular blocky; very friable; plentiful fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 50%; clear wavy boundary; 25 to 36 cm thick.
- C 36 to 66 plus cm; brown (7.5YR 5/2 m) very gravelly loamy sand; single grain; loose; few fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 70%.

COMMENTS:

There is occasionally a small amount of degraded Ae like material in these pedons but it is insufficient to modify the classification. The land upon which this map unit was sampled is currently being used as a campground.

MAP UNIT NO. 19 (Rego Black and Orthic Black Chernozemics)¹

The soils of this map unit are coarse textured with mainly gravel sized coarse fragments. They have formed on alluvial sands and gravels and occasionally on local modified fan alluvium. There is typically an increase in gravel sized coarse fragments with depth, and stratification within and below the pedon is fairly common. In general, this map unit is found in fairly small isolated areas, a notable exception being east of Knight's Lake. Some of the areas mapped as map unit 19, because of their location next to streams and rivers, have proven to be valuable archaeological sites. Map unit 19 is geographically located adjacent to Knight's Lake and the Waterton River and occasionally near other smaller streams.

Associated Map Units

Map units 1, 15, 17, 32, 50, 52, 53, and 190 are found in association with map unit 19. Where streams ran as ice marginal channels during the retreat of the last

¹ The pedon described is classified as a Rego Dark Brown Chernozemic but many areas of this map unit are slightly darker in colour and have Bm horizons, thus qualifying for Black Chernozemic.

glacier finer textured alluvial terraces were formed adjacent to the coarser outwash. Map unit 1 is found on the outwash and map unit 19 on the terraces. Map unit 15 is finer textured, found next to oxbows, or other places where soils were deposited from slow moving water. It does not show the increase in coarse fragments with depth that map unit 19 does. Map unit 17 is similar to map unit 19 except found on drier sites where water runs off rather than accumulates. Thus, it has a brownish Ah and a well developed Bm whereas 19 has a deep dark Ah often extending to the C horizon. Map units 32 and 53 are found in depressional areas adjacent to map unit 19, map unit 32 having formed on medium textured alluvium and map unit 53 formed on medium textured till. Map units 50 and 52 are Chernozemic and Brunisolic soils respectively, both formed on till rather than alluvium as in the case of map unit 19. Map unit 190 is an Organic soil sometimes found in depressional areas adjacent to map unit 19.

Competing Map Units and Differentiae

Map unit 11 is also found on river terraces but the soils often have very little to no Ah and represent soils found in areas subject to frequent reworking by water. Soils of map unit 15 are finer textured, found in areas where alluvial deposits were made from slow moving water. Map unit 16 is characterized by Regosolic soils found on very uniform textured, very fine sandy loam and silt loam material containing essentially no coarse fragments, and high in lime. Map unit 17 is closely associated with 19, found on drier positions where the soils have browner Ah horizons and a well developed Bm horizon. Map unit 27 is found on fans, generally under coniferous vegetation and the soils have little development of Ah horizon. Map units 37 and 19 are quite similar and can be separated mainly by a fan landform in the former and the river terrace landform in the latter. Map unit 37 generally has some cobble and boulder sized coarse fragments whereas these are rare in 19. Map unit 42 is found on fans and the soils are finer textured than 19. Map unit 50 is dominantly Chernozem soils but is found on till.

Vegetation

There are two major vegetation association on map unit 19. Several areas are characterized by the vegetation found east of Knight's Lake (Stringer, 1969).

Here there are essentially no trees or shrubs. Herbs are dominated by Gramineae (grasses) including Bromus pumpellianus (northern awnless brome), Poa pratensis (Kentucky bluegrass), Festuca idahoensis (bluebunch fescue), and Phleum pratense (timothy). Other herbs include Lupinus sericeus (Purch's silky lupine), Galium boreale (northern bedstraw), Taraxacum officinale (common dandelion), Vicia americana (wild vetch), Achillea millefolium (common yarrow), and Erigeron glabellus sub species Pubescens (wild daisy). Other areas are characterized by Populus tremuloides (trembling aspen) often about 20 to 40 feet tall and providing 20 to 40% cover (Lopoukhine, 1968). The understory in these areas is characterized by the shrub association made up of Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose), and Rubus parviflorus (thimbleberry) and the herb association made up of Gramineae (grasses, probably similar to above), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip), and Thalictrum venulosum (veiny meadow rue).

Pedon Description (C160)

Classification: Rego Dark Brown Chernozemic (Calcic Pachic Cryoboroll)

Described by: Gerald Coen .

Date: July 25, 1972.

Location: about 1 mile north of the YMCA camp along the shore of Knight's Lake (Fig. 22).

Climate: continental.

Parent Material: coarse textured alluvium with increasing gravels with depth.

Landform: river terrace.

Slope: 2% in the vicinity of the pedon and 0 to 5% associated with the map unit.

Elevation: 4,195 feet ASL.

Relief: about 20 feet.

Aspect: none.

Estimated Drainage: moderately well drained.

Water table: probably within the pedon for short periods in the spring when the river is high.

Vegetation: Dominated almost entirely by Bromus pumpellianus or Bromus inermis (northern awnless brome or awnless brome).

Notes: There were very few boulders within the pedon or on the surface. The soil was in a virgin condition.

- Ah1 0 to 38 cm ; very dark brown (10YR 2/2 m) and dark brown (7.5YR 4/2 d) gravelly sandy loam; weak large granular to medium subangular blocky; slightly sticky, very friable; abundant very fine and plentiful fine roots; few medium pores; no clay films; no effervescence; estimated coarse fragments 25%; gradual, wavy boundary; 36 to 43 cm thick.
- Ah2 38 to 94 cm ; very dark grayish brown (10YR 3/2 m) and brown (7.5YR 4/2 d) gravelly sandy loam; weak medium subangular blocky; very friable; abundant very fine and plentiful fine roots; few medium pores; no clay films; no effervescence; estimated coarse fragments 30%; clear, wavy boundary; 50 to 61 cm thick.
- AC 94 to 109 cm ; dark brown (10YR 3/3 m) gravelly sandy loam; single grain very friable; plentiful very fine and few fine roots; cannot observe pores; no clay films; no effervescence; estimated coarse fragments 45%; clear smooth boundary; 8 to 15 cm thick.
- Ck 109 to 127 plus cm ; brown (7.5YR 5/3 m) gravelly coarse sandy loam; single grain; loose; few fine roots; cannot observe pores; no clay films; weak to moderate effervescence; estimated coarse fragments 80%.

COMMENTS:

There is 1.5 to 2.5 cm of partly decomposed grass litter on the surface of this pedon.

In areas covered with aspen an L-H horizon is prevalent and can be quite thick.

Pedons within the forested and grassland areas are quite similar with the above exception.

MAP UNIT NO. 20 (Orthic Regosol)¹

This map unit is confined to the active portion of stream and river channels where vegetation does not become established and erosion removes most of the fine earth (less than 2 mm) fraction. This map unit is found throughout the park, sometimes in stream channels occupied intermittently by water for short periods in the

¹ Most of this map unit is Cobbly Alluvial Land falling within the definition of "Miscellaneous Land Type" or possibly "Natural Non-Soil Features" as set out in the Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, Saskatoon. May, 1973.

spring, and in channels that have continuous flows of water. On occasion the intermittent channels are found on 25 to 30% slopes.

Because the map unit is defined as being the active portion of stream channels, there is insufficient soil to describe.

The stream channels are subjected to seasonal wide variations in the amount of water they carry. Some portions of the channels are being scoured, or shifted, by the erosive forces of the stream itself; other portions, such as the lower part of Blakiston Brook (where it crosses Blakiston fan), are aggrading, or building up their stream channels. Such aggradation could result in stream overflow and flooding during periods of high flow.

MAP UNIT NO. 21 (Orthic Regosol)¹

The soils of this map unit are coarse textured with a very high coarse fragment component. Most of the coarse fragments are gravels and cobbles. The soils have formed from alluvial fan deposits composed of gravel and cobble sized red and green argillites, sandstones and limestones. The cobbles contain a higher percentage of sandstones and limestones relative to the argillites than do the gravels. As is usual with fans, the upslope soils are coarser and contain more coarse fragments than the soils found nearer the fan margin. There is little evidence of systematic change in depth of the Ah horizon with slope position. The occurrence of limestone coatings and pendants on skeletal rocks is dominant throughout this map unit. The shallow (1 to 2 feet deep) meander scars of abandoned channels are very evident over the landscape. There are no layers or horizons to impede permeability, and with limited rainfall and very little water storage capacity these soils are very droughty. In the early spring there may be very short periods when the water table rises to within 3 feet of the surface on some of the areas mapped as map unit 21.

Because of the droughtiness of the soil, vegetative growth is short and relatively low volume. The limited vegetative growth plus shifting of material by running water does not allow significant profile development to take place, hence these soils

¹ Although the profile described is a Rego Dark Brown Chernozem, much of the area has Ah horizons too thin for Chernozemics, hence the map unit classification Regosol.

are classified as Regosols, showing little evidence of soil horizonation.

Geographically, these soils are mainly located on the Blakiston and Sofa Creek fans.

Associated Map Units

Map units 1, 4, 20, 22, 25, 26, 29, 36 and 50 are found associated with map unit 21. Map units 1 and 4 adjoin map unit 21 when deep hummocky outwash material and shallow outwash over bedrock respectively, abut the margins of the fan. Map unit 20 is found in and adjacent to the main stream channel that runs through the fan upon which map unit 21 is located. Map unit 22 is located on fan material very similar to map unit 21 but it is somewhat raised or protected from flooding or erosion hence exhibits a Bm horizon development distinguishing it from map unit 21. Map units 25, 26 and 29 are located closer to the apron of the fan than is map unit 21 and are differentiated from it by finer textures with few gravels. Map unit 36 is located along the east wall of the main Waterton Valley above and to the side of map unit 21. Occasionally the fan where map unit 21 is located has built up against a moraine upon which map unit 50 is situated.

Competing Map Units and Differentiae

Map unit 16 is differentiated from map unit 21 because it is not found on fan shaped landforms, and has few gravels or cobbles. Map unit 17 is very similar to map unit 21 in profile characteristics but is located as narrow bands on river terraces rather than on fans. Map unit 22 is very similar to map unit 21 except that stronger profile development is exhibited as evidenced by a Bm horizon. Map units 25, 26 and 29 are finer textured with few gravel or cobble sized fragments. Map units 27 and 48 are developed on gravelly fan materials but differ from map unit 21 by the occurrence of an L-H associated with forest cover on the former. Map unit 38 is separated from map unit 21 by a deeper (20 to 30 cm) more moder Ah horizon.

Vegetation

Grassy vegetation is characteristic of this map unit. There are few if any trees, even Populus tremuloides (trembling aspen) seldom survives. The shrubs and herbs in this area appear to suffer more from drought in midsummer than those in map unit 21. There is nearly 100% coverage of an association of herbs characterized by Festuca

idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), Danthonia parryi (parry oatgrass) and Lupinus sericeus (pursh's silky lupine). About 5% of the area is covered by Potentilla fruticosa (shrubby cinquefoil).

Pedon Description (C108)

Classification: Rego Dark Brown Chernozemic (Calcic Cryoboroll).

Described by: Gerald Coen.

Date: August 7, 1971.

Location: about 2/10 of a mile east and 100 yards north of the stables east of the cemetery (Fig.22).

Climate: semiarid continental.

Parent Material: coarse textured fan alluvium.

Landform: low angle alluvial fan.

Slope: 2% across the pit and relatively uniform throughout the area.

Elevation: 4,205 feet ASL.

Relief: less than 20 feet on the map unit where this pedon is located.

Aspect: about 135 degrees, barely perceptible.

Estimated drainage: rapidly drained:

Water table: probably seldom within 90 cm of the surface.

Vegetation: much of the ground surface is covered with mosses or is bare, 40 - 50% is covered by Festuca spp. (fescue grasses). There are several species of Compositae evident in the area.

Notes: Soil temperature at 50 cm was 20 degrees C. There are few boulders on the soil surface; most of the soil has not been cultivated or much disturbed by man. Erosion and deposition is probably active during some years (such as 1964) when extensive flooding occurs.

Ah 0 to 13 cm ; dark brown (7.5YR 3/2 m) and brown (7.5YR 4/2 d) gravelly sandy loam; single grain; very friable; plentiful, fine roots; estimated coarse fragments 50%; gradual, wavy boundary; 8 to 18 cm thick.

- Ck1 13 to 76 cm ; grayish brown (10YR 5/2 d) very gravelly coarse sandy loam; single grain; loose; few, fine and medium roots; weak, effervescence (mainly from CaCO_3 coatings on fine gravels); estimated coarse fragments 90% (not all voids filled with fines); diffuse, wavy boundary; 58 to 69 cm thick.
- Ck2 76 to 89 plus cm ; grayish brown (10YR 5/2 d) very gravelly coarse sandy loam; single grain; loose; few to no roots; weak effervescence (somewhat more effervescence associated with fine earth fraction than in the Ck1); estimated coarse fragments 90% (not all voids are filled with fines).

COMMENTS:

The Ah horizon is not continuous over the entire map unit. Some areas, in the erosion channels, have had so little time since deposition or removal that no horizonation has occurred.

MAP UNIT NO. 22 (Orthic Dark Brown Chernozemic)

The soils of this map unit are mainly coarse textured with many cobbles and some boulders within 100 cm of the surface. They have formed from gravelly and cobbly fan alluvium generally with a south facing slope. Red and green argillite fragments dominate the fine gravels. Because of the coarse fragments these soils have little water holding capacity and are considered droughty. These soils have been mapped mainly in the Red Rock Canyon area and on the Sofa Creek fan.

Associated Map Units

Map units 1, 11, 17, 21, 29, 36 and 50 are found in association with map unit 22. Map unit 1 is located adjacent to the fan margins where outwash materials abut map unit 22. Map units 11 and 17 are found along the fan aprons where map unit 22 is encroaching upon river terraces. Map unit 21 is found on the more unstable portions of the fans where profile development is minimal. Map unit 29 is found near fan margins where the water table is higher, often between map unit 21 and a body of water. Map unit 36 is located along the east wall of the main Waterton Valley above and to the side of map unit 22. Map unit 50 occurs adjacent to map unit 22 when the fan abuts a morainic landform.

Competing Map Units and Differentiae

Soils of map unit 22 differ from map unit 21 mainly in depth of Ah (meets the requirement of a Chernozemic Ah) and development of a Bm. This indicates that the

landform on which map unit 22 develops is somewhat more stable than the landform on which map unit 21 develops. Map unit 17 differs from map unit 21 mainly because it is located as narrow bands on river terrace alluvium. Map unit 38 is separated from map unit 22 by soils with a deeper (20 to 30 cm) more moder Ah horizon.

Vegetation

Vegetation characteristic of this map unit is dominantly shrubs and herbs. The shrub layer consists of 5% coverage with Rosa woodsii (Wood's rose) and Potentilla fruticosa (shrubby cinquefoil). Herbs consist of 100% coverage with Phleum pratense (timothy), Poa pratensis (Kentucky blue grass), Bromus inerme (awnless brome grass), and Taraxacum officinale (dandelion).

There are also on this map unit areas associated with draws and locations which receive excess moisture where the vegetation is comprised of a tree layer of less than 20 fee tall Populus tremuloides (trembling aspen) providing 40 - 60% coverage with stagnant young growth. The lower vegetation in these areas consists of 25% coverage by Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose) and Rubus parviflorus (thimbleberry) and 80% coverage with Gramineae (grasses), Hedysarum sulfurescens (yellow hedysarum), Heracleum lanatum (cow parsnip), and Thalictrum venulosum (veiny meadow rue).

Pedon Description (C119)

Classification: Orthic Dark Brown Chernozemic (Typic Cryoboroll).

Described by: Gerald Coen.

Date: Ausust 24, 1971.

Location: about 3/10 of a mile east of junction of Red Rock canyon road and Crandell campground turn off, then north of the road 1/10 mile on the fan (Fig. 22).

Climate: semiarid continental.

Parent Material: coarse textured, very stony fan alluvium.

Landform: alluvial fan slope 10 to 16%.

Elevation: about 4,650 feet ASL.

Relief: locally of the landform, 60 to 100 feet.

Aspect: about 180 degrees.

Estimated Drainage: rapidly drained.

Water table: deep.

Vegetation: Populus tremuloides (trembling aspen) along the draws and Amelanchier alnifolia (saskatoon) in a few clumps. Arctostaphylos uva-ursi (kinnikinnick) was evident in open areas although not predominant. Festuca idahoensis (bluebunch fescue) and Festuca scabrella (rough fescue) were the main grasses around the pit.

Notes: Soil temperature at 50 cm was 14 degrees Centigrade. Surface stones were quite evident, often several larger than 6" in diameter per 100 sq. ft. The soil is virgin.

- Ah 0 to 30 cm ; dark reddish brown (5YR 3/2 m) and dark reddish brown (5YR 3.5/3 d) gravelly loam; moderate, large granular near the top of the horizon grading to single grain near the bottom of the horizon; plentiful, very fine roots; estimated coarse fragments greater than 40%; gradual, wavy boundary; 25 to 38 cm thick.
- Bm 30 to 71 cm ; dark reddish gray (5YR 4/2 d) very gravelly coarse sand loam; single grain; loose; plentiful, very fine roots, especially around rock surfaces; estimated coarse fragments greater than 70%; gradual, wavy boundary; 36 to 46 cm thick.
- Ck 71 to 91 plus cm ; reddish brown (5YR 5/3 d) very gravelly coarse sandy loam; single grain; loose (somewhat firm in place); slight effervescence; estimated coarse fragments greater than 80%.

COMMENTS:

Calcium carbonate pendants are quite usual in the lower Bm and in the Ck. These are present at shallower depths than effervescence is observable in the fine earth fraction.

MAP UNIT NO. 25 (Orthic and Cumulic Regosols)

The soils in this map unit are generally coarse textured but have few gravels and essentially no cobbles or stones within 76 cm of the surface. The soils have formed from fairly active alluvial fan deposits which are, by virtue of their landscape position, somewhat protected from erosion during floods. Often they are located in areas of deposition during floods. The coarse sands and fine gravels are dominated by red and green argillites and sandstones with some limestone fragments. Surface

drainage is provided by the erosion channels so that there is rarely any local ponding. There are no dense or compact layers which impede permeability and because of the coarse texture percolation is rapid. The variation in texture with depth due to varying sedimentary conditions provides for some layers with finer textures and greater water holding capacity than the adjacent soils of map unit 21; thus these soils are not as arid and the difference is reflected in the vegetation. Geographically these soils are mainly located on the Blakiston and Sofa Creek fans.

Associated Map Units

Map units 1, 20, 21, 26, 29 and 32 are found in association with map unit 25. Map unit 1 is located on outwash material near the margins of the fan on which map unit 25 is located. Map unit 20 is situated near streams and stream channels flowing adjacent to or through map unit 25. Map unit 21 is located near the centre of the fan whereas map unit 25 is situated near the toe where running water has deposited finer materials. Map unit 26 is located in similar fan positions as map unit 25 but is so situated that it seldom receives sediments during flooding, allowing significant profile development. Map units 29 and 32 are in the imperfectly and poorly drained positions near the toe of the fan. Map unit 25 is generally located between these poorly drained soils and the gravelly soils of map unit 21.

Competing Map Units and Differentiae

Map unit 15 can be differentiated from map unit 25 because of soils with finer texture and deeper Ah horizons as well as by the fact that they are developed on alluvial terrace landforms rather than fan land forms. Soils of map unit 21 are much coarser textured and contain many more gravels than does map unit 25. Map unit 26 has soils with a thick Chernozemic Ah which separates them from map unit 25. Map unit 27 has soils with many gravel sized fragments and an L-H horizon both of which serve to distinguish it from the soils in map unit 25. Map unit 29 has dominantly imperfectly drained soils which separates it from map unit 25, with well drained soils. Map units 37, 38 and 42 are all located on fan shaped landforms but the soils have deep, dark colored Ah horizons which distinguish them from those of map unit 25. Map units 54 and 55 can be distinguished from map unit 25 because the soils are developed on till materials. Map units 141 and 142 are found on generally steep slopes, which because of downslope

creep give rise to Regosol soils whereas map unit 25 is found on more gently sloping fans where soils are disrupted occasionally by deposition during flooding.

Vegetation

The vegetation associated with this map unit is dominantly Populus tremuloides (trembling aspen). Tree heights are generally less than 40 feet and often less than 20 feet. The canopy density ranges up to 60% but in many, if not most cases, it is less than 40%. Stand conditions range from immature, exhibiting normal diameter and height growth, to thrifty mature stands with occasional windfall. Some areas have retarded growth as a result of one or more of site, climate, and overstocking. The understory is characterized by an association of herbs having 80% coverage and an association of shrubs having 25% coverage. The herb association includes Gramineae (grass family), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip), Thalictrum venulosum (veiny meadow-rue), and the shrub association includes Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose), and Rubus parviflorus (thimbleberry).

Because of the unstable nature of the parent materials the profiles show very little horizon differentiation and thus are classified as Regosols.

Pedon Description (C109)

Classification: Orthic Regosol (Typic Cryofluvent).

Described by: Gerald Coen.

Date: August 7, 1971

Location: about 2/10 of a mile east and 100 yards south of the stables east of the cemetery (Fig. 22).

Climate: Semiarid continental.

Parent material: fan alluvium.

Landform: low angle alluvial fan.

Slope: 2% across the pit and relatively uniform 2% throughout the area.

Elevation: 4,205 feet ASL.

Relief: less than 10 feet on the map unit where this pedon is located.

Aspect: about 145 degrees barely perceptible.

Estimated drainage: well drained.

Water table: seldom within 1 m of the surface.

Vegetation: mostly scrubby Populus tremuloides (trembling aspen) with some Symphoricarpos occidentalis (snowberry) and Bromus inermis (brome grass)

Notes: Soil temperature at 50 cm. was 14 degrees C. There are practically no boulders on the soil surface. There may have been some disturbance by man in some of these soils. There is 2.5 to 5 cm of partially decomposed grass litter.

- Ah 0 to 3.5 cm ; dark brown (10YR 3/3 m) and dark gray (10YR 4/1 d) sandy loam; weak medium granular; very friable; plentiful very fine roots, less than 5% coarse fragments most of gravel size; clear, wavy boundary; 2.5 to 8 cm thick.
- C1 3.5 to 15 cm dark brown (10YR 3/3 m) and grayish brown (10YR 5/3 d) sandy loam; weak large subangular blocky to massive; very friable; few very fine roots; very few fine pores; less than 1% coarse fragments; clear, wavy boundary; 13 to 20 cm thick.
- C2 15 to 28 cm , very dark grayish brown (10YR 3/2 m), grayish brown (10YR 5/2 d) gravelly sandy loam; single grain; loose abundant medium roots; pores could not be observed; effervescence on rock surfaces; estimated 30% coarse fragments; clear, wavy boundary; 9 to 13 cm thick.
- C3 28 to 114 plus cm ; brown (10YR 5/5 m) silt loam; massive; friable; few very fine roots; few fine and coarse pores; no evident effervescence; less than 1% coarse fragments.

MAP UNIT NO. 26 (Rego Dark Brown Chernozemic)

The soils of this map unit are medium to coarse textured with very few to no coarse fragments. They have formed on fairly uniformly textured alluvial fan material. These soils are located in the direct path of the winds coming down the Waterton valley. Vegetation growing on these soils is subject to some exposure and very high evapotranspiration rates resulting in the mainly grassland cover. The occurrence of grassland on these soils distinctly influences the kind and degree of horizon development which occurs. Also the fact that these soils are located on the finer textured part near the toe of an alluvial fan where there is also a fairly shallow depth to watertable results in a more lush growth of grasses than some of the associated soils at slightly higher elevations and with slightly coarser textures. Map unit 26 is geographically located on the Blakiston fan in the Waterton River valley.

Associated Map Units

Map units 21, 25, 29 and 32 are found in association with map unit 26. Map unit 21 is found on the up-slope portion of the fan which is much more gravelly and cobbly than is map unit 26. Map unit 25 is found on similar slope positions as map unit 26 but differs by not having a well developed Ah horizon. Map units 29 and 32 are found in depressional and water accumulation areas on the slightly lower portions of the fan.

Competing Map Units and Differentiae

The lack of coarse fragments and the presence of a well developed deep black Chernozemic Ah horizon serves to separate map unit 26 from most other map units within the park. Map unit 19 may at times appear similar to map unit 26 because of the deep Black Rego Chernozemic horizons but the presence of coarse fragments in this instance plus the occurrence on flood plains or river terraces serves to separate it. Map unit 25 differs from map unit 26 because of the lack of a well developed deep Ah horizon. Map unit 29 similarly does not have a deep Ah horizon and is also gleyed which serves to separate it from map unit 26. Map unit 42 is very similar to map unit 26 and is differentiated almost entirely on the basis of being a silt loam texture rather than a sandy loam texture.

Vegetation

Vegetation associated with this map unit is Gramineae (grasses). Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue) and Danthonia parryi (parry oat grass) are the dominant species. This area has been used for forage and pasture quite extensively and such species as Phleum pratense (timothy) and Bromus inermis (awnless brome) are also very common. Other herbs such as Lupinus sericeus (perennial lupine) and Erigeron glabellus (smooth fleabane) are found (Stringer 1969).

Pedon Description

Classification: Rego Dark Brown Chernozemic (Calcic Cryoboroll).

Described by: Gerald Coen.

Date: September 14, 1972.

Location: about $\frac{1}{2}$ mile east of Highway 5 on the trail to a picnic area found north of Blakiston Brook and south of Knight's Lake (Fig. 22).

Climate: semiarid continental.

Parent Material: well sorted, non-stony, fan alluvium.

Landform: very gently sloping fan.

Slope: about 1% in the vicinity of the pedon and ranging from 0 to 5% on the map unit.

Elevation: 4,200 feet ASL.

Relief: about 30 feet.

Aspect: 90 degrees.

Estimated drainage: well drained.

Water table: greater than 120 cm below the surface at this time.

Vegetation: the main species noted were Phleum pratense (timothy) and Bromus inermis (awnless brome). Other species of grasses mainly Festuca spp. were not identified. Erigeron glabellus var pubescens (smooth fleabane) and other Compositae were noted as well.

Notes: The soil temperature at 50 cm was 9 degrees C. There were no stones within the pedon or on the ground surface. The land was used until the late 1960's as a source of hay and pasture. There may have been areas that were cultivated.

- Ah 0 to 30 cm ; dark reddish brown (5YR 2/2 m) and dark reddish gray (5YR 4/2 d and crushed) sandy loam; weak medium granular; friable; plentiful fine roots; few fine pores; no clay films; no effervescence; no coarse fragments; gradual wavy boundary; 28 to 33 cm thick.
- C 30 to 74 cm ; dark brown (7.5 YR 3/2 m) and pinkish gray (7.5YR 6/2 d) sandy loam; massive; friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments less than 5%; diffuse wavy boundary; 38 to 43 cm thick.
- Ck1 74 to 107 cm ; brown (7.5YR 4/4 m) sandy loam; massive; very friable; few fine roots; common fine pores; no clay films; strong effervescence; no coarse fragments; clear wavy boundary; 30 to 36 cm thick.
- Ck2 107 to 117 plus cm ; reddish gray (5YR 5/2 m) gravelly sandy loam; single grain; loose; no roots; no pores; no clay films; strong effervescence; estimated coarse fragments 20%.

COMMENTS:

There is considerable rodent activity resulting in frequent krotovinas. There is also considerable earthworm activity. The high fauna activity results in mixing which may account for lack of a significant Bm horizon.

MAP UNIT NO. 27 (Cumulic and Orthic Regosols)

The soils of this map unit are coarse textured with abundant coarse fragments, most of which are in the fine gravel fraction. They have formed on variously colored sands and gravels of alluvial fan origin. The alluvial origin in many cases causes geological stratification resulting in various amounts of different size particles being in particular layers. Occasionally strata of materials are found as fine textured as silt loam. A notable example is the areas mapped as 27 on the east side of Cameron Lake. The water holding capacity of these soils will, to a large extent, depend on the presence of finer textured strata. In general, percolation rates will be very rapid. Buried Ah and L-H horizons are a common characteristic of this map unit although any given pedon may not exhibit the characteristic. Geographically this map unit is located along the foot of the steeper slopes in the more mountainous part of the park notably along the Waterton Lakes, Cameron and Bertha Lakes.

Associated Map Units

Map units 28, 52, 57, 64, 90R, 91R, 141 and 156 are found associated with map unit 27. Map unit 28 is occasionally found associated with map unit 27 when a portion of the fan has become isolated and is no longer accreting with current erosion pattern thus allowing the formation of a Brunisolic profile. Map units 52, 57 and 64 are all formed on till and thus are easily separated from map unit 27, which is developed on fan alluvium. Map units 90R and 91R are both lithic soils generally associated with steep slopes and map units 141 and 156 are colluvial soils associated with steep slopes thus allowing relatively easy separation between these units and map unit 27.

Competing Map Units and Differentiae

Map units 28, 29, 38 and 48 are similar to map unit 27 in that they all have alluvial fans as parent materials. Map unit 28 can be separated from map unit 27 by the Brunisolic Bm horizon. Map unit 29 is a Gleyed Regosol and can be separated from map unit 27 by the gley characteristics. Map unit 38 is found on relatively steep slopes, generally under grass cover, and thus does not have an L-H horizon characteristic of map unit 27. Map unit 48 is generally found on steeper slopes and contains

a larger proportion of coarse fragments in the cobble and boulder category. Map unit 27 is largely restricted to slopes less than 5% whereas map unit 48 is generally restricted to slopes greater than 5%. On occasion map unit 21 may appear to be difficult to separate from map unit 27, however, the brown color associated with the grassland and the lack of L-H horizon in map unit 21 should serve as a guide to separating it from map unit 27.

Vegetation

Vegetation associated with this map unit is generally characterized by coniferous stands unless disturbed by man or fire. In general, immature stands of 40 to 60 foot tall Pinus contorta (lodgepole pine) and/or Pseudotsuga menziesii (Douglas fir) providing 40 to 60% cover are found on the isolated fans mapped as map unit 27. Occasionally where map unit 27 is mapped at higher elevations such as Bertha Lake, Abies lasiocarpa (alpine fir) is the dominant tree species. The over mature 60 to 80 foot tall stands of Picea glauca, Picea engelmannii (white spruce, Engelmann spruce) and Abies lasiocarpa (alpine fir) found near Cameron Lake on map unit 27 are somewhat unique for the map unit. This may in part be the result of the somewhat finer textures exhibited by map unit 27 in this area and possibly by the change in moisture relationships that occur on the east side of Cameron Lake. Occasionally stands of Populus tremuloides (trembling aspen) and deciduous shrubs are found associated with map unit 27. Because of the variability of the vegetation on this map unit no particular association aptly characterized the vegetation. The dominant shrubs, not in order of importance, are Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), Berberis repens (creeping mahonia), Acer glabrum (mountain maple), Alnus crispa (green alder), and Cornus stolonifera (red osier dogwood). Herbs commonly found on map unit 27 include Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (vienny meadow-rue), Epilobium angustifolium (fireweed), Clintonia uniflora, Xerophyllum tenax (bear grass), and Gramineae (grasses). At higher elevations such as Bertha Lake and Cameron Lake shrub species such as Menziesia ferruginea (false huckleberry) Vaccinium membranaceum (tall bilberry), and Vaccinium scoparium (grouse berry) are common. Herbs in the latter areas include Xerophyllum tenax (bear grass), Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow-rue), and Angelica dawsonii (yellow angelica).

Pedon Description (D2)

Classification: Cumulic Regosol (Typic Cryofluvent).

Described by: D. Allan, W. D. Holland and Gerald Coen.

Date: June 14, 1972.

Location: about 150 feet northwest of the Boundary Bay warden's cabin (Fig.22).

Climate: continental.

Parent material: variously coloured red and gray fine gravels and sands found on fan alluvium.

Landform; fairly broad alluvial fans.

Slope: 2 to 3% in the vicinity of the pedon and ranging up to 5% on some of the areas mapped as 27.

Elevation: 4200 feet ASL.

Relief: about 20 feet.

Aspect: 120 degrees.

Estimated drainage: well drained.

Water table: probably rarely within 90 cm of the surface at any season of the year.

Vegetation: Pinus contorta (lodgepole pine) is dominant. Regeneration with Pseudo-tsuga menziesii (Douglas fir) and Picea glauca (white spruce) is common. Shrubs noted at the site included Acer glabrum (mountain maple), Shepherdia canadensis (Canadian buffalo berry), Spiraea lucida (white meadowsweet), Rubus parviflorus (thimbleberry), and Amelanchier alnifolia (saskatoon). Herbs included Xerophyllum tenax (bear grass), Arnica cordifolia (heart-leaved arnica), Clintonia uniflora, Thalictrum venulosum (veiny meadow-rue), and Gramineae (grasses). Mosses were relatively common, providing about 8% cover adjacent to the pedon.

Notes: Cobbles and boulders were not common on the ground surface or within the pedon. Soil was in a virgin condition. Traces of buried Ah and L-H were found within the pedon resulting in the cumulic classification.

L-H 5 to 0 cm ; dark reddish brown and very dark greyish brown (5YR 2/2 m and 10YR 3/2 d); relatively undecomposed and slightly decomposed leaves, needles, and rotten wood with some grasses. Charcoal also was evident. Few to no mycelia observed; plentiful fine and medium roots; clear wavy boundary; 3.5 to 5 cm thick.

- C1 0 to 2.5 cm ; brown (7.5YR 5/2 m) loam; weak fine platy to structureless; very friable; plentiful fine and medium roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments less than 10%; clear broken boundary; 1.5 to 2.5 cm thick.
- C2 2.5 to 18 cm ; dark reddish brown (5YR 3/4 m) gravelly sandy loam; single grain; loose; abundant fine and medium roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 50%; clear wavy boundary; 14 to 15 cm thick.
- C3 18 to 38 cm ; dark reddish brown (5YR 3/4 m) gravelly coarse sand; single grain; loose; plentiful coarse and few fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 20%; clear smooth boundary; 18 to 23 cm thick.
- C4 38 to 45 cm ; reddish brown (5YR 4/3 m) silt loam; massive; very friable; plentiful coarse and few fine roots; few very fine pores in the peds; no clay films; no effervescence; estimated coarse fragments 5%; clear wavy boundary; 2.5 to 10 cm thick.
- C5 45 to 89 cm ; reddish brown (5YR 4/3 m) gravelly coarse sand; single grain; loose; few fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 10%; clear smooth boundary; 41 to 48 cm thick.
- C6 89 to 112 plus cm ; reddish brown (5YR 4/3 m) gravelly coarse sand;(mostly less than 5 mm.); single grain; loose; few fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 60%.

COMMENTS:

Discontinuous pockets of materials similar to C4 were found within C6. Some of the soils mapped as map unit 27 have more layers of fine texture such as layer C4 in this pedon. A notable example is the area east of Cameron Lake. Probably the most characteristic criteria of this map unit is the prevalence of fine gravels and the occurrence of fairly fine texture strata within the pedon.

MAP UNIT NO.28 (Orthic Eutric Brunisol)

The soils of this map unit are coarse textured with a fair amount of coarse fragments mainly of gravel and cobble size. They have formed on broad, ill-defined fan shaped landforms having fairly coarse textured materials dominated by red and green argillites in the fine gravel fraction. Because of the fissile nature of the sedimentary

materials from which the fan alluvium is derived the sands and fine gravels are plate shaped giving the soils an easily erodable nature. Because of the small dispersed nature of the stable areas of the fans where Brunisols can develop, map unit 28 is often mapped as a complex with map unit 27 to show the Brunisol-Regosol relationships. Map unit 28 is of limited areal extent and is geographically located adjacent to the Waterton and Cameron Lakes and along the Blakiston and Bauerman Brooks.

Associated Map Units

Map units 27, 38, 39, 49, 52, 64, 141 and 90R are found in association with map unit 28. Map units 27 and 28 are intimately associated sometimes on the same landform but map unit 27 is generally found in the somewhat more unstable slope positions. Map units 38, 39 and 49 are sometimes found on the steeper fans or landforms where these are adjoining with the more stable fans or landforms of map unit 28. Depending upon the region within the park, and the degree of development of the soil, map units 52 and 64 are sometimes found on the till uplands associated with the fans upon which map unit 28 is developed. Occasionally map unit 28 abuts the steeper slopes upon which map units 141 and 90R are developed.

Competing Map Units and Differentiae

Map unit 18 differs from map unit 28 mainly because of its river terrace position and because of the greater component of coarse fragments in the soils. A sequence of soils ranging from Regosols to Brunisols to Podzols can be established on fans. Map units 27, 38, 39 and 48 fall into the Orthic Regosols of this sequence. Map unit 28 is dominantly Orthic Eutric Brunisol soil. Map unit 47 is dominantly Degraded Eutric Brunisol and map unit 49 is Ortho Humo-Ferric Podzol soils. Some of the soils mapped as map unit 156 may be Brunisolic but differ because of the colluvial landform and greater tendency toward instability.

Vegetation

Vegetation associated with this map unit is dominated by Pinus contorta (lodgepole pine), Pseudotsuga menziesii (Douglas fir) and Abies lasiocarpa (alpine fir). In some locations Populus tremuloides (trembling aspen) is also found. Common shrub species include Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), Shepherdia canadensis (Canadian buffalo-berry), and occasionally such species as Vaccinium membranaceum (tall bilberry) and Menziesia ferruginea (false huckleberry). Associated

herbs include Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum, (veiny meadow-rue), Epilobium angustifolium (fireweed), Gramineae (grasses) and such species as Xerophyllum tenax (bear grass) and Disporum oreganum (fairybells).

Pedon Description (C228)

Classification: Orthic Eutric Brunisol (Typic Cryochrept)¹

Described by: Gerald Coen.

Date: September 11th, 1972.

Location: About one-quarter mile north of Crandell Lake and 50 feet east of the trail (Fig. 22).

Climate: continental.

Parent Material: coarse textured alluvium with a high component of plate-like fine gravels in the coarse fraction.

Landform: ill-defined fan or gently sloping colluvial landforms.

Slope: 12% in the vicinity of the pedon and ranging from 8 to 25% on the landform.

Elevation: 4,800 feet ASL.

Relief: about 100 feet.

Aspect: 45 degrees

Estimated drainage: well drained.

Water table: below the pedon.

Vegetation: spindly even aged 30 to 40 foot tall Pinus contorta (lodgepole pine) providing 40 to 50% cover. There is an odd Pseudotsuga menziesii (Douglas fir) regenerating the area. Shrubs noted in the vicinity included Alnus crispa (green alder), Shepherdia canadensis (Canadian buffaloberry), Spiraea lucida (white meadow-sweet), Berberis repens (creeping Mahonia), Chimaphila umbellata var. occidentalis (prince's pine) and the odd Rubus parviflorus (thimbleberry). Herbs noted included Campanula rotundifolia (common bluebell) Epilobium angustifolium (fireweed), Arnica cordifolia (heart-leaved arnica), Pyrola spp. (wintergreen) and Goodyera oblongifolia (rattlesnake plantain). Some mosses and grasses were also observed.

Notes: Stones but not boulders were common within the pedon and on the soil surface. The soil was in a virgin condition.

¹ The classification of this soil is not firm. Pyrophosphate (and citrate-dithionite) data are not available. There is a Bf horizon based on Fe + Al by Oxalate extraction but pyroclastic shards are present, which probably weather easily to give amorphous sesquioxide. Neither the morphology nor the environment are typical of Podzolic (Spodosol) soils.

- L-H 1.5 to 0 cm ; black (5YR 2/1 m) and dark brown (10YR 3/3 m) partially and well decomposed organic litter; abrupt wavy boundary; 0 to 2.5 cm thick.
- Ah 0 to 12 cm ; brown (7.5YR 4/2 m) gravelly sandy loam; moderate medium subangular blocky breaking to moderate medium granular; very friable; abundant medium and few fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 30%; clear wavy boundary; 9 to 14 cm thick.
- Bf 12 to 38 cm ; strong brown (7.5YR 5/6 m) gravelly sandy loam; moderate medium subangular blocky; very friable; plentiful fine roots; many fine pores; no clay films; no effervescence; estimated coarse fragments 30%; abrupt wavy boundary; 20 to 38 cm thick.
- C 38 to 76 plus cm ; brown (7.5YR 5/2 m) gravelly loamy coarse sand; single grain; loose; very few fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 45%.

COMMENTS:

The parent material at this particular site is quite similar to the parent material found under map units 38 or 48. In the C horizon the color is really an average of the variously colored green and red fine gravel and sand fraction.

MAP UNIT NO. 29 (Gleyed Cumulic Regosol)

The soils of this map unit are coarse to fine sandy loams and silt loams with few cobbles within 100 cm of the surface. Fine gravel sized fragments are composed of red and green argillites. They formed from periodically accreted and/or eroded alluvium found on the lower slopes of some fans. The parent material is imperfectly drained alluvium located at the toe of some fans, generally with a shallow and fluctuating water table. Percolation is rapid, and there is probably much lateral movement of water, especially with increased creek flow after rains or snowmelt. The largest areas of these map units are to be found along the margins of the Sofa Creek and Blakiston Creek fans. Slopes are generally less than 2%. Geographically this map unit is recognized mainly in the main Waterton Valley, north of the townsite.

Associated Map Units

Map units 19, 20, 25, 26, 31, 32 and 170 are found associated with map unit 29. The river terraces upon which map unit 19 is situated are sometimes found adjacent to the fan margins where map unit 29 is mapped. Map unit 20 is situated adjacent to the stream channels and occasionally a stringer of this map unit will divide two areas of map unit 29. Map units 25 and 26 are well drained associates of map unit 29, generally located up-slope from it. Map unit 32 and 31 are characterized by poorly and very poorly drained soils respectively and are associated downslope from map unit 29. Map unit 170 is found on the east side of Knight's Lake where the sand dunes are adjacent to map unit 29.

Competing Map units and Differentiae

Map unit 29 differs from most other map units in the Park by virtue of the soils being imperfectly drained. Map units 14, 31, 32, 44 and 53 are all Gleysols, but are poorly or very poorly drained. Map unit 25 is similar to map unit 29 but is characterized by well drained soils.

Vegetation

Vegetation characteristic of this map unit is dominantly Populus balsamifera (balsam poplar) and Populus trichocarpa (black cottonwood) with some Populus tremuloides (trembling aspen). Many of the stands are 40 to 60 feet tall with some stands 60 to 80 feet tall. Canopy density is often 40 to 60% and sometimes 20 to 40%. The taller stands generally have considerable windfall and decadence. The shorter stands are often immature with some retarded growth due to site and climate. There are some thrifty mature stands. The lower vegetation consists of 25% coverage of the shrub association of Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose) and Rubus parviflorus (thimbleberry); and 80% coverage of the herb association consisting of Gramineae (grasses), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip) and Thalictrum venulosum (veiny meadow-rue).

Pedon Description (C110)

Classification: Gleyed Cumulic Regosol (Aquic Cryofluvent)

Described: Gerald Coen.

Date: August 7, 1971.

Location: About $\frac{1}{2}$ mile south east of the riding stables (Fig. 22).

Climate: continental.

Parent material: recent fan alluvium.

Landform: low angle alluvial fan.

Slope: 1 to 2% in the area and the same across the pit.

Elevation: about 4200 feet ASL.

Relief: about 20 feet on this landform.

Aspect: about 150 degrees, barely discernible.

Estimated drainage: imperfectly drained.

Water table: within 100 cm in spring and lower in fall.

Vegetation: about 40 to 50% canopy density consisting of Populus balsamifera (balsam poplar) and Populus tricarpha (black cottonwood) about 40 to 60 feet tall. Salix spp. (willows) and Betula occidentalis (swamp birch) are found close by and Gramineae (grasses) and Heracleum lanatum (cow parsnip) are associated herbs.

Notes: Soil temperature at 50 cm was 10 degrees C. There was essentially no stones in the upper 76 cm. The Ckg3 horizon was estimated to contain 15% cobble sized coarse fragments. There were few, if any, boulders or stones on the soil surface. The soil is virgin. A flood along the Blakiston Creek in 1964 probably deposited the Ck1 described below.

L 0.5 to 0 cm ; undecomposed deciduous leaves.

Ck1 0 to 5 cm ; light brownish gray (10 YR 6/2 m) very fine sandy loam with few, fine distinct reddish yellow (7.5 YR 7/6 m) mottles; weak, coarse platy; very friable; abundant medium roots; few to no pores; strong effervescence; abrupt, smooth boundary; 3.5 to 6.5 cm thick.

Ahb 5 to 10 cm ; reddish brown (5YR 4/4 m) silt loam without evident mottles; weak, fine granular with evidence of medium subangular blocky; friable; abundant large roots; no evidence of pores; very weak effervescence; clear, wavy boundary; 2.5 to 8 cm thick.

Ck2 10 to 25 cm ; dark brown (7.5YR 4/4 m) sandy loam and fine sandy loam without evident mottles; massive; friable; plentiful medium roots; few, fine pores; strong effervescence; clear, wavy boundary; 13 to 19 cm thick.

- Ckg1 25 to 46 cm ; grayish brown (10YR 5/2 m) sandy loam with few fine faint (10YR 5/4 m) mottles; single grain; loose; plentiful medium roots; no evident pores; strong effervescence; clear, wavy boundary; 15 to 23 cm thick.
- Ckg2 46 to 74 cm ; brown (10YR 5/3 m) silt loam with many, medium distinct yellowish red (5YR 4/6 m) mottles; massive; friable; few medium roots; few medium pores; strong effervescence; clear, wavy boundary; 25 to 30 cm thick.
- Ckg3 74 to 90 plus cm ; brown (7.5YR 5/2 m) gravelly sandy loam with common medium distinct dark reddish brown (5YR 3/4 m) mottles; single grain; loose; few medium roots; moderate effervescence; estimated 15% cobble sized coarse fragments.

COMMENTS:

Each "horizon" is more like a layer representing one or several flood accumulations of material of similar texture. Other pedons in the area are relatively more homogeneous (with regard to texture and morphology) and often do not have free lime at or near the surface.

MAP UNIT NO. 31 (Orthic Humic Gleysol)

The soils of this map unit are medium textured. They have formed from alluvium along the edges of bodies of water where spring flooding is frequent. The soil is saturated until late spring or early summer resulting in reducing conditions for much of the year. The water table is high enough in the spring that it restricts the growth of Populus balsamifera (balsam poplar) and in many cases Salix spp. (willows). Associated better drained map units are 30 and 29. Some inclusions of these map units are also present. Geographically these soils are mainly located along the margins of lower Waterton Lake, Knight Lake and the Dardanelles.

Associated Map Units

Map units 25, 29, and 32 are found in association with map unit 31. Where map unit 31 is found it will be situated between one of the three above map units and a body of water. With increasingly better drainage the sequence is 31, 32, 29 and 25. Occasionally the transition will be abrupt enough that map unit 32 and less often 29 are not recognized between map unit 31 and map unit 25.

Competing Map Units and Differentiae

The very poorly drained soils characterizing map unit 31 separate it from most

other map units in the Park. Map units 14, 44 and 53 are also characterized by poorly drained soils but the river terrace landform of map unit 14, the very cobbly nature of map unit 44 and the till material of map unit 53 separate them from map unit 31. Map unit 32 is inundated by water for shorter periods than is map unit 31 and thus is separated by the dominance of poorly drained, rather than very poorly drained soils.

Vegetation

Vegetation characteristically associated with this map unit is Carex aquatilis (water sedge) and other Carex spp. (sedges).

Pedon description (C118)

Classification: Orthic Humic Gleysol (Calcic Cryaquoll)

Described by: Gerald Coen.

Date: August 20, 1971.

Location: The southeast corner of the east arm of Maskinonge Lake (Fig.22).

Climate: continental

Parent Material: medium textured alluvium located adjacent to river and lake margins.

Landform: slow water alluvial terraces and lacustrine margins.

Slope: less than $\frac{1}{2}\%$.

Elevation: 4,195 feet ASL.

Relief: 1 or 2 feet on this map unit.

Aspect: none.

Estimated drainage: very poorly drained.

Water table: most seasons probably at the surface until mid-July.

Vegetation: odd Salix spp.(willow) near margin of map unit and on hummocks, otherwise Carex spp. (sedges).

Notes: Soil temperature at 50 cm was 10 degrees C. Estimated cobbles in entire pedon less than 1% by volume increasing slightly with depth. The soil is virgin.

Ah_{gk} 0 to 15 cm ; very dark brown (10YR 2/2 m) and very dark gray (10YR 3.5/1 d) loam with few fine distinct dark yellowish brown (10YR 4/4 m) mottles; moderate fine granular; friable; plentiful fine roots; pores were not observed; strong effervescence; estimated coarse fragments less than 1% by volume; abrupt, irregular boundary (tonguing); 10 to 18 cm thick.

- Bgk 15 to 41 cm ; dark gray (10YR 4/1 m) silt loam to silty clay loam with many medium distinct strong brown (7.5YR 5/8 m) mottles; moderate, medium sub-angular blocky; friable; few fine roots; common fine pores; very slight effervescence; estimated coarse fragments less than 1% by volume; abrupt, smooth boundary; 20 to 28 cm thick.
- BCgk 41 to 76 cm ; gray (5Y 6/1 m) silt loam with few medium strong brown (7.5YR 5/8m) mottles; weak large subangular blocky; friable; very few roots; common fine pores; strong effervescence; estimated coarse fragments less than 2% by volume; diffuse, wavy boundary; 35 to 37 cm thick.
- Cgk 76 to 89 plus cm ; gray (N 6/ m) silt loam with many medium prominent strong brown (7.5YR 5/8 m) mottles; massive; friable; no roots; common fine pores; strong effervescence; estimated coarse fragments less than 2% by volume

COMMENTS:

There was a 1 cm thick band of Ahb (k) horizon at about 28 cm depth (the Bgk - BCgk horizon boundary) indicating the cumelic nature of the profile development. Snail shells are evident in the BCgk and Cgk and occasionally in the Ahgk horizon. On August 20, 1971 the river and lake level had dropped so that at this site the water table was deeper than 76 cm below the surface. However, at the end of June 1971 the area was flooded with 15 to 30 cm of water.

MAP UNIT NO. 32 (Orthic Humic Gleysol)

The soils of this map unit are medium textured varying from fine sandy loam to loam. They have formed from alluvium along fan margins adjacent to the Waterton river or lakes. The parent material is saturated much of the year and wet most of the summer. The soils are probably quite permeable but the water table is so close to the surface that the permeability is of little practical consequence. The inclusions are mainly of the slightly better drained soils (map unit 29) and of the very poorly drained soils (map unit 31) both of which have similar texture and development. Geographically these soils are located mainly on both sides of the Dardanelles and adjacent to the shores of Lower Waterton Lake and Knight's lake.

Associated Map Units

Map units 15, 19, 25, 26, 29, 31, 50, 53 and 57 are found in association with map unit 32. Map unit 32 is generally situated between the above map units and a

body of water or, on occasion map unit 31 may be between map unit 32 and the body of water. Map unit 29 is generally on a slightly better drained position, between map unit 32 and map units 25 or 26. Occasionally map units 25 and 26 may have a common boundary with map unit 32, when a fairly abrupt change occurs from well to poorly drained. Map units 15 and 19 adjoin map unit 32 when the fan upon which map unit 32 is located dissects a river terrace on which map units 15 and 19 are located. Map units 50, 57 and 53 adjoin map unit 32 when morainic landforms form the boundary of the fan on which map unit 32 is located. Map units 50 and 57 adjoin in upland positions and map unit 53 adjoins map unit 32 in poorly drained positions.

Competing Map Units and Differentiae

The poorly drained, nearly stone free nature of the soils characterizing map unit 32 separate it from most of the other map units in the Park. Map units 14, 44 and 53 are characterized by poorly drained soils but the river terrace landforms of map unit 14, the very cobbly nature of map unit 44 and the till material of map unit 53 separates them from map unit 32. Map unit 31 is inundated by water for most of the growing season and is separated from map unit 32 by its very poorly drained soils whereas map unit 32 is characterized by poorly drained soils. Map units 29, 15 and 42 are similar in texture to map unit 32 but are imperfectly and well drained rather than poorly drained.

Vegetation

Vegetation characteristic of this map unit is dominantly shrubs and herbs. The shrub layer association provides about 60% cover with Salix spp. (willows) and Alnus tenuifolia (mountain alder). Herbs provide about 50% cover in an association including Petasites sagittatus (arrow-leaved colt's foot), Carex flava, Carex aquatilis (water sedge) and Carex rostrata (beaked sedge).

Pedon Description (C116)

Classification: Orthic Humic Gleysol (Typic Cryaquoll)

Described by: Gerald Coen.

Date: August 12, 1971.

Location: about 1/10 mile south of Blakiston Creek and 1/10 mile east of the Dardanelles.
(Fig. 22).

Climate: Continental.

Parent material: alluvium located at fan margins.

Landform: Alluvial fan.

Slope: $\frac{1}{2}\%$ to level.

Elevation: 4,203 feet ASL.

Relief: about 20 feet on the landform.

Aspect: about 150 degrees barely discernible.

Estimated drainage: poorly drained.

Water table: at or near the surface in June and probably part of July, within 40 cm. throughout the season in many years.

Vegetation: near the pit Salix spp. (willows) were abundant and Carex spp. (sedges) filled the small open areas between the shrubby trees.

Notes: There were very few cobbles and boulders within the pedon and none were observed on the surface. The present soil is virgin, but because of frequent inundation with water and sediment, there is little profile development.

Ahg 0 to 13 cm ; dark reddish brown (5YR 3/2 m) and brown (7.5YR 4.5/2 d) loam with common fine faint dark reddish brown (5YR 3/3 m) mottles; moderate, medium granular; friable; abundant very fine roots; common fine pores; estimated coarse fragments - nil; clear, wavy boundary; 13 to 18 cm thick.

Bg1 13 to 18 cm; reddish gray (5YR 5/2 m) very fine sandy loam to silt loam with common fine distinct yellowish red (5YR 5/8 m) mottles; moderate medium subangular blocky; friable; few medium roots; common fine pores; weak effervescence locally around fragments of limestone; estimated coarse fragments less than 5%; abrupt, broken boundary; 1.5 to 8 cm thick.

Bg2 18 to 53 cm ; brown (7.5YR 5/2 m) silt loam with common fine distinct yellowish red (5YR 4/6 m) mottles and blotches of dark reddish gray (5YR 4/2 m) material; moderate, medium subangular blocky; friable; very few medium roots; many fine pores; estimated coarse fragments less than 5%; clear, wavy boundary; 33 to 41 cm thick.

Cg 53 to 76 plus cm ; dark brown (7.5YR 4/2 m) very fine sandy loam with few fine distinct strong brown (7.5YR 5/6 m) mottles; massive, friable; roots and pores could not be determined because below water table; estimated coarse fragments 5%.

COMMENTS:

At the time of sampling the groundwater level was 38 cm below the soil surface. There were a few gravel sized materials distributed throughout the pedon but considerably less than 20%.

MAP UNIT NO. 36 (Orthic and Dark Gray Luvisols)

The soils of this map unit are medium to coarse textured with very few coarse fragments. They appear to have formed on brownish sandstone which has either weathered in situ or been locally transported by alluvial water action. The soils are somewhat finer textured where they are shallow to the sandstone bedrock and at the foot of slopes where water wash appears to have been more active these soils are somewhat coarser. In stable positions where coniferous vegetation is present the classification of the dominant pedon is Orthic Gray Luvisol, however in stable positions where deciduous trees, mainly Populus tremuloides (trembling aspen) are common the earthworm activity associated with these soils results in considerable mixing (see map unit 58) of the L-H and Ah horizons with the Ae horizon resulting in a type of Dark Gray Luvisolic development. On some lower slopes the mixing by earthworms is apparently sufficient to prevent any illuvial-eluvial horizon separation resulting in an apparent AC profile or a Regosolic profile. Map unit 36 is geographically located east of the Dardanelles and Knight's Lake near the top of the ridge that forms the valley and small areas east of the Belly River and north of the highway north of Sofa Mountain, and along the north fork of the Belly river near the Park boundary.

Associated Map Units

Map units 25, 29, 32, 50, 55, 57, 58, 61 and 141 are found in association with map unit 36. Map unit 25 is found on well formed fans which are subjected to enough disturbance to prevent profile formation. Map unit 29 is found in very gently sloping areas where forested Gleyed Regosol soils are found. Map unit 32 is found in fairly strong depressional areas where water stands for significant periods of the year forming Gleysols. Map units 50 and 58 are found in association with the Dark Gray Luvisolic end member of map unit 36. Map unit 50 is associated with the grassland and shrubby Populus tremuloides areas whereas map unit 58 is associated with earthworm mixing of soils tending towards Luvisols. Map unit 55 is associated

with map unit 36 where steep till slopes abut the sandy outcrops. Map unit 57 is generally found in association with the Gray Luvisol end members of map unit 36 and shows up where the dense cordilleran tills with coniferous vegetation abut the sandstone or weathered sandstone outcrops. Where map unit 36 is close to steep mountain fronts such as the north fork of the Belly River map units 61 and 141 are found abutting it on till and colluvial slopes respectively.

Competing Map Units and Differentiae

Soils with few coarse fragments and relatively coarse texture are the two characteristics which will be most useful in separating map unit 36 from other map units in the Park. Map unit 25 may have few coarse fragments and a coarse texture but does not have a B horizon and thus can be separated. Map unit 26 is generally associated with a grassland environment and soils with Chernozemic Ah horizons separates it from the soils with Luvisolic Ah-Ae horizon sequence of map unit 36. Map unit 29 is in an area of excess moisture, thus the soils have Gleyed characteristics. Map unit 37 has soils with a deep black surface which may, at times, be confused with the Dark Gray Luvisolic end member of map unit 36. However, the lack of a B horizon and any associated increase in clay in the B horizon of the soils should make separation relatively simple. Map units 41 and 42 may at times be similar to map unit 36 but should be easily separable because of their silt loam textured soils.

Vegetation

Vegetation associated with the Dark Gray Luvisolic end member of this map unit is dominantly relatively pure stands of 20 to 40 foot tall Populus tremuloides (trembling aspen) providing 40 to 60% coverage. Where significant amounts of Pinus contorta (lodgepole pine) or occasionally Picea glauca (white spruce) are found a Gray Luvisol end member is dominant. In this map unit shrubs are characterized by the associations made up of Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose), and Rubus parviflorus (thimbleberry) and herbs are characterized by the association made up of Gramineae (grasses), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip), and Thalictrum venulosum (veiny meadow-rue). In the areas where appreciable coniferous trees are present,

Shepherdia canadensis (Canadian buffaloberry) and Cornus stolonifera (red osier dogwood) are found rather than the saskatoon and thimbleberry. Herbs more prominent in the latter situation include Disporum oreganum (fairybells) and Fragaria sp. (strawberry).

The two type pedons making up this map unit are given in the following pedon descriptions:

Pedon Description (C157)

Classification: Orthic Gray Wooded (Typic Cryoboralf).

Described by: W. D. Holland and Gerald Coen.

Date: July 25, 1972.

Location: near the top of the ridge about $\frac{1}{4}$ mile southwest of where Sofa Creek changes from a northerly direction to a westerly direction (Fig. 22).

Climate: continental.

Parent Material: brownish sandstone either weathered in situ or modified by the action of running water to give local alluvium.

Landform: valley sides or modified alluvial fans.

Slope: about 17% in the vicinity of the pedon and 5 to 40% in the map unit.

Elevation: 4,700 feet ASL.

Relief: about 200 feet.

Aspect: 290 degrees.

Estimated drainage: well drained.

Water table: probably rarely within 90 cm of the surface.

Vegetation: mixed forest with a fairly high percentage of coniferous trees such as Pinus contorta (lodgepole pine), Pseudotsuga menziesii (Douglas fir), and Picea glauca (white spruce). Deciduous trees included Populus trichocarpa (black cottonwood), Populus tremuloides (trembling aspen), and Betula papyrifera (white birch). A dense understory very rich in species, included shrubs such as Symphoricarpos occidentalis (western snowberry), Amelanchier alnifolia (saskatoon), Rubus parviflorus (thimbleberry), and Rosa acicularis (prickly rose). Herbs included Thalictrum venulosum (veiny meadow-rue), Veratrum eschscholtzii (false hellebore), Heracleum lanatum (cow parsnip), and Gramineae (grasses).

Notes: There were few stones or boulders either within the pedon or on the soil surface. The soil was in a virgin condition.

- L-H 18 to 0 cm ; black (10YR 2/1 m); moderately well, grading to well decomposed organic matter with depth; common white mycelia; abundant coarse and medium roots; abrupt smooth boundary; 13 to 20 cm thick.
- Ae 0 to 18 cm; grayish brown to dark grayish brown (10YR 5/2 to 4/2 m) sandy loam; moderate coarse platy; very friable; abundant coarse and medium roots; few fine pores; no clay films; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 13 to 23 cm thick.
- Bt 18 to 51 cm; brown to dark yellowish brown (10YR 4/3 to 4/4 m) sandy clay loam; moderate coarse subangular blocky; firm; few medium roots; common medium pores; continuous thin clay films; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 15 to 20 cm thick.
- C 51 to 76 plus cm ; dark grayish brown (10YR 4/2 m) loamy sand; massive to single grain; loose; few fine roots; few medium pores; no clay films; no effervescence; estimated coarse fragments less than 5%.
- R(?) Sandstone similar to the C material. It is fractured but may be bedrock. At this depth it can be dug with a shovel. Some rocks similar to the ones here are seen within the solum and are entirely weathered, only their outline remaining.

COMMENTS:

There is some mixing of the L-H with the Ae by earthworms causing areas of the Ae to be darker than the matrix. However, if the lightest color is used it falls within the definition of an Ae.

Pedon Description (C249)

Classification: Dark Gray Luvisol (Mollic Cryoborall)

Described by: Gerald Coen.

Date: September 16, 1972.

Location: about 2½ miles east of the Cardston Highway along the Chief Mountain Highway and then south of the old highway about 100 yards (Fig.22).

Climate: continental.

Parent material: brownish sandstone either weathered in situ or modified by the action of running water to give local alluvium.

Landform: valley sides or modified alluvial fans.

Slope: 15% in the vicinity of the pedon and 10 to 30% in the map unit.

Elevation: 4,500 feet ASL.

Relief: less than 100 feet.

Aspect: 250 degrees.

Estimated drainage: well drained.

Water table: water table is probably rarely found within the pedon.

Vegetation: 30 to 40% cover with 30 to 40 foot tall Populus tremuloides (trembling aspen) with much regeneration by aspen. The abundant understory is rich in species including shrubs such as Berberis repens (creeping mahonia), Betula occidentalis (water birch), Rosa acicularis (prickly rose), Symphoricarpos occidentalis (western snowberry), Spiraea lucida (white meadowsweet), Prunus virginiana (chokecherry), and the odd Salix spp. (willows). Common herbs include Epilobium angustifolium (fireweed), Thalictrum venulosum (veiny meadow rue), Arnica cordifolia (heart-leaved arnica), Lathyrus ochroleucus (wild sweetpea), Disporum oreganum (fairybells), and an occasional Heracleum lanatum (cow parsnip) and Geranium viscosissimum (sticky purple geranium). Gramineae (grasses) provide about 30% cover.

Notes: The soil temperature at 50 cm was 9 degrees C. There were essentially no stones on the surface in the vicinity of the pedon nor within the pedon itself. Within the map unit stones vary from 0 to 20% in the pedon. The soil was in a virgin condition.

- L-H 4 to 0 cm; very dark brown (10YR 2/2 m); fluffy relatively well decomposed deciduous leaves; plentiful fine roots; abrupt wavy boundary; 1.5 to 8 cm thick.
- Ahe 0 to 8 cm ; very dark brown (10YR 2/2 m) sandy loam; weak fine granular; friable; abundant fine and medium roots; unable to observe pores; no clay films; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 8 to 13 cm thick.
- Ae 8 to 15 cm ; grayish brown (10YR 5/2 m) sandy loam; weak fine platy; friable; plentiful fine roots; common fine pores; no clay films; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 5 to 10 cm thick.
- Bt 15 to 46 cm ; dark grayish brown (10YR 4/4 m) matrix and brown (10YR 4/3 m) ped face, loam; moderate medium subangular blocky; friable; plentiful fine roots; common medium and plentiful fine pores; common thin clay films; no effervescence; estimated coarse fragments less than 2%; gradual wavy boundary; 25 to 36 cm thick.
- C1 46 to 97 cm ; light olive brown (2.5Y 5/4 m) sandy loam; massive (pseudo medium platy); friable; very few roots; common fine pores; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 48 to 53 cm thick.

- C2 97 to 109 plus cm ; light olive brown (2.5Y 5/4 m) sandy loam; massive (strong large pseudo platy); firm; few medium roots; very few pores; no clay films; no effervescence. The C2 horizon is comprised of weathered sandstone which can be relatively easily dug and having easily discernible strata. This may be bedrock or only a large flag.

COMMENTS:

The Ae horizon is about 40 to 60% disturbed by dark earthworm channels up to 5 mm in diameter. This pedon may be somewhat coarser than the average of the map unit.

MAP UNIT NO. 37 (Cumulic Regosol)

The soils of this map unit are medium and coarse textured with only occasional coarse fragments. They have formed on gently sloping fan materials which are in a landscape position that favours the collection of water from higher slope positions. The frequent movement of water through and beneath the profile promotes the development of a black, organic rich Ah horizon which is fairly thick. The continual downslope erosion of soil materials also lends to the cumulic nature of the thick Ah horizons. Map unit 37 is geographically located mainly between Sofa Mountain and the Chief Mountain highway. Isolated areas are also found near Cameron Lake and in the Horseshoe Basin- Oil Basin area.

Associated Map Units

Map units 29, 32, 38, 47, 50, 52, 55, 57, 64, 141, 156 and 160 are found associated with map unit 37. Map units 29 and 32 are found at lower elevations in wet depressional areas adjoining map unit 37. Map units 38 and 47 when they adjoin map unit 37, are generally found at somewhat higher elevations and on somewhat more steeply sloping fans where the characteristics are not significantly influenced by accumulating water. Map units 50, 52, 55, 57 and 64 are found on morainic landforms adjacent to or higher than the associated map unit 37. Map unit 64 is generally restricted to the western part of the Park whereas map unit 50 is restricted to the grassland areas. Map units 141, 156 and 160 are found associated with map unit 37 upslope adjacent to the mountains and on considerably more steeply sloping land.

Competing Map Units and Differentiae

Map unit 19 differs from map unit 37 because it is characterized by soils which lack a significant L-H horizon and by its occurrence on alluvial river terraces rather than fan shaped landforms. Map unit 25 differs from map unit 37 because its soils have thin not prominent Ah horizons and generally insignificant L-H horizons. Soils of map unit 29 differ from those of map unit 37 mainly because of thin L-H and Ah horizons. Soils of map unit 32 differ from those of map unit 37 because of their very strongly gleyed characteristics. The lack of an L-H horizon and the very predominant fine gravel fraction composed of shales serves to differentiate map unit 38 from map unit 37. The finer texture and the presence of well developed structure in soils of map units 41 and 42 serve to separate them from map unit 37. Map unit 48 differs by having soils with a considerably greater number of coarse fragments and coarser texture as well as lacking a significantly deep organic rich Ah horizon. Map unit 67 differs from map unit 37 by the till parent material on which it is developed and by the considerably finer texture.

Vegetation

Vegetation associated with this map unit is generally characterized by various associations of Populus balsamifera (balsam poplar), Populus tremuloides (trembling aspen), and Picea glauca (white spruce). Occasionally one or more of these species will be found mixed with Abies lasiocarpa (alpine fir) or Pinus contorta (lodgepole pine). Occasionally wet inclusions within the map unit are covered by vegetative species such as Alnus tenuifolia (river alder) and Salix spp. (willows). Shrubs associated with this map unit include such species as Rubus parviflorus (thimbleberry), and in some areas Menziesia ferruginea (false huckleberry) and in other areas Amelanchier alnifolia (saskatoon), Spiraea lucida (white meadowsweet) and Rosa acicularis (prickly rose). Herbs include such species as Thalictrum venulosum (veiny meadow rue), Heracleum lanatum (cow parsnip), Arnica cordifolia (heart-leaved arnica) and Hedysarum sulphurescens (yellow hedysarum).

Pedon Description (C216)

Classification: Cumulic Regosol¹ (Aquic Cryoborall)

Described by: Gerald Coen.

- 1 Strictly interpreted the Ah horizon might fall within the definition of a Chernozemic Ah but it violates the traditional concept of Chernozemic soils which are thought to form under grassland or transitional grassland-forest vegetation.

Date: September 8th, 1972.

Location: about $\frac{1}{2}$ mile east of the turnoff to the fire tower on Chief Mountain Highway and then $1\frac{1}{2}$ miles south (Fig. 22).

Climate: continental.

Parent material: coarse and medium textured stratified alluvium with few coarse fragments.

Landform: gently sloping fans somewhat constricted by the adjacent valley walls.

Slope: 4% in the vicinity of the pedon and ranging from 2 to 10% on the landform.

Elevation: 5400 feet ASL.

Relief: 40 feet.

Aspect: 0 degrees.

Estimated Drainage: moderately well drained.

Water table: 50 cm from the ground surface.

Vegetation: about 25% cover was provided by 30 to 40 foot tall trees such as Populus balsamifera (balsam poplar), Populus tremuloides (trembling aspen) and Picea glauca (white spruce). Shrubs observed included Cornus stolonifera (red osier dogwood), Lonicera involucrata (bracted honeysuckle), Ribes oxycanthoides (wild gooseberry) and Ribes hudsonianum (wild black currant). Herbs observed included Epilobium angustifolium (fireweed), Hedysarum sulphurescens (yellow hedysarum), Geranium viscosissimum (sticky purple geranium), Heracleum lanatum (cow parsnip), Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Veratrum eschscholtzii (false hellebore) and Pyrola spp. Few grasses or mosses were observed.

Notes: The soils temperature at 50 cm below the mineral surface was 8 degrees C.

There were very few stones within the pedon or on the surface. The soil was in a virgin condition.

L-H 15 to 0 cm ; black (5YR 2/1 m) well decomposed organic material with a fairly high mineral component; abundant fine and medium roots; abrupt wavy boundary; 13 to 20 cm thick.

Ah 0 to 13 cm ; black (5YR 2/1 m) and very dark gray (5YR 3/1 d) sandy loam to loam; weak large subangular blocky; very friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 2%; clear wavy boundary; 10 to 20 cm thick.

- C 13 to 46 cm ; dark gray (5YR 4/1 m) and pinkish gray (7.5 YR 6/2 d) sandy loam with very dark gray (5YR 3/1 m) blotches; massive to single grain; very friable; few fine roots; few fine pores; no clay film; no effervescence; estimated coarse fragments less than 2%; abrupt wavy boundary; 23 to 36 cm thick.
- Ahb 46 to 53 cm ; dark reddish brown (5YR 3/2 m) and brown (7.5YR 5/2 d) sandy loam; moderate coarse subangular blocky; very friable, non-sticky non-plastic; few fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments less than 2%; abrupt wavy boundary; 5 to 10 cm thick.
- Cg 53 to 61 plus cm ; dark reddish gray (5YR 4/2 m) sandy loam with common large distinct reddish brown (7.5YR 4/4 m) mottles; weak large subangular blocky; loose; very few fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments less than 2% .

COMMENTS:

The areal extent of map unit 37 contains better drained soils than the above pedon which has 2 to 5 cm of L-H horizon and only 13 to 15 cm of Ah horizon over C horizons. In other areas the Ah horizon is as thick as 75 cm without an intervening C horizon and the drainage exhibited in this pedon is probably typical of much of the areal extent of the more gentle slopes of map unit 37 although it is at the more poorly drained end of the range of soils within the map unit. The C:N ratio of the Ah horizon is 13.

MAP UNIT NO. 38 (Orthic Regosol)

The soils of this map unit are coarse textured with many cobbles and boulders within the solum. They have formed on coarse textured, loose alluvium deposited in a fan shaped landform. The cobbles, stones and boulders are made up of about 50% limestone and 20% sandstone. Red and green argillites predominate in the gravel sizes. The materials in this landform have been transported very short distances (often less than a mile) resulting in angular (unweathered) fragments. In general these soils have been mapped at 5,000 feet ASL or higher and are associated with fairly steep fans where streams break through a cleft in the mountains. As a consequence the surface materials are quite unstable and do not remain undisturbed long enough to develop distinct horizonation and thus are Regosols, both Cumulic and Orthic. The number

of boulders on the surface varies widely over relatively short distances - probably related to snow slides more than to physical movement by water. In general, large stones and boulders are quite common. In landscape positions where snowbeds provide continued run-off over much of the summer some of these soils may be imperfectly drained, although profile characteristics do not indicate lack of oxygen. Geographically these soils are located in small areas throughout the northern fringes of the mountains.

Associated Map Units

Map units 29, 37, 39, 64, 141, 142, 156 and Talus are associated with map unit 38. At the toe of fans where finer textured soils with few cobbles and boulders are found map unit 38 has a common boundary with map units 29 or 37. Map unit 39 is commonly found on the relatively gently sloping landforms confining the fans on which map unit 38 is located. Where steeply sloping colluvial landforms adjoin fans upon which map unit 38 is located, map units 141 or 142 have a common boundary with map unit 38. In the western portion of the Park map unit 156 may be associated with map unit 38 when steeply sloping colluvial landforms adjoin coarse textured fans. When morainic landforms in the western part of the Park adjoin coarse textured fans, map unit 38 and 64 have common boundaries. The map unit Talus often is found in upslope positions above a common boundary with map unit 38.

Competing Map Units and Differentiae

Map unit 38 is separated from map unit 21 by soils with a deeper (20 to 30 cm rather than 10 to 13 cm) Ah more moder than the Chernozem-like Ah horizon of map unit 21. The gravels are mainly 2 to 5 mm in size and comprised of flat pieces of argillites rather than the more rounded gravels as in map unit 21. Vegetation on the two areas differs considerably (see pedon description). Map units 41 and 142 differ mainly because the landform is not fan shaped and in general has greater than 50% slope. Map unit 39 is very similar except that it does not have the fan shape. Also the type example has more scrubby trees and less herbs and shrubs.

Vegetation

Vegetation characteristic of this map unit is comprised of both open grassy areas and areas with trembling aspen and spruce. The shrub association in the open areas provides about 5% coverage with Potentilla fruticosa (shrubby cinquefoil) and the herb

association provides about 100% coverage with Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), Danthonia parryi (parry oat grass) and Lupinus sericeus (pursh's silky lupine). The areas covered with trees have a mixture of Populus spp. (poplar) and Picea spp. (spruce) generally 20 - 50 feet tall and providing 20 to 40% canopy density. (Populus tremuloides (trembling aspen), Populus balsamifera (balsam poplar) and Populus trichocarpa (black cottonwood) were collectively grouped as Populus and Picea glauca (white spruce) and Picea engelmannii (Engelmann spruce) were grouped as Picea.) Stand conditions vary from immature stands to thrifty mature stands. The lower vegetation in the wooded areas consists of 25% coverage of the shrub association comprised of Spiraea lucida (white meadowsweet), Rubus parviflorus (thimbleberry), and Amelanchier alnifolia (saskatoon). The herb association provides 80% cover with Thalictrum venulosum (veiny meadow rue), Gramineae (grasses), Epilobium angustifolium (fireweed) and Equisetum arvense (common horsetail).

Pedon Description (C123)

Classification: Orthic Regosol (Typic Cryoboroll) ¹

Described by: Gerald Coen.

Date: September 15th, 1971.

Location: south of the fire tower about 1 mile on a fan located at the base of Sofa Mountain (Fig. 22).

Climate: continental.

Parent Material: loose coarse local alluvium.

Landform: fairly steep fan.

Slope: about 18% fairly uniform slope.

Elevation: 6,200 feet ASL.

Relief: about 300 feet associated with the landform:

Aspect: about 340 degrees.

Estimated drainage: well drained.

Water table: below 100 cm , probably always quite deep.

Vegetation: the pit was located in an open area and vegetation consisted mainly of Festuca spp. (fescues), Danthonia parryii (parry oat grass), Lupinus sericeus (pursh's silky lupine) and shrubs such as Potentilla fruticosa (shrubby cinquefoil).

¹ The environment at about 6000 feet ASL is close to subalpine and Chernozemic soils are excluded from these areas by C.S.S.C. (1970).

Notes: Surface stones are quite variable and are much larger and more prevalent at the top of the fan. The soil is in a virgin condition.

- Ah1 0 to 20 cm ; dark reddish brown (5YR 3/3 m) and dark reddish gray (5YR 4/2 d) sandy loam to loam; weak coarse granular (little evidence of ped formation); friable (held together mainly by fine roots); abundant very fine roots; pores were not observable; no effervescence; estimated coarse fragments about 20% mainly less than 1 cm in diameter and mostly flat or platy; gradual, wavy boundary; 18 to 23 cm thick.
- Ah2 20 to 30 cm ; dark reddish brown (5YR 3/3 m) and dark brown (7.5YR 4/4 d) gravelly sandy loam; weak coarse granular as above; friable; plentiful very fine roots; pores were not observable; no effervescence; estimated coarse fragments about 40% mainly less than 10 cm in diameter; clear, wavy boundary; 8 to 13 cm thick.
- C1 30 to 71 cm ; reddish brown (5YR 5/3 m) and light reddish brown (7.5YR 5.5/3 d) gravelly loam; clods bounded by rock faces and have appearance of moderate medium angular and subangular blocky; very friable; soft; few very fine roots; few very fine pores; no effervescence; estimated coarse fragments about 50%; diffuse, wavy boundary; 36 to 46 cm thick.
- C2 71 to 81 plus cm ; reddish brown (5YR 5/3 m) and light reddish brown (7.5YR 5.5/3 d) gravelly sandy loam; single grain to massive; very friable; soft; few roots; many fine pores; no effervescence; estimated coarse fragments about 50%.

COMMENTS:

Carbonate pendants were evident within 30 cm of the surface although the fine earth fraction did not effervesce. Fifty per cent of the cobbles, stones and boulders were comprised of limestone and 20% of sandstone. The gravel sizes were dominated by red and green argillites. The C:N ratio of the Ah horizon is 10.

MAP UNIT NO. 39. (Cumulic Regosol)

The soils of this map unit are coarse textured with common coarse fragments. They have formed on relatively loose alluvial or colluvial material found on slopes that are less steep than colluvial slopes typical of Waterton Lakes National Park. The land-form is probably best considered a group of coalescing fans without any particular major source of the alluvial material. In general tree growth is sufficient to prevent creep and erosion from incorporating the F-H horizons with the mineral material. Map unit 39 is geographically located mainly east of the Waterton valley.

Associated Map Units

Map units 36, 37, 38, 57, 142 and Talus are found in association with map unit 39. Map units 36, 37 and 38 are all found on fan shaped or poorly defined fan shaped landforms abutting map unit 39. Map unit 39 is generally at somewhat higher elevations than the other preceding map units. Map unit 57 is found on morainic landforms adjoining the lower portions of map unit 39. Talus is also located at the extreme upper portions of map unit 39.

Competing Map Units and Differentiae

Map unit 39, like so many other of the map units in the Park, is characterized by Regosol soils which have little profile development. However, the coarse texture and coarse fragments serve to separate it from several other units and the landform to which it is associated also serves to make separation especially from moraines and river terraces. Map units 38 and 48 are generally somewhat less steeply sloping (generally less than 20%) than is map unit 39 (20 to 40%). Soils of map unit 38 differ by having a deep Ah and lacking an L-H horizon. Map units 141 and 142 differ mainly by the well defined colluvial landform and the steeper slopes associated with this landform. In many ways map unit 39 is a transitional soil between map units 38 and 48 and map units 141 and 142.

Vegetation

Vegetation associated with this map unit is characterized by 20 to 40 foot tall mixed forest providing 40 to 60% cover. Picea glauca (white spruce), Pinus contorta (lodgepole pine), Abies lasiocarpa (alpine fir) and Pseudotsuga menziesii (Douglas fir) are the main evergreen species. The dominant deciduous species is Populus tremuloides (trembling aspen). The understory vegetation varies considerably depending upon the combination of species in the tree layer. Shrub species such as Spiraea lucida (white meadowsweet), Rubus parviflorus (thimbleberry), Amelanchier alnifolia (saskatoon) and Rosa acicularis (prickly rose) are prominent on many areas of map unit 39. Herbs such as Thalictrum venulosum (veiny meadow rue) and Gramineae (grasses) are common to most of the areas associated with map unit 39. Other herb species such as Epilobium angustifolium (fireweed), Heracleum lanatum (cow parsnip) and Hedysarum sulphurescens (yellow hedysarum) are also common.

Pedon Description (C255)

Classification: Cumulic Regosol (Typic Cryofluvent).

Described by: Gerald Coen.

Date: September 17, 1972.

Location: south of the trail about mid-way between the Bosporus and the start of the Dardanelles on the southeast side of Lower Waterton Lake (Fig. 22).

Climate: continental.

Parent Material: fairly coarse textured loose somewhat unstable alluvium-colluvium.

Landform: coalescing fans with many small source streams.

Slope: 25% in the vicinity of the pedon and ranging from 20 to 40% on the landform.

Elevation: 4,400 feet ASL.

Relief: about 500 feet.

Aspect: 300 degrees

Estimated Drainage: well drained.

Water table: probably never within 90 cm of the surface.

Vegetation: about 10 to 20% coverage with 20 to 30 foot tall Pseudotsuga menziesii (Douglas fir). Shrubs noted in the area included Acer glabrum (mountain maple), Symphoricarpos occidentalis (western snowberry), Spiraea lucida (white meadow-sweet), Berberis repens (creeping mahonia), Ribes oxycanthoides (wild gooseberry) and Rosa acicularis (prickly rose). Herbs observed in the area included Thalictrum venulosum (veiny meadow rue), Clematis verticellaris (purple clematis), and Disporum oreganum (fairybells). A few grasses and some mosses were observed.

Notes: The soil temperature at 50 cm was 9 degrees C. There were a few cobble sized stones on or near the surface and common gravels and cobbles within the pedon. The soil was in a virgin condition.

- F-H 5 to 0 cm ; very dark brown (10YR 2/2 m) moderately well to well decomposed organic material; clear wavy boundary; 2.5 to 8 cm thick.
- Ah 0 to 2.5 cm ; very dark brown (10YR 2/2 m) sandy loam; weak fine granular; very friable; abundant medium and plentiful fine roots; pores could not be observed because of disruption; no clay films; no effervescence; coarse fragments not estimated; clear wavy boundary; 1 to 4 cm thick.
- C1 2.5 to 28 cm ; weak red (10R 4/2 m) gravelly coarse sandy loam; massive to single grain; very friable; plentiful fine roots; pores could not be observed; no clay films; no effervescence; estimated coarse fragments 30 to 40%; diffuse wavy boundary; 23 to 28 cm thick.

- Ahb 28 to 30 cm ; very dusky red (10R 2/2 m) sandy loam; massive; very friable; plentiful fine roots; pores could not be observed; no clay films; no effervescence; coarse fragments not estimated; abrupt broken boundary; 0 to 5 cm thick.
- C2 30 to 66 plus cm ; weak red (10R 4/2 m) very gravelly sandy loam; massive to single grain; very friable; few medium and very few large roots; pores could not be observed; no clay films; no effervescence; estimated coarse fragments 60%.

COMMENTS:

The Ah horizon has about 30% organic material and may, in fact, classify as an organic horizon. The Ahb horizon appears to be a blotch of buried Ah horizon probably caused by tree throw, and is not continuous around the pit. This pedon is probably on the fine textured end of the texture range associated with map unit 39. It contains considerably fewer plate like fine gravels than some of the examples found north of Sofa Mountain.

MAP UNIT NO.41 (Orthic Regosol)

The soils of this map unit are mainly medium textured with few cobbles in the upper 30 cm or so. Below a surficial silty deposit the material is fine textured till with considerable numbers of rocks and boulders. This map unit is generally located in draws and small catchment basins. The occurrence of finer textured till material under a silty surficial deposit provides a restriction to vertical water movement and may promote considerable lateral flow.

Associated Map Units

Map unit 57 is found on the steeper, convex till slopes associated with the draws in which map unit 41 is found. Map unit 100 is found associated with map unit 41 where fine textured dark coloured shales outcrop and on which Regosolic soils develop. Map unit 53 is associated in the low morainic areas where there is excess moisture above field capacity for significant periods of the year.

Competing Map units and Differentiae

Map unit 42 differs in that it is found mainly under grassland vegetation on well developed fans. Map unit 37 differs in that it has a deep very dark gray cumulic type of Ah, mainly loam in texture and generally occurs in an area that receives some runoff water.

Vegetation

Vegetation characteristic of this map unit is typified by 20 to 40% canopy density of 40 to 60 foot tall immature and mature Pinus contorta (lodgepole pine). The trees characteristic of this map unit generally have less canopy density than in the adjacent map units such as 57. The lower vegetation consists of 30% coverage with the shrub association of Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), and Berberis repens (creeping mahonia), and 70% coverage of an herb association consisting of Arnica cordifolia (heart-leaved amica), Thalictrum venulosum (veiny meadow rue), and Epilobium angustifolium (fireweed).

Pedon Description (C130)

Classification: Orthic Regosol (Typic Cryorthent).

Described by: Gerald Coen and W. D. Holland.

Date: September 23, 1971.

Location: about $\frac{1}{2}$ mile east of the Chief Mountain Highway, east of the turnoff to the Belly River campground (Fig.22).

Climate: continental.

Parent Material: shallow alluvium over till.

Landform: narrow constricted fan or draw.

Slope: ranges from 2 to 6%, across pit 4%.

Elevation: about 5,200 to 5,300 feet ASL.

Relief: 20 feet.

Aspect: about 270 degrees.

Estimated Drainage: well to moderately well drained.

Water Table: possibly perched within the pedon for a period in the spring.

Vegetation: about 35% canopy density of 40 foot tall Pinus contorta (lodgepole pine).

There are a few Picea glauca (white spruce) as understory. A few Shepherdia canadensis (buffaloberry) and Rubus parviflorus (thimbleberry) were noted as well as Epilobium angustifolium (fireweed). Very few grasses and mosses were evident.

Notes: The soil temperature at 50 cm was 4 degrees C. Several large boulders were found in the till (IIC). Not many were noted in the silty alluvial wash material. The

soil is virgin. The alluvial-till contact is quite sharp. The alluvial material appears to be an accumulation of translocated till deposited when fast moving water in the draws slows down allowing deposition of suspended material.

- L-H 5 to 0 cm of decayed wood, twigs, needles and leaves. White and yellow mycelia are quite evident; abrupt, clear boundary; 1.5 to 6.5 cm thick.
- C1 0 to 13 cm ; dark brown (7.5YR 3/2 m) loam; weak fine granular; very friable; abundant, coarse roots; few, medium pores; estimated coarse fragments 5%; gradual, wavy boundary; 10 to 15 cm thick.
- C2 13 to 43 cm ; brown (7.5YR 4/4 m) silt loam; weak, large subangular blocky to massive; friable; plentiful, medium and abundant, coarse roots; very few medium pores; estimated coarse fragments 5%, mainly gravel sizes; abrupt wavy boundary; 25 to 36 cm thick.
- IIC1 43 to 84 cm ; brown (10YR 4/3 m) gravelly clay loam with weathered stones giving strong brown (7.5YR 5/8 m) blotches; weak, large subangular blocky to massive; friable; few coarse roots; few, medium pores; few, very thin clay films; estimated coarse fragments 50%; diffuse, wavy boundary; 41 to 46 cm thick.
- IIC2 84 to 102 plus cm ; light olive brown (2.5Y 5/4 m) and yellowish brown (10YR 5/4 m) gravelly loam with light olive brown (2.5Y 5/6 m) blotches from weathered rock; massive; friable; very few, medium roots; few, fine pores; estimated coarse fragments 50%.

MAP UNIT NO.42 (Rego Dark Brown Chernozemic)

The soils of this map unit are mainly medium textured with few cobbles and stones within 100 cm. They have developed on relatively low angle fans associated with the finer textured tills and shales in the Belly River area. No layers restrictive to water movement are encountered within 100 cm of the surface. Below 100 cm the material may be gravelly. Variations in texture with depth are not unusual and are the result of the stratified alluvial materials on which the soils are formed. Map unit 42 is geographically located east of the Waterton River, mainly in the Belly River area.

Associated Map Units

Map unit 15 is located on alluvial terraces rather than fan shaped landforms. Map unit 41 is developed on local fan alluvium but differs by not having a Chernozemic Ah and by supporting good forest growth, mainly lodgepole pine. Generally map unit 41 is located upslope from map unit 42 and in draws in a till landscape. Map unit 44 is located in fan positions where a high water table is present for significant periods of the year. Map unit 57 is comprised dominantly of GrayLuvisol soil found on till and is generally found associated somewhat upslope from map unit 42.

Competing Map Units and Differentiae

Map unit 15 is characterized by Gleyed and Orthic Regosols on river terrace alluvium rather than Chernozemic soils on fan alluvium as in map unit 42. Map unit 41 is characterized by Orthic Regosols developed in draws and local basins rather than on grassy fans as in map unit 42. Map unit 38 differs in that it is found on generally steeper fans, is coarser textured, and has many cobbles and boulders. Map unit 44 differs in that it is characterized by Rego Humic Gleysols.

Vegetation

Vegetation characteristic of this map unit is typified by parkland-like communities of grasses and poplars. Overmature stands of Populus tremuloides (trembling aspen) generally varying from 20 to 40 feet tall and having about 20 to 40% canopy density dot the landscape. Understory vegetation in these areas is dominated by about 25% cover by the shrub association including Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose) and Rubus parviflorus (thimbleberry) and about 80% cover by the herb association including Gramineae (grasses), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip), and Thalictrum venulosum (veiny meadow rue). Open areas of the landscape are dominated by about 5% cover with Potentilla fruticosa (shrubby cinquefoil) and about 100% cover by the herb association including Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), Danthonia parryi (parry oat grass) and Lupinus sericeus (pursh's silky lupine).

Pedon Description (C128)

Classification: Rego Dark Brown Chernozemic (Typic Cryoboroll)

Described by: W. D. Holland and Gerald Coen.

Date: September 22, 1971.

Location: Belly river campground (Fig. 22).

Climate: continental.

Parent Material: stone free medium textured fan alluvium.

Landform: alluvial fan.

Slope: 5%, relatively uniform.

Elevation: about 4600 feet ASL.

Relief: about 30' on this landform.

Aspect: about 270°.

Estimated Drainage: well drained.

Water table: below 100 cm for all but possibly very short periods in the spring.

Vegetation: at the site of sampling about 30% coverage of mature Populus tremuloides (trembling aspen) 25 to 30 feet tall. Symphoricarpos occidentalis (western snowberry) was the prominent shrub observed. Herbs included a dominance of Festuca spp. (fescue grasses) and some Phleum pratense (timothy) as well as Heracleum lanatum (cow parsnip) Lupinus sericeus (Pursh's silky lupine) and Aquilegia flavescens (yellow columbine).

Notes: Soil temperature at 50 cm was 5° C. Surface stones were not prevalent and in much of the area were essentially absent. The soil was virgin in most areas but there may have been some vegetative disturbance.

- Ah 0 to 20 cm ; very dark brown (10YR 2/2 m) and dark gray (10YR 4.5/1 d) loam; moderate medium granular; friable; plentiful fine roots; common fine pores; many earthworm casts; clear, wavy boundary; 18 to 25 cm thick.
- C1 20 to 61 cm ; very dark grayish brown (10YR 3/2 m) silt loam; weak large subangular blocky to massive (peds are poorly defined); friable; plentiful medium and coarse roots; few fine pores; clear, wavy boundary; 30 to 46 cm thick.

- C2 61 to 119 cm ; dark yellowish brown (10YR 4/4 m) silt loam; massive; friable; few medium and coarse roots; few medium and fine pores; clear, wavy boundary; 53 to 64 cm thick.
- C3 119 to 130 cm plus; dark yellowish brown (10YR 4/4 m) gravelly clay loam; massive; friable; about 40 to 60% by volume of coarse fragments, mainly gravel and cobble sized silt-stones.

COMMENTS:

There is about 0.5 cm of organic litter comprised of deciduous leaves and grass stems and leaves. Strictly the Ah appears to meet the definition of a Chernozemic Ah but there is no effervescence within 127 cm so part of the character of a Rego Chernozem is missing. Perhaps these soils should be classified as Orthic Regosols. The range of pedons mapped withing this map unit includes gleyed members and well developed cumulic members with good Ahb horizons.

MAP UNIT NO. 44. (Rego Humic Gleysol)

The soils of this map unit are coarse textured with many cobble and gravel sized coarse fragments. They have formed on coarse textured poorly drained fan alluvium. The poor drainage is caused by seepage coming to the surface near the watertable in the floodplain of the Belly River. The two areas mapped as 44 are associated with the periphery of the fan formed by the north fork of the Belly River.

Associated Map Units

Map units 14, 15, 39 and 101 are found in association with map unit 44. Poorly drained map unit 14 and moderately well drained map unit 15 are found where the flood plain of the Belly River encroaches upon the fan where map unit 44 is located. Map unit 39 is found along the valley wall where the wall abuts map unit 44. Map unit 101 is also found where the valley wall encroaches upon the fan where map unit 44 is located.

Competing Map Units and Differentiae

The poorly drained character of the soils associated with map unit 44 separate it from most of the other map units within the park. Map unit 14 differs by the lack of coarse fragments and the somewhat finer texture of its soils as well as its floodplain position. Map units 29, 31 and 32 are all characterized by poorly drained soils on

fans but differ mainly by their lack of coarse fragments and again by their somewhat finer texture. Map unit 53 may at times appear quite similar to map unit 44 but differs by having a till parent material. Map unit 105 may at times have a similar landform position but differs by its almost complete lack of cobble size coarse fragments and its considerably finer texture.

Vegetation

Vegetation associated with this map unit is characterized by shrubs such as Salix spp. (willow), and Alnus tenuifolia (river alder). The dominant herbs include Heracleum lanatum (cow parsnip), Veratrum eschscholtzii (false hellebore), Carex spp. (sedges) and Gramineae (grasses). Patches or clumps of Populus balsamifera (balsam poplar) are also observed within the map unit.

Pedon Description (N85, N87)

Classification: Rego Humic Gleysol (Typic Cryaquent).

Described by: Z. Nemeth.

Date: July 27, 1971.

Location: about $\frac{1}{4}$ mile west of the Belly River and $\frac{1}{4}$ mile south of the south boundary of the Blood Timber limit (Fig. 22).

Climate: continental.

Parent Material: poorly drained cobbly fan alluvium.

Landform: alluvial fan.

Slope: less than 5%.

Elevation: 4,500 feet ASL.

Relief: less than 20 feet.

Aspect: 80 degrees.

Estimated drainage: very poorly drained.

Water table: about 30 cm.

Vegetation: Salix spp. (willow) and Alnus tenuifolia (river alder) as well as Populus balsamifera (balsam poplar) were the main shrubs. A small number of Picea glauca (white spruce) and Populus tremuloides (trembling aspen) were also noted. Carex spp. (sedges), Gramineae (grasses), and Equisetum arvense (common horsetail) were also observed.

Notes: A few cobble sized stones were noted on the surface and many were observed in the pedon. The soil was in a virgin condition.

Ah 0 to 10 cm; very dark grayish brown (10YR 3/2 m) loam; massive; slightly sticky, slightly plastic; 5 to 13 cm thick.

Cg 10 to 50 plus cm ; light gray (10YR 6/1 m) gravelly sandy loam (gleyed but mottle colors not recorded); massive; non-sticky, non-plastic; estimated coarse fragments 50% or greater.

COMMENTS:

The coarse fragments observed were mainly cobble sized and often had lime coatings or pendants. This provides some indication that there are periods of the year when these soils are fairly well drained. Occasional pockets of clay loam material were observed on this map unit especially near the toe of the fan. These pockets were probably caused by river flooding over the toe and allowing accumulation of sediment.

MAP UNIT NO 46 (Orthic Gray Luvisol)

The soils of this map unit are fine and medium textured with moderate amounts of coarse fragments. They have formed on fairly steeply sloping, relatively stable fans. The relatively well developed Gray Luvisol profile is indicative of the stability. Very few fans within the Park are sufficiently stabilized to fall within the map unit 46. Map unit 46 is geographically located mainly in the area of the North Fork of the Belly River.

Associated Map Units

Map units 11, 36, 50, 53, 57, 58 and 61 are found associated with map unit 46. Map unit 11 is generally located somewhat downslope from map unit 46 and between map unit 46 and water courses. Occasionally, depending on the parent material, map units 46 and 36 may be closely associated on similar landscapes. Map unit 53 is found adjoining the lower margins of the fans upon which map unit 46 is found in the poorly drained situations. Depending upon the location within the Park, map units 50, 57, 58 or 61 may be found adjoining map unit 46 at the margins of the landforms.

Competing Map Units and Differentiae

Map units 36, 38, 48 and 49 are similar to map unit 46 in that they are associated with the same parent materials and the same landforms. However, soils of map units 38 and 48 are Regosols and soils characteristic of map unit 49 are Podzols which allows easy separation from map unit 46. Map unit 36 is similar to map unit 46 in that they are both represented by Gray Luvisols, but map unit 36 differs because of its lack of coarse fragments and its somewhat more uniform coarse texture. Map units 57 and 61 are Gray Luvisols, the same as map unit 46, but differ because of their till parent materials, and in the case of map unit 61, its very stony nature. Map units 102 and 106 are both characterized by Gray Luvisols, but differ from map unit 46 by their fine texture and lack of coarse fragments. Soils of map unit 160 are Gray Luvisols, but differ from map unit 46 by their colluvial parent materials and the generally steeper slopes.

Vegetation

Vegetation associated with this map unit is characterized by 40 to 60% cover with 20 to 40 foot tall Pinus contorta (lodgepole pine) in some areas of the Park, and in other areas of the Park, it is characterized by 20 to 40% coverage with 20 to 40 foot tall Populus tremuloides (trembling aspen). In the areas where lodgepole pine is found, the shrub species are characterized by Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), and Berberis repens (creeping mahonia). Associated herbs include Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed) and Gramineae (grasses). Shrubs associated with trembling aspen include Rosa acicularis (prickly rose) and Amelanchier alnifolia (saskatoon). In the latter area herbs include Gramineae (grasses), Hedysarum sulphurescens, (yellow hedysarum), Heracleum lanatum (cow parsnip), and Thalictrum venulosum (veiny meadow rue).

Pedon Description (C210)

Classification: Orthic Gray Luvisol (Typic Cryoboralf)

Described by: Gerald Coen.

Date: August 29, 1972.

Location: about $\frac{1}{2}$ mile north-east, downstream, from the Belly River warden's cabin and 100 yards east of the trail (Fig. 22).

Climate: continental.

Parent Material: medium textured alluvium with many coarse fragments.

Landform: stable alluvial fan.

Slope: 25% within the vicinity of the pedon and from 10 to 30% associated with the map unit.

Elevation: 5100 feet ASL.

Relief: about 100 feet.

Aspect: 135 degrees.

Estimated Drainage: well drained.

Water table: below the pedon.

Vegetation: about 40% cover with 40 to 50 foot tall Pinus contorta (lodgepole pine) with little understory regeneration. Shrubs observed included Amelanchier alnifolia (saskatoon), Symphoricarpos occidentalis (western snowberry), Berberis repens (creeping mahonia), and Shepherdia canadensis (Canadian buffaloberry). Herbs included Arnica cordifolia (heart-leaved arnica), Geranium viscosissimum (sticky purple geranium), Clintonia uniflora (one-flowered clintonia) and Disporum oreganum (fairybells). About 1 to 2% cover with Calamagrostis rubescens (pine grass) was also noted.

Notes: The soil temperature at 50 cm was 12° C. There were few large stones on the surface, but cobbles were quite common within the pedon. The soil was in a virgin condition.

- L-F 1 to 0 cm ; very dark grayish brown (10YR 3/2 m) partly decomposed organic material; plentiful fine roots, abrupt wavy boundary; 1 to 2.5 cm thick.
- Ae 0 to 8 cm ; light brown (7.5YR 6/4 m) sandy loam; moderate coarse platy; friable; common fine and medium roots; plentiful fine pores; no clay films; no effervescence; estimated coarse fragments 10%; clear wavy boundary; 5 to 10 cm thick.
- Bt 8 to 38 cm ; brown (7.5YR 4/4 m) gravelly clay loam; moderate large subangular blocky; firm; plentiful fine roots; many fine pores; many thin clay films; no effervescence; estimated coarse fragments 40%; gradual wavy boundary; 25 to 38 cm thick.

Ck 38 to 64 plus cm ; pale brown (10YR 6/3 m) gravelly loam; massive; very friable; few roots; pores unobserved; no clay films; moderate effervescence; estimated coarse fragments 40%, mostly gravels.

COMMENTS:

Within the area outlined as map unit 46 there is occasionally shallow alluvium over till, rather than the pedon just described. However, this pedon probably provides a fairly good concept of the major portion of the map unit.

MAP UNIT NO. 47 (Degraded Eutric Brunisol)

The soils of this map unit are coarse textured with about 30% coarse fragments within the pedon and a fairly stony surface. They have formed on fairly coarse textured fan alluvium which appears to be subjected to very little geologic erosion or disruption. The fan nature of the landform upon which these soils are found indicates that they are generally found in isolated pockets along the edges of major valleys. Map unit 47 is almost entirely located in the western part of the park where the more mountainous topography is associated with greater amounts of rainfall and available moisture.

Associated Map Units

Map units 11, 17, 22, 27, 48, 50, 57, 64, 91R, 141 and 156 are found in association with map unit 47. Map units 17 and 11 are found along stream courses where the fans upon which map unit 47 are located abut the stream terraces. In the tension zone between grassland and forest map unit 22 may be found on some of the fans adjoining or abutting map unit 47. Map units 27 and 48 are found on similar fans in similar areas to map unit 47 but differ because the dominant soil is Regosolic. Map units 50, 57 and 64 are dominated by soils developed on till and abut map unit 47 at the margins or at the upper ends of the map unit. Map units 91R, 141 and 156 are dominated by Regosolic soils or Podzolic soils developed on colluvium and thus are generally located at the upper margins of the fans upon which map unit 47 is located.

Competing Map Units and Differentiae

Map units 18, 28, 66, 150 and 156 are all Brunisolic but except for map unit 28 differ from map unit 47 by having non-fan parent materials. Map unit 28 differs from map unit 47 by the lack of an Ae horizon and the lack of any tendency

towards a Bt horizon. Map units 38, 46, 48 and 49 are found on similar kinds of fans to that upon which map unit 47 is found but differ in the case of 38 and 48 by having Regosolic development, in the case of 46 by having Luvisolic development and in the case of 49 by having Podzolic development.

Vegetation

Vegetation associated with this map unit is characterized by 40 to 60% coverage with 20 to 40 foot tall Pinus contorta (lodgepole pine). The secondary species vary somewhat by areas within the Park and range from Pseudotsuga menziesii (Douglas fir) to Populus tremuloides (trembling aspen). The understory vegetation on map unit 47 varies somewhat according to the diverse regions within the park. The major area of the map unit is characterized by shrub association made up of Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), and Berberis repens (creeping mahonia). The herb association includes Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (viens meadow rue), Epilobium angustifolium (fireweed), and Gramineae (grasses).

Pedon Description (C213)

Classification: Degraded Eutric Brunisol (Typic Cryochrept)

Described by: Gerald Coen.

Date: August 31, 1972.

Location: about 2 miles west of Red Rock Canyon and then north of the fire road in a blowdown area.

Climate: continental.

Parent Material: fan alluvium containing abundant amounts of fine gravel sized red and green shales.

Landform: low angle alluvial fan.

Slope: about 5% in the vicinity of the pedon and from 2 to 10% on the fan.

Elevation: 5100 feet ASL.

Relief: 50 feet.

Aspect: 190 degrees.

Estimated drainage: well drained.

Water table: probably never within 90 cm of the surface.

Vegetation: the area where these samples were taken had been fairly recently subjected to severe winds causing many of the trees to be blown down. There is considerable regrowth of Abies lasiocarpa (alpine fir). The odd Pinus contorta (lodgepole pine) was also seen in the new growth. Shrubs observed included Berberis repens (creeping mahonia), Chimaphila umbellata var. occidentalis (Prince's pine), Linnaea borealis var. americana (twin flower) and Spinaea lucida (white meadowsweet). Herbs observed included Arnica cordifolia (heart-leaved arnica), Clintonia uniflora (one-flowered clintonia) and Epilobium angustifolium (fireweed). About 20% cover was provided by Calamagrostis rubescens (pine grass). A few mosses were noted in the area.

Notes: The soil temperature at 50 cm was 10⁰ C. There was 20 to 30% coarse fragments within the pedon, and coarse cobbles and fine boulders were common on the surface. The soil was in a virgin condition.

- L-H 5 to 0 cm ; very dark grayish brown (10YR 3/2 m) partially decomposed organic matter with many white and yellow mycelia. There are pockets of fairly well decomposed and humified organic material near the mineral contact; plentiful medium roots; abrupt wavy boundary; 2.5 to 7 cm thick.
- Ae 0 to 2.5 cm ; light brown (7.5YR 6/4 m) gravelly sandy loam grading to pinkish gray (7.5YR 6/2 m) with depth; weak coarse platy; very friable; abundant medium and fine roots; no pores observed; no clay films; no effervescence; estimated coarse fragments 25%; clear wavy boundary; 1.5 to 5 cm thick.
- Bm 1.5 to 30 cm ; strong brown (7.5YR 5/6 m) gravelly sandy loam; weak medium subangular blocky; very friable; plentiful fine and medium roots; no pores observed; no clay films; no effervescence; estimated coarse fragments 30%; gradual wavy boundary; 25 to 30 cm thick.
- C 30 to 64 plus cm ; brown (10YR 5/3 m) gravelly sandy loam; single grain; loose; few fine roots; no pores observed; no clay films; no effervescence; estimated coarse fragments 25%.

COMMENTS:

Map unit 47 is transitional between the Orthic Humo-Ferric Podzols of map unit 49 and the Orthic Eutric Brunisols of map unit 28 and as such it has variable depths and distinctness of Ae horizons and varying brightness of Bm horizons.

MAP UNIT NO. 48 (Orthic Regosol)

The soils of this map unit are coarse textured with plentiful coarse fragments of various sizes within the pedon and on the surface. They have formed on coarse textured alluvial fans, generally quite limited in areal extent in any given map area. Through natural geologic processes there is sufficient disturbance of these soils to prevent significant horizon development. There appears to be more moisture in these soils than would be suggested by their texture and organic matter contents. Presumably from up-slope, water is seeping laterally close enough to the surface to be available to the vegetative cover. This condition probably accounts for the presence of the L-H horizon associated with trees rather than the Ah horizon associated with shrubby and grassy vegetation of map unit 38. Map unit 48 is geographically located mainly west of the Waterton lakes, along the Cameron and Bauerman-Blakiston Creek valleys.

Associated Map Units

Map units 11, 47, 49, 52, 57, 64, 90R, 141 and 156 are found in association with map unit 48. Where map unit 48 encroaches upon stream terraces it may have a common boundary with map unit 11. Depending upon the area within the Park, map units 47 and 49 may be found on the same or adjacent fans as map unit 48. Also depending upon the area within the Park, map unit 52, 57 or 64 may abut map unit 48 when morainic landforms adjoin the margin of the fans. Map units 90R, 141 and 156 are found at higher elevations where colluvial slopes are adjacent to the fans upon which map unit 48 is located.

Competing Map Units and Differentiae

Map units 46, 47 and 49 are formed on similar material and landforms but are differentiated by their well developed Luvisolic, Brunisolic and Podzolic horizon sequences respectively. Map unit 55 has Regosolic profile development but is developed on finer textured till parent material. Map unit 38 is similar to map unit 48 in landform and parent material but map unit 38 has a well developed Ah horizon without an L-H horizon (associated with the lack of trees) whereas map unit 48 seldom has any Ah and has a prominent L-H horizon. Map unit 27 is separated from map unit 48 because it generally has few cobbles or boulders and is found on gentle slopes whereas map unit

48 often has cobbles and boulders and occurs on greater than 5% slopes.

Vegetation

Vegetation associated with this map unit is characterized by Pinus contorta (lodgepole pine), plus Picea glauca (white spruce) or Abies lasiocarpa (alpine fir) which generally provide 40 to 60% cover with 20 to 40 foot tall trees. Occasionally Pseudotsuga menziesii (Douglas fir) and Populus tremuloides (trembling aspen) are found associated with the above species. Dominant shrubs associated with the under-story include Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), Alnus crispa (green alder) and in some areas Menziesia ferruginea (false huckleberry). Herbs include Thalictrum venulosum (veiny meadow rue), Xerophyllum tenax (bear grass), Arnica cordifolia (heart-leaved arnica) and in some areas Smilacina stellata (star-flowered Solomon's seal).

Pedon Description (C236)

Classification: Orthic Regosol (Typic Cryothent)

Described by: Gerald Coen.

Date: September 13, 1972.

Location: adjacent to the small tributary which joins Cameron Creek from the east about $\frac{1}{2}$ mile down stream from little Cameron Lake (Fig. 22).

Climate: continental.

Parent Material: stratified coarse textured cobbly alluvium.

Landform: alluvial fans.

Slope: 18% in the vicinity of the pedon and from 5 to 25% on the landform.

Elevation: 5,800 feet ASL.

Relief: about 50 feet.

Aspect: about 300 degrees.

Estimated Drainage: moderately well drained.

Water table: probably above 100 cm below the surface during periods of the year.

Vegetation: about 40% cover was provided by 40 to 50 foot tall Abies lasiocarpa (alpine fir), Picea glauca (white spruce) and Pinus contorta (lodgepole pine). The major shrubs noted included Menziesia ferruginea (false huckleberry) and Rubus parviflorus (thimbleberry). The herb species noted included Arnica

cordifolia (heart-leaved arnica), Xerophyllum tenax (bear grass), Smilacina stellata (star-flowered Solomon's seal) and Clintonia uniflora (one-flowered clintonia).

Notes: The soil temperature at 50 cm was 6° C. Few stones showed through the surface L-F layer but gravels and cobbles were common within the pedon. The soil was in a virgin condition.

- L-F 5 to 0 cm ; very dark brown (10YR 2/2 m) relatively undecomposed leaf and needle organic litter; abrupt wavy boundary; 5 to 8 cm thick.
- C1 0 to 46 cm ; dark reddish gray (5YR 4/2 m) gravelly silt loam; massive; very friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 30%; gradual wavy boundary; 43 to 50 cm thick.
- C2 46 to 76 plus cm ; dark reddish gray (5YR 4/2 m) gravelly sandy loam; massive; loose; few to no roots; pores could not be observed; no clay films; no effervescence; estimated coarse fragments 40%. The C material is stratified and also shows what appears to be occasional charcoal layers. However there are no apparent variations in organic matter to suggest modern cumulic characteristics.

MAP UNIT NO. 49 (Orthic Humo-Ferric Podzol)

The soils of this map unit are coarse textured with abundant coarse fragments particularly cobble and gravel sizes. They have formed on coarse textured fans which are not disturbed significantly by soil creep or water erosion. The occurrence of these soils in the more mountainous regions of the western half of the Park corresponds with the increased rainfall there. The map units are generally small in areal extent and not particularly prevalent throughout the Park. Map unit 49 is geographically located along the margins of the Cameron valley and its tributaries.

Associated Map Units

Map units 48, 53, 90R, 141, 142, 150 and 156 are found in association with map unit 49. Map unit 48 is sometimes found on the same fan but on a landform or elevation location that allows water erosion to disrupt the profile development. In situations where morainic depressions adjoin the lower margin of a fan map unit 53 may occasionally have a common boundary with map unit 49. Occasionally the upper margins

of fans may have common boundaries with such units as map unit 90R, 141, 142, 150 or 156.

Competing Map Units and Differentiae

The coarse texture and bright reddish colored B horizon serves to differentiate map unit 49 from many of the other map units in the Park. Map units 64 and 156 also have bright reddish B horizons but are developed on till and colluvium respectively. Map unit 47 may at times be difficult to differentiate from map unit 49 because, strictly speaking, the differentiating criteria are those of free iron chemistry. However for practical purposes the separation was tentatively made by placing any soils with B horizon colours redder than 7.5YR hue into the Podzolic order or map unit 49 and those yellower than 7.5YR into map unit 47.

Vegetation

Vegetation associated with this map unit is characterized by species such as Abies lasiocarpa (alpine fir) and Picea glauca (white spruce). Occasionally one or more of the above species are mixed with either Pinus contorta (lodgepole pine) or Larix lyallii (alpine larch). Shrubs are characterized by an association made up of Menziesia ferruginea (false huckleberry), Vaccinium membranaceum (tall bilberry) and Vaccinium scoparium (grouse-berry). The corresponding herb association is made up of Xerophyllum tenax (bear grass), Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue) and Angelica dawsonii (yellow angelica). At higher elevations the herbs comprise a large proportion of the total understory vegetation and have in addition such species as Luzula glabrata (woodrush) and Mitella breweri (bishop's cap).

Pedon Description (C235)

Classification: Orthic Humo-Ferric Podzol (Typic Cryorthod) ¹

Described by: Gerald Coen.

Date: September 13, 1972.

Location: about $\frac{1}{2}$ mile northeast of Little Cameron Lake and about 100 yards south of the small tributary to Cameron Creek.

¹ Classification in the American Classification System is tentative for the Spodosol Order.

Climate: continental.

Parent Material: coarse textured fairly stable alluvium with a fairly high component of coarse fragments in the gravel and cobble sizes.

Landform: upper portions of an alluvial fan.

Slope: about 18% in the vicinity of the pedon and from 10 to 30% on the landform.

Elevation: 5,800 feet ASL.

Relief: about 500 feet.

Aspect: about 300 degrees.

Estimated drainage: well drained.

Water table: greater than 150cm below the surface.

Vegetation: about 20% cover with 20 to 30 foot tall Abies lasiocarpa (alpine fir) and Pinus contorta (lodgepole pine). The dominant shrub noted was Menziesia ferruginea (false huckleberry). Linnaea borealis var. americana (twin flower) was also noted in the area. The herbs noted included Goodyera oblongifolia (rattlesnake plantain) and Pyrola sp. (wintergreen). Xerophyllum tenax (bear grass) provides about 20% cover. Many mosses and lichens were also observed in the vicinity of the pedon.

Notes: The soil temperature at 50 cm was 6° C. Gravel and cobble sized stones were prevalent both on the surface and within the pedon. The soil was in a virgin condition.

L-H 1 to 0 cm ; very dark brown (10YR 2/2 m) moderately well decomposed organic material; few fine roots; abrupt irregular boundary; 0 to 2.5 cm thick.

Ae 0 to 10 cm ; pinkish gray (5YR 6/2 m) gravelly sandy loam; moderate fine platy; very friable; plentiful fine roots; many fine pores; no clay films; no effervescence; estimated coarse fragments 35 to 40%; abrupt irregular boundary; 4 to 13 cm thick.

Bf 10 to 30 cm ; yellowish red (5YR 4/6 m) grading with depth to brown (7.5YR 4/4m) gravelly loam; weak medium subangular blocky; friable; abundant fine roots; common fine pores; no clay films; no effervescence; estimated coarse fragments 35 to 40%; abrupt irregular boundary; 15 to 23 cm thick.

- Aeb 30 to 41 cm ; brown (7.5YR 5/4 m) gravelly sandy loam; single grain; loose; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 45%; abrupt irregular boundary; 8 to 15 cm thick.
- Bfb 42 to 50 cm ; strong brown (7.5YR 5/8 m) gravelly very fine sandy loam; weak fine subangular blocky; very friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 45%; clear wavy boundary; 5 to 14 cm thick.
- C 50 to 90 plus cm ; weak red (2.5YR 4/2 m) gravelly sandy loam; massive; very friable; few fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 50%.

COMMENTS:

Not all of map unit 49 has soils with buried Ae and Bf horizons. However, the occurrence of these horizons is intermittent and unpredictable. Most of the map unit does, however, have at least one good Podzolic Bf horizon.

MAP UNIT NO 50. (Orthic Dark Brown and Orthic Black Chernozemic Soils)

The soils in this map unit are dominantly on the coarse side of medium textured with many gravel and cobble sized fragments. They have formed from compact, impervious, calcareous, pinkish till. The fine gravels, from 2 to 5 mm are comprised dominantly of red and green argillites with some sandstones and limestones. With increasing size there is a greater percentage of sandstones and limestones. These soils are found adjacent to and as islands within map unit 1 wherever the till was not covered with the outwash materials. In general, there are more surface boulders associated with map unit 50 than map unit 1. The knob and kettle areas east of the buffalo paddock have more surface boulders than the drumlin areas west of Knight Lake, both of which are included in map unit 50. Some of the limestone boulders are characteristically etched by rain and wind into very jagged, sharp, windward surfaces. These soils are found in several instances on drumlins or drumlinoid-shaped features. In general where the till mantles the entire landscape the kettles are filled with permanent or seasonal sloughs. There is quite a sharp change from well drained to poorly drained soils and the Gleysol areas are too small to recognize independently. These have been included as inclusions of Gleysol soil in the generally

well drained soils of map unit 50. Soils on the tops of the knobs and drumlins often have a solum as shallow as 25 cm. In general the sola get deeper downslope, reaching a maximum depth of about 60 to 80 cm. Also in areas which receive runoff and protected areas where there is more effective moisture, the surface of the soils are considerably darker. Lower slopes are generally somewhat finer textured on the surface and with fewer coarse fragments. Slopes within this map unit vary from about 5 to 50%. Because of the very dense till parent material, these soils have restricted permeability. Thus, there are sloughs in the kettles whereas the nearby soils on outwash materials do not have perched water in the kettles.

Associated Map Units

Map units 1, 19, 25, 29, 32, 52, 53 and 58 are found in association with map unit 50. The drumlinoid landforms upon which some of map unit 50 is developed are partially covered by the outwash materials upon which map unit 1 is situated, hence map unit 1 often occurs downslope at slope breaks from map unit 50. Occasionally map unit 50 encroaches upon Knight's Lake and a thin band of map unit 19 is generally found separating map unit 50 from the water. Map units 25, 29 and 32 are found on fans which abut the base of the drumlinoid or morainic landforms upon which map unit 50 is located. Occasionally map units 52 and 58 are found in the tension zone between grassland and forest along the margins of the main Waterton valley. Map unit 53 is found in poorly drained enclosed depressions associated with the morainic landforms of map unit 50.

Competing Map Units and Differentiae

Map unit 1 differs from map unit 50 in that it is developed on coarse outwash materials rather than till. The characteristic very dense, carbonate-cemented C horizon of the soils which characterize map unit 50 is missing in the soils of map unit 1. Map unit 4 is lithic which separates it from map unit 50. Map unit 8 is not developed on morainic landforms, and its soils contain very few cobbles and gravels, both features which distinguish it from map unit 50. The river terrace landforms and alluvial material upon which map unit 17 is developed differentiates it from map unit 50. Map units 52, 53, 54, 55, 57 and 58 are all developed on similar till materials but differ by their

profile morphology. The above map units are classified as Brunisolic, Gleysolic, Regosolic, Gray Luvisols and Dark Gray Luvisols respectively. Map unit 67 is developed on finer textured Continental till rather than the Cordilleran till upon which map unit 50 is developed.

Vegetation

Vegetation associated with this map unit is mainly dryland grasses and shrubs. Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), Danthonia parryi (Parry oat grass) and Lupinus sericeus (Pursh's silky lupine) comprise the most evident flora. Potentilla fruticosa (shrubby cinquefoil) is found dispersed throughout the map unit and comprises about 5% of the ground cover. Shrubby Populus tremuloides (trembling aspen) are found on lower slopes and on the north (lee) side of hills where snow collects and where they are less exposed to wind.

Pedon Description (C105)

Classification: Orthic Black Chernozem (Typic Cryoboroll)

Described by: Gerald Coen.

Date: August 5, 1971.

Location: 3/10 mile west of Knight's Lake about half way along the lake in north-south direction (Fig. 22).

Climate: semiarid continental.

Parent Material: coarse textured, compact, high lime till.

Landform: drumlin.

Slope: 5% across pit, up to 40% in map unit.

Elevation: 4,450 feet ASL.

Relief: estimated maximum of 200 feet.

Aspect: 250 degrees (near top of ridge).

Estimated drainage: well drained.

Water table: probably never within the pedon.

Vegetation: nearly 100% coverage with previously mentioned grasses and shrubs.

Notes: Soil temperature at 50 cm was 14° C. There are quite a few large stones and boulders exposed on the surface of these soils. More surface stones are

evident in the knob and kettle till areas than associated with the drumlins.

The present land use is virgin prairie and erosion is not a problem.

- Ah1 0 to 9 cm; very dark grayish brown (10YR 3/2 m) and dark grayish brown (10YR 4/2 d) gravelly loam; weak, fine granular (fluffy); soft, very friable; common, very fine roots; clear, wavy boundary; about 25% coarse fragments; 2.5 to 10 cm thick.
- Ah2 9 to 15 cm; dark brown (7.5YR 3/2 m) and dark grayish brown (10YR 4.5/2 d) gravelly loam; weak, fine granular and moderate medium subangular blocky; friable, slightly hard; common, very fine roots; clear, wavy boundary; about 25% coarse fragments; 5 to 10 cm. thick.
- Bm 15 to 43 cm; brown (10YR 5/3 m) and pale brown (10YR 6/3 d) gravelly sandy loam to loam; moderate medium subangular blocky; friable, slightly hard; few very fine and fine roots; few discontinuous pores; clear, wavy boundary; about 40% coarse fragments; 20 to 30 cm thick.
- Ck 43 to 61+ cm; light reddish brown (5YR 6/4 d) gravelly loam; massive (brittle); slightly hard (hard in place); few very fine roots to no roots; common fine pores; strong effervescence; about 40% coarse fragments.

COMMENTS:

The very compact till is very difficult to dig when dry and when broken out from the pit the clods shatter.

MAP UNIT NO. 52 (Orthic Eutric Brunisol)

The strong brown soils of this map unit are medium textured with moderate amounts of coarse fragments. They have formed on generally light coloured Cordilleran till. Generally these soils are found in the transition zone between the Luvisolic soils in the eastern portion of the Park, and the Podzolic soils found to the west in the mountain area. Some members of map unit 52 appear to have the brownish characteristics intergrading to Podzolics while other members appear to have grayish colours in the B region intergrading to Luvisolics. In many cases the tills upon which these soils are formed are shallow and some are even shallow enough that lithic variants of the Orthic Brunisol occur. The dense underlying till material offers considerable resistance to percolating water and also offers resistance to water erosion. Map unit 52 is geographically located on the east and west sides of the upper Waterton Lake, along the sides of the lower Cameron Creek Valley and Blakiston Creek Valley, north of Sofa Mountain and the Bellevue Hill and Lakeview Ridge areas.

Associated Map Units

Map units 1, 19, 29, 50, 55, 67, 90R, 91R, 141 and 150 are associated with map unit 52. In major valleys map unit 52 is occasionally found adjacent to the outwash soils characterized by map unit 1. Occasionally map unit 52 adjoins streams or creek bottoms where the deep black soils of map unit 19 are found in association with it. At the lower margins of fans the somewhat poorly to imperfectly drained map unit 29 may abut the till soils of map unit 52. Where the Chernozemic soils of map unit 50 follow up valleys to a considerable elevation there is some encroachment of Pinus flexis (limber pine) on the typical prairie landform and in association with these limber pine, map unit 52 is found. In these cases map unit 52 does not have sufficient Ah to meet the Chernozemic requirement and sometimes shows evidence of eluviation. Map unit 55 is found on the steep and very steep eroded slopes and creek banks associated with most till soils including map unit 52. In the Kesler Lake - Oil Basin area the fine textured Black Chernozemic soils located on tills characterized by map unit 67 are found in association with map unit 52. Where map unit 52 abuts the steep mountain slopes it is found in association with the lithic soils mapped as 90R and 91R and in association with the deep colluvial soils mapped as 141 and 150.

Competing Map Units and Differentiae

Map units 28, 47, and 49 are all similar to map unit 52 in that they are characterized by Brunisolic soils, however they all differ because of their alluvial parent material associated with fans. Map unit 66 is characterized by Brunisolic soils but differs in being finer textured than soils of map unit 52. The Brunisolic soils associated with map unit 150 are found on steep colluvial slopes and should not be difficult to separate from the till soils of map unit 52. Map units 53, 55, 57, 58 and 64 are all found on tills, however, the separations can be made relatively easily if the characteristics of the other map units are noted. Map unit 53 is poorly drained and the mottles in the profile separate it from map unit 52. Soils of map units 57 and 58 have well developed illuvial and eluvial horizons and thus should be relatively easily separated from those of map unit 52 which does not have these horizons. Map unit 67 is characterized by a Chernozemic soil and as such has a deep black surface horizon meeting the requirements of Chernozemic Ah and does not have the browner color of

map unit 52. Soils of map unit 55 are Regosols and do not have any horizon differentiation to provide a Bm characteristic of map unit 52.

Vegetation

Vegetation associated with this map unit is characterized by fairly diverse associations depending upon which areas within the Park the soils are located. The best examples of map unit 52 are located along the east and west shores of upper Waterton lake. Here the vegetation is dominated by 20 to 40 foot tall immature and often overstocked Pinus contorta (lodgepole pine) providing 60 to 80% coverage. Pseudotsuga menziesii (Douglas fir) is found occasionally and in clumps. The understory shrubs are characterized by the association made up of Rubus parviflorus (thimbleberry), Spirea lucida (white meadowsweet), and Berberis repens (creeping mahonia). The herbs are characterized by an association made up of Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed), and Gramineae (grasses). Other areas where map unit 52 is found such as north of Sofa Mountain, northwest of the buffalo paddocks and in the Oil Basin-Cloudy Ridge area have stunted evergreen shrubs such as Pinus Flexilis (limber pine), and stunted Abies lasiocarpa (alpine fir), and shrubby Populus tremuloides (trembling aspen). There are also significant areas of 20 to 40 foot tall Populus tremuloides (trembling aspen) providing 20 to 40% cover. In the latter mentioned areas the understory vegetation includes the understory vegetation previously mention plus Alnus crispa (green alder), Ribes viscosissimum (sticky currant), Amelanchier alnifolia (saskatoon), and Potentilla fruticosa (shrubby cinquefoil). Herbs other than those previously mentioned include Equisetum arvense (common horsetail), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip), and Festuca spp. (fescues).

Pedon Description (C203)

Classification: Orthic Eutric Brunisol (Typic Cryochrept)

Described by: Gerald Coen .

Date: August 27, 1972 .

Location: about $\frac{1}{4}$ mile north and $\frac{1}{4}$ mile west from the Boundary Bay cabin (Fig. 22).

Climate: continental.

Parent Material: light brown medium to coarse textured till materials.

Landform: moraine of varying character depending on the location. The area along the shores of Waterton Lake has a landform which is largely bedrock controlled showing little typical morainic topography. The other areas are by and large more characteristic of the humpy topography associated with moraines.

Slope: 10% in the vicinity of the pedon and from 5 to 40% associated with the map unit.

Elevation: 4500 feet ASL.

Relief: about 500 to 800 feet.

Aspect: about 340 degrees.

Estimated drainage: well drained.

Water table: deep.

Vegetation: 40 - 60% coverage with 30 to 40 foot tall Pinus contorta (lodgepole pine).

This area was harvested for lumber the last of which was taken out in the 1950's.

Rubus parviflorus (thimbleberry) and Symphoricarpos occidentalis (western snowberry) were two of the common shrubs. Herbs included Epilobium angustifolium (fireweed) and Pyrola spp. (wintergreen). Few grasses or mosses were observed.

Notes: The soil temperature at 50 cm was 11.5⁰ C. Stones and rock outcrops were common on the land surface in this map unit and stones were quite evident within the pedon. The soil was in a virgin condition.

L-F 2.5 to 0 cm ; dark brown (7.5YR 3/2 m); moderately decomposed pine needles with many white mycelia; abrupt wavy boundary; 1 to 4 cm thick.

Ah 0 to 2.5 cm; dark brown (7.5YR 3/2 and 4/4 m) gravelly loam; weak fine granular; very friable; plentiful fine roots; too disrupted to see the pores; no clay films; no effervescence; abrupt wavy boundary; 1 to 4 cm thick.

Bf 2.5 to 25 cm ; strong brown (7.5YR 5/6 m) gravelly loam; weak medium subangular blocky; very friable; abundant medium and fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 20%; clear wavy boundary; 20 to 25 cm thick.

C 25 to 76 plus cm ; light brown (7.5YR 6/4 m) gravelly sandy loam; massive; friable (slight brittle tendency); few roots except adjacent to rocks; common very fine pores; no clay films; no effervescence; estimated coarse fragments 30%.

COMMENTS:

The Ah horizon seems to be slightly mixed with the overlying organic Lf horizon and an occasional pocket (1 cm. or less in thickness) of Ae material is evident. Lithic soils, that is soils that are less than 50 cm. deep to bedrock, are an integral part of this map unit. Colour values in the Bm horizons may vary from 4 to 6 and chromas may vary from 4 to 8. Because these soils occupy the position in the landscape between Podzols and Luvisols, in different areas they tend to have characteristics of either, thus some may be redder than the type example quoted and some may be grayer than this example. Also, some Bm horizons may have a tendency towards clay accumulation insufficient to meet the definition of a Bt horizon.

MAP UNIT NO.53 (Orthic Humic Gleysol)

The soils of this map unit are medium and coarse textured with variable amounts of coarse fragments. They have formed on till materials found in depressions or seepage areas. The extent to which poor drainage affects these soils varies considerably, but all are poorly drained enough to fall within the Gleysolic order. Most of these soils have a relatively thick layer of organic material on the surface, thus qualifying as Humic Gleysols. Map unit 53 is geographically located throughout the Park wherever poorly drained soils are found developed on till materials.

Associated Map Units

Map units 19, 32, 50, 57, 64 and 190 are found in association with map unit 53. Occasionally map unit 19 is found on river terraces adjacent to the morainic landforms of map unit 53. The poorly drained soils of map unit 32 sometimes adjoin depressional areas of till upon which map unit 53 is found. Depending on the geographic location within the Park, map units 50, 57 or 64 can be found on the upland moraine associated with the depressional soils of map unit 53. The organic soils of map unit 190 are found at lower elevations in depressional areas adjacent to map unit 53.

Competing Map Units and Differentiae

Map unit 53 is one of the five map units which has as its dominant member a Gleysolic soil. Map unit 53 is the only map unit dominated by Gleysolic soil thus can be differentiated with relative ease from other Gleysolic soils. On occasion, map unit 44 may contain sufficient coarse fragments to allow some confusion with map unit 53, but the characteristic fan-shaped landform of map unit 44 should allow easy separation. Other till soils found on map units such as 52, 55, 57, 58 and 67 differ from map unit 53 by generally steeper slopes and the lack of mottling indicative of poor drainage.

Vegetation

In the western portions of the Park, the vegetation associated with map unit 53 is dominated by 20 to 40% cover with 40 to 60 foot tall stands of Picea glauca (white spruce) and Abies lasiocarpa (alpine fir). The associated understory is dominated by shrubs such as Menziesia ferruginea (false huckleberry), Vaccinium membranaceum (tall bilberry) and Vaccinium scoparium (grouse berry). Associated herbs include Xerophyllum tenax (bear grass), Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow-rue) and Angelica dawsonii (yellow angelica). East of Waterton Lakes, the vegetation associated with map unit 53 is dominated by shrubs such as Salix spp. (willows) and Alnus tenuifolia (river alder). Associated herbs include Petasites sagittatus (arrow-leaved coltsfoot), Carex flava, Carex aquatilis (water sedge) and Carex rostrata (beaked sedge).

Pedon Description (C204)

Classification: Orthic Humic Gleysol (Aeric Humic Cryaquept)

Described by: Gerald Coen.

Date: August 28, 1972.

Location: about 100 yards south of Little Cameron Lake and 200 yards east of Cameron Creek.

Climate: continental.

Parent Material: relatively coarse Cordilleran till.

Landform: relatively low relief moraine.

Slope: 3% in the vicinity of the pedon and 0 to 10% on the map unit.

Elevation: 4450 feet ASL.

Relief: about 100 feet.

Aspect: 150 degrees.

Estimated drainage: very poorly drained.

Water table: about 8 cm below the ground surface.

Vegetation: 20 to 30% cover with 40 to 60 foot tall Picea glauca (white spruce) and/or Picea engelmannii (Engelmann spruce) were the dominant tree species observed. Some Abies lasiocarpa (alpine fir) were noted in the understory. The main shrub was Menziesia ferruginea (false huckleberry). Herbs included Streptopus amplexifolius (twisted stock), Thalictrum venulosum (veiny meadow rue) and Pyrola sp. (wintergreen). Few grasses were observed. Mosses provided almost a complete cover of the ground surface.

Notes: The soil temperature at 50 cm was 9° C. There were few stones on the surface and relatively common stones within the pedon. The soil was in a virgin condition.

- L 1 to 0 cm ; dark brown (7.5YR 3/2 m) slightly decomposed moss layer; plentiful fine roots; abrupt wavy boundary; 0 to 2.5 cm thick.
- Ahg 0 to 9 cm ; very dark gray (5YR 3/1 m) loam; moderate medium granular; friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 5%; clear wavy boundary; 5 to 15 cm thick.
- Bg 9 to 18 cm ; dark reddish brown (5YR 3/2 m) loam with common medium distinct dark red (2.5YR 3/6 m) mottles; moderate medium subangular blocky; friable; few fine roots; very few medium pores; no clay films; no effervescence; estimated coarse fragments 5%; clear wavy boundary; 8 to 18 cm thick.
- BCg 18 to 25 cm ; dark brown (5YR 3/4 m) mottles; weak fine subangular blocky (structure badly distorted and difficult to observe); friable; very few fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 50%; clear wavy boundary; 5 to 10 cm thick.

Cg 25 to 50 plus cm ; reddish gray (5YR 5/2 m) gravelly fine sandy loam with many medium distinct yellowish red (5YR 5/8 m) and many medium prominent light olive gray (5Y 6/2 m) mottles; massive; friable with some brittle tendency; very few roots; very few pores; no clay films; no effervescence; estimated coarse fragments 20%.

COMMENTS:

There are occasionally blotches of Ahg horizon material found within the upper part of the Bg horizon. The area where the above pedon is found is a seepage area. In this vicinity there are several areas of peaty-phase Gleysols. There does not appear to be any Rego Gleysols in the Cameron Lake area. Map unit 53 is also found associated with depressional areas or any other areas which are inundated with water for a considerable period of time and have a till parent material.

MAP UNIT NO. 54 (Orthic Regosol)

The soils of this map unit are medium to coarse textured and often have many coarse fragments, especially of cobble and boulder sizes. They have formed on the local lateral and end moraines bordering and closing the cirques at high elevations (around 6500 feet ASL). The boulders show very little rounding and the tills are very heterogeneous, strongly reflecting the adjacent rock outcrops. These soils have rock exposed on the surface which appears similar to "pattern ground" found associated with soils having extensive frost action. Map unit 54 is geographically located throughout the western portion of the Park in the cirque basins at higher elevations.

Associated Map Units

Map units 48, 64, 141, 142, 150, as well as Talus and Rock, are found associated with map unit 54. Map unit 48 is found on the forested fans adjacent to some areas of map unit 54. Map unit 64 sometimes has a common boundary with map unit 54 in places where vegetation and landscape position favour Podzolic development rather than the Regosolic development found in 54. Map units 141, 142 and 150 are found on the colluvial slopes which may be impinging on the moraine upon which map unit 54 is found. In the small cirque basins where map unit 54 is generally found, steep rock cliffs and talus are very common.

Competing Map Units and Differentiae

Soils of both map units 27 and 48 are Regosolic with abundant coarse fragments but can be easily distinguished from map unit 54 by their typical fan landform and alluvial parent material. Map unit 55 is also characterized by stony Regosolic soils and is developed on till but does not show the turfy Ah development characteristic of soils of map unit 54. Map unit 53 is located in depressions where excess water is standing for significant periods of the year, thus characterized by soils classed as Gleysolics as opposed to Regosolics for map unit 54. Map unit 52 shows slight profile development characteristic of Brunisolics and can be separated from map unit 54 in this way. Soils of map units 57 and 61 are Gray Luvisols, thus easily separated from map unit 54. Map unit 61 is also very stony and bouldery but the soils do not have the well developed turfy Ah. Map unit 64 is characterized by Podzolics and thus the bright reddish Bf provides an easy means of separation from map unit 54.

Vegetation

Vegetation associated with this map unit is characteristically composed of less than 20 foot tall Abies lasiocarpa (alpine fir) providing about 20 to 40% cover. Larix lyallii (alpine larch) is a common component of the forest cover on this western part of the Park. Other shrub species such as Juniperus communis (ground juniper) and Juniperus horizontalis (creeping juniper) are common. Understory and open areas are vegetated with alpine species including Gramineae (grasses), Heuchera cylindrica (alum root), Luzula glabrata (wood rush), and Mitella breweri (bishop's cap).

Pedon Description (C174)

Classification: Orthic Regosol ("Alpine") (Typic Cryorthent¹)

Described by: Gerald Coen and W. D. Holland.

Date: July 31, 1972.

Location: Between the trail and the north shore of lower Carthew Lakes (Fig. 22).

Climate: continental.

¹ The mean annual temperature may be less than 0° C. in which case the classification should be Pergelic Cryorthent.

Parent Material: Bouldery and stony till.

Landform: end and lateral or medial moraines near cirque basins.

Slope: 12% in the vicinity of the pedon and 5 to 20% on the landform.

Elevation: 7100 feet ASL.

Relief: about 50 feet.

Aspect: about 10 degrees.

Estimated drainage: well drained.

Water table: greater than 75 cm from the surface.

Vegetation: Abies lasiocarpa (alpine fir) and Larix lyallii (alpine larch) with a krummholz habit. Also observed were Arnica sp., Luzula glabrata (wood rush), Valerina sitchensis (wild heliotrope) and Erythronium grandiflorum (glacier lily).

Notes: There were very many stones and boulders, both within the solum and on the soil surface. The soils was in a virgin condition.

Ah 0 to 4 cm ; very dark grayish brown (10YR 3/2 m) loam; weak fine granular; friable; abundant very fine and micro roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 15%; clear, wavy boundary; 1.5 to 8 cm thick. The Ah is very turfy and appears to have a low bulk density.

C 4 to 38 plus cm ; reddish brown (5YR 4/4 m) gravelly loam; structureless or massive; very friable; abundant fine roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 50%.

MAP UNIT NO. 55 (Orthic Regosol)

The soils of this map unit are medium and coarse textured with common cobbles and boulders within the solum. They have formed on medium textured calcareous tills which are actively eroding resulting in Regosolic profile development. This map unit is generally associated with steep stream channel walls and occasionally on steep till slopes. Map unit 55 has also been mapped on less steep slopes where Regosolic profile development occurs because of landscape position or other factors resulting in unstable soil conditions. Texture and coarse fragments in these soils is quite variable and strongly related to the parent tills in which they develop. Geographically these soils are located throughout the Park.

Associated Map Units

Map units 1, 11, 20, 25, 36, 41, 50, 52, 57, 58, 64, 100, 101, 156 and Rock are found associated with map unit 55. Map unit 1 is found on grassy, gravelly outwash material at about the same elevation as the associated map unit 55. Map units 11 and 20 are found at the bottom of stream courses adjacent to the steeper slopes upon which map unit 55 is found. Map units 25, 36 and 41 are found on fan shaped landforms generally below and/or adjacent to map unit 55. Map units 50, 52, 57, 58 and 64 are associated with map unit 55 in varying portions of the Park. They are at approximately the same elevations as the adjacent map unit 55. Map units 100 and 101 are found randomly associated with map unit 55 depending on accidents of slump. Map unit 156 may at times adjoin map unit 55 generally at the upper margin of the latter map unit. Rock sometimes adjoins map unit 55 where steep cliffs are found above the till slopes.

Competing Map Units and Differentiae

Map unit 55 is the only map unit within the Park found on till which is characterized by soils which are mainly Regosols. Map unit 52 can be distinguished from map unit 55 by the Brunisolic development in the B region of the profile. Map unit 61 has considerably more and larger boulders than map unit 55 and in stable, somewhat sheltered areas, has Luvisolic development. There are many other map units which are characterized by Regosol Soils but none are developed on tills and thus separating the map units with lower numbers than 55 from map unit 55 is not difficult. Map units 141 and 142 differ from map unit 55 in that the soils do not contain free lime and they are much looser with a more consistent fine gravel assortment of coarse fragments.

Vegetation

There is no particular vegetation or group of vegetation species which can be thought of as being associated with map unit 55. In the eastern part of the Park around the Belly River Populus tremuloides (trembling aspen) and Picea glauca (white spruce) are predominant. In the Belly River area there are also some map units which are not forested. In the Sofa Creek and adjacent to the creek itself fairly good stands of Picea glauca (white spruce) and Pseudotsuga menziesii (Douglas fir) are common. In the more westerly portion of the Park in the Cameron Lake and boundary region Abies lasiocarpa

(alpine fir) and Pinus albicaulis (white-bark pine) are also associated with map unit 55. In the Horseshoe Basin and Oil Basin areas Pinus contorta (lodgepole pine), Populus tremuloides (trembling aspen) and Picea glauca (white spruce) are common. The understory vegetation is very variable depending on the region of the Park in which map unit 55 is found. Species commonly found associated with the trees will be found in the different regions as described earlier.

Pedon Description (C212)

Classification: Orthic Regosol (Typic Cryorthent)

Described by: Gerald Coen.

Date: August 30, 1972.

Location: near the top of the south bank of Galway Creek about 1 mile west of where it leaves the Park (Fig.22).

Climate: continental .

Parent Material: calcareous till.

Landform: steep creek bank.

Slope: 65% in the vicinity of the pedon and ranging from 50 to 70% associated with the map unit.

Elevation: about 4,950 feet ASL.

Relief: about 200 feet.

Aspect: 0 degrees.

Estimated drainage: well drained.

Water table: probably never within 90 cm of the surface.

Vegetation: the dominant vegetation at this site was Pseudotsuga menziesii (Douglas fir) with some Picea glauca (white spruce) and Populus tremuloides (trembling aspen). Shrubs noted included Lonicera involucrata (bracted honeysuckle), Symphoricarpos occidentalis (western snowberry) and some Acer glabrum (mountain maple). Herbs noted included Disporum oreganum and Disporum trachycarpum (fairybells), Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Geranium viscosissimum (sticky purple geranium) and Epilobium angustifolium (fireweed). Mosses were fairly common but few grasses were noted.

Notes: The soil temperature at 50 cm. was 10° C. There were few stones on the surface but they were relatively common within the pedon. The soil was in a virgin condition.

- L-F 2.5 to 0 cm very dark grayish brown (10YR 3/2 m) partially decomposed leaf and needle litter; few fine roots; abrupt wavy boundary; 0 to 5 cm thick.
- Ck1 0 to 15 cm ; reddish brown (5YR 4/3 m) sandy loam; single grain; loose; plentiful fine roots; no pores; no clay films; slight effervescence; estimated coarse fragments 10%; clear wavy boundary; 10 to 18 cm thick.
- Ck2 15 to 61 cm ; reddish brown (5YR 5/3 m) gravelly sandy loam; massive and single grain; friable and loose, brittle sometimes; plentiful fine roots; few fine pores; no clay films; moderate effervescence; estimated coarse fragments 45%; gradual wavy boundary; 41 to 50 cm thick.
- Ck3 61 to 76 cm ; reddish brown (5YR 5/3 m) gravelly sandy loam to gravelly silt loam; massive; firm, brittle tendency; very few fine roots; few fine pores; no clay films; moderate effervescence; estimated coarse fragments 45%; gradual wavy boundary; 5 to 20 cm thick.
- Ck4 76 to 100 plus cm ; pinkish gray (7.5YR 6/2 m) gravelly sandy loam; single grain; loose; few fine roots; no pores; no clay films; moderate to strong effervescence; estimated coarse fragments 45%.

COMMENTS:

The Ck1 is probably the result of the ever present downslope creep. The profile seems to be relatively uniform except for occasional pockets of cementation around the larger rocks. There is considerable variability within this map unit. Its major uniformity is steepness of slope causing unstable conditions resulting in the formation of Regosols.

MAP UNIT NO. 57 (Orthic Gray Luvisol)

The soils of this map unit are mainly coarse to medium textured with many cobbles and boulders within the solum. They have formed on dense, pinkish and brown calcareous till. The fine gravels are comprised dominantly of green argillites and sandstones with some limestone or dolomitic limestone. Red argillites are fairly common as well and may, in fact, in some pedons be the major coarse fragment. The parent material is very dense and brittle in places, providing a very impermeable layer. The Bt is also sufficiently developed to impede percolation. In general these soils are well drained. This map

unit is generally confined to the more prominent glaciated topographic highs. The landforms are characterized by generally long simple slopes and thus there are not too many inclusions of Gleysols. Soils on top of the ridges and on steeper sideslopes are generally somewhat shallower than those on the lower slopes. Their geographic location is mainly west of the Blood Timber Limit and north of Sofa Mountain and east of the Belly River. The soils of this map unit are generally finer textured on the east side of the Belly River, because of the occurrence of soft, fine textured bedrock from which they derive part of their materials. The till in this area is also less dense than further west.

Associated Map Units

Map units 36, 37, 38, 39, 41, 50, 52, 53, 55, 100, 101 and 190 are found associated with map unit 57. Map unit 36 is found on the east Waterton Valley side, generally at a lower elevation than map unit 57. Map unit 37 is found on poorly defined fan areas adjacent to the lower slopes of the till covered hills upon which map unit 57 is found. Map units 38 and 39 are found on fan and fan-like landforms which adjoin the upper slopes of the till covered landforms upon which map unit 57 is located. Map unit 41 is found east of the Belly River in shallow draws running through areas mapped as map unit 57, where the till material has become covered with a thin deposit of slope-wash. Map unit 50 is found occasionally on grasslands adjoining the wooded landscape of map unit 57. Map unit 52 is generally found in the transition areas between the grasslands of map unit 50 and the forests of map unit 57. Map unit 53 is found in some poorly drained depressions in the till mantled landform of map unit 57. Map unit 55 is found on steep riverbanks and other steep slopes in the till materials upon which map unit 57 is located. In the Belly River area a thin mantle of till covers very fine textured soft, dark coloured shale bedrock. Where slumps have removed the tillmantle and exposed the shale material map unit 100 and 107 are found in abrupt contact with map unit 57. Occasionally small poorly drained depressions in the till landform may have organic deposits which result in the intimate association of map unit 57 with map unit 190.

Competing Map Units and Differentiae

Map unit 57 is the only unit characterized by Orthic Gray Luvisol soils developed on till which was mapped in the Park and thus is one of the most easily recognized map units.

Map units 50, 52, 53, 54, 55, 58, 61 and 64 are all developed on pinkish cordilleran till but are differentiated by their distinctive profile development. Map unit 46 is characterized by Orthic Gray Luvisol soils but is differentiated because of the fan shaped landforms upon which it is mapped. Map unit 102 is also characterized by Orthic Gray Luvisol soils but is developed on stone-free fine textured materials. The Orthic Gray Luvisol soils of map unit 160 are differentiated on the basis of being developed on colluvial materials.

Vegetation

Vegetation characteristic of this map unit is dominantly Pinus contorta (lodgepole pine). The height is around 40 to 60 feet and the canopy density is about 20 to 40%. The stand condition is thrifty mature trees with occasional windfall. The lower vegetation consists of 30% cover of the shrub association of Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet) and Berberis repens (creeping mahonia), and 70% coverage of an herb association consisting of Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), and Epilobium angustifolium (fireweed).

Pedon Description (C107)

Classification: Orthic Gray Luvisol (Typic Cryoboralf)

Described by: Gerald Coen.

Date: August 6, 1971.

Location: about $\frac{1}{4}$ mile north of Chief Mountain Fire Tower, along cutline (Fig.22).

Climate: continental.

Parent Material: compact, calcareous, pinkish till (no evidence of shield erratics).

Landform: dissected till plain,

Slope: 8% in the vicinity of the pedon and up to 60% in the area.

Elevation: about 5,200 feet ASL.

Relief: 400 to 500 feet;

Aspect: about 310 degrees.

Estimated Drainage: well drained.

Water Table: possibly perched within the pedon in the spring.

Vegetation: About 60 to 70% of the ground is covered with Pinus contorta (lodgepole pine). The lodgepole pine is of a uniform height of about 25 to 30 feet. There are a few Pseudotsuga menziesii (Douglas fir) in the understory. There are few understory plants at this site.

Notes: Soil temperature was 9° C. at 50 cm. Surface stones in the area are variable but quite evident, in general. The present soil is virgin and land use is native regeneration of tree species after fire.

- L-F** 2.5 to 0 cm ; dark brown (10YR 3/3 m) undecomposed organic matter; few fine roots; abrupt smooth boundary; 1.5 to 4 cm thick.
- Ae1** 0 to 8 cm ; light grayish brown (10YR 6/2 d) and grayish brown (10YR 5/2 m) gravelly very fine sandy loam; weak fine platy; very friable, soft; few fine and many medium roots; common fine pores; estimated 20% coarse fragments; clear, wavy boundary; 5 to 10 cm thick.
- Ae2** 8 to 14 cm ; pale brown (10YR 6/3 d) and light yellowish brown (10YR 6/4 m) gravelly silt loam; moderate medium subangular blocky macro structure and weak medium platy meso structure; very friable, soft; many medium roots; common fine pores; estimated 20% coarse fragments; clear, wavy boundary; 2.5 to 13 cm thick.
- Bt1** 14 to 44.5 cm ; brown (7.5YR 5/4 m) grading with depth to strong brown (7.5YR 5/6 m) gravelly silty clay loam; moderate medium subangular blocky; firm; plentiful fine and medium roots; few medium pores; many very thin clay films; estimated 40% coarse fragments; gradual wavy boundary; 23 to 36 cm thick.
- Bt2** 44.5 to 66 cm ; strong brown (7.5YR 5/6 m) gravelly silty clay loam; moderate medium subangular blocky; firm; few fine roots; few medium pores; many very thin clay films; estimated 40% coarse fragments; clear, wavy boundary; 18 to 25 cm thick.
- Ck** 66 to 81 plus cm ; brown (10YR 5/3 m) gravelly silt loam; massive; firm; few to no roots; few fine pores; few thin clay films; slight effervescence; estimated 40% coarse fragments.

COMMENTS:

The till is very hard to fracture in place, although once fractured out it can be broken relatively easily with the fingers. It is quite brittle even when moist. It also appears to have quite a high bulk density. There are no signs of impeded internal drainage.

MAP UNIT NO. 58 (Dark Gray Luvisol)

The soils of this map unit are fine and medium textured with relatively few coarse fragments. They have formed on the dark coloured tills which appear to have been associated with the continental ice sheet and which are quite fine textured with few coarse fragments. However, some areas identified as map unit 58 are probably associated with tills having a Cordilleran origin. The aspen forests under which these soils are generally found are adjacent to grassland areas and associated Chernozemic soils. The forest vegetation appears to modify the genetic developmental sequence resulting in the formation of eluvial horizons. Extensive earthworm activity resulting in the mixing of the L-H and Ah horizons with eluvial horizons causes the typical Dark Gray Luvisol to take on a Gray Brown Luvisol appearance. Map unit 58 is geographically located north of the registration office and in the Oil Basin cabin area.

Associated Map Units

Map units 36, 50, 53, 57 and 67 are found in association with map unit 58. Map unit 36 is found on associated sandy soils. Map unit 50 is found on grassland soils associated with map unit 58. Map unit 53 is located in associated wet areas. Map unit 57 is generally found at higher elevations and does not exhibit the typical earthworm mixing of map unit 58. Map unit 67 is associated with map unit 58 in the Oil Basin area but does not exhibit the eluvial characteristics of the latter.

Competing Map Units and Differentiae

Soils of map unit 36 often have similar mixing of the Ah and Ae horizons but do not have as high a stone content as does map unit 58 and are considerably coarser textured. Map units 50, 57 and 67 are similar to map unit 58 in that they are all formed on tills. However, map unit 50 is characterized by Chernozemic soils developed on grassland. Map unit 57 is characterized by a well developed Gray Luvisol developed under coniferous forests. Map unit 67 is often similar to map unit 58 but does not have evidence of degradation in the A horizon.

Vegetation

Vegetation associated with this map unit is characterized by immature stands of Populus tremuloides (trembling aspen) 20 to 40 feet tall and having a canopy density

of 20 to 40% and sometimes 40 to 60%. The understory shrubs are characterized by an association made up of Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose) and Rubus parviflorus (thimbleberry). The herbs are characterized by association made up of Gramineae (grasses), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip) and Thalictrum venulosum (veiny meadow rue).

Pedon Description (C140)

Classification: Dark Gray Luvisol (Typic Cryboralf).¹

Described by: Gerald Coen.

Date: June 7th, 1972.

Location: east of the Waterton River and about 1 mile east of the Junction of Highways 5 and 6 and then $\frac{1}{2}$ mile north along the east Park boundary (Fig.22).

Climate: continental.

Parent Material: gray to dark gray fairly fine textured (silty clay loam)till.

Landform: moraine with long, not too steep slopes.

Slope: ranges from 4% across the pit to up to 10% in the area.

Elevation: 4,300 feet ASL.

Relief: about 50 feet on the landform.

Aspect: 280 degrees.

Estimated drainage: well drained.

Water table: below the pedon and probably rarely within three feet of the surface.

Vegetation: about 30% cover with Populus tremuloides (trembling aspen) 30 to 40 feet high. Amelanchier alnifolia (saskatoon) is the most common shrub with others including Symphoricarpos occidentalis (western snowberry), Berberis repens (creeping mahonia), and Rosa acicularis (prickly rose). Common herbs include Hedysarum sulphurescens (yellow hedysarum), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed), Geranium viscosissimum (sticky purple geranium) and Heracleum lanatum (cow parsnip).

¹

The classification of these soils is somewhat indefinite because there is no distinct Ah or Ae horizon, only fragments of either mixed in an Ae-like matrix all of which is designated Ahe in the Pedon description.

Notes: The soil temperature at 50 cm was 8° C. There were few stones on the soil surface or within the pedon. The soil was in a virgin condition.

- L-H 5 to 0 cm ; very dark grayish brown (10YR 3/2 m); relatively undecomposed organic matter with few mycelia; abrupt smooth boundary, 2.5 to 8 cm thick.
- Ahe 0 to 15 cm ; grayish brown (10YR 5/2 m) and light gray (10YR 7/2 d) silt loam; moderate, coarse, platy; friable; abundant medium and plentiful very fine roots; many very fine pores; no clay films; no effervescence; estimated coarse fragments 5%; clear smooth boundary; 10 to 18 cm thick.
- Bt1 15 to 30 cm ; yellowish brown (10YR 5/4 m) silty clay loam with blotches of brownish yellow (10YR 6/6 m); moderate medium subangular blocky; friable; plentiful fine roots; common, very fine pores; many moderately thick clay films; no effervescence; estimated coarse fragments 5%, clear wavy boundary; 15 to 20 cm thick.
- Bt2 30 to 50 cm ; yellowish brown (10YR 5/4 m) silty clay loam; moderate medium subangular blocky; friable; few fine roots; common very fine and medium pores; continuous moderately thick clay films in ped interiors and continuous fine clay films on ped surfaces; no effervescence; estimated coarse fragments 5%; clear smooth boundary; 15 to 20 cm thick.
- Ck1 50 to 64 cm ; dark grayish brown (2.5Y 4/2 m) silt loam; massive; friable; plentiful very fine roots; common very fine pores; clay films not observed; moderate effervescence; estimated coarse fragments 7%; gradual wavy boundary; 10 to 18 cm thick.
- Ck2 64 to 125 plus cm ; pale olive (5Y 6/3 m) silt loam; platy, (resulting from weathering rock); friable; plentiful medium roots; many very fine pores; no clay films; strong effervescence; estimated coarse fragments 5%.

COMMENTS:

Earthworms were observed to be very active in the pedon particularly in mixing what appears to be Ah and Ae horizons to give a composite Ahe horizon. Also krotovinas indicating a rodent burrow were observed.

MAP UNIT NO. 61 (Orthic Gray Luvisols and Orthic Regosols)

The soils of this map unit are medium to coarse textured with very many gravels, cobbles and boulders both within the pedon and on the soil surface. They have formed on Cordilleran till which is comprised of materials carried only very short distances.

Thus, the boulders and gravels are only slightly rounded. Many examples of this map unit are found on exposed areas and the vegetation is often not continuous over the landscape. Patches of bare soil with a continuous gravel sized coating of stones is a common occurrence. In these latter areas there is often no Ae horizon but simply a B or Bt horizon. In areas covered with shrubby and mossy vegetation the Ae is generally reasonably well developed and has a Bt below it giving the classification of Orthic Luvisol. Map unit 61 is geographically located at the base of the northeast corner of Sofa Mountain and occasionally in the Horseshoe Basin area.

Associated Map Units

Map units 46, 52, 55, 57, 100, 141 Talus and Rock are found associated with map unit 61. Map unit 46 is found associated with map unit 61 on the adjacent fans. Map unit 52 is found on moraine landforms associated with map unit 61 but does not exhibit the typical Gray Luvisol character and is generally at slightly lower elevations. Map unit 55 is found on the very steep slopes associated with map unit 61 where the erosion keeps exposing the till parent material. Map unit 57 is a Gray Luvisol soil found associated with map unit 61 on the till materials which generally have been transported somewhat further and hence are downslope. Map units 100 and 101 are found associated with map unit 61 on associated exposed weathered shales. Where colluvial material covers the moraine of map unit 61, map unit 141 and 142 are found. Rock and Talus are commonly found delineating the upslope extent of the morainic materials of map unit 61.

Competing Map Units and Differentiae

Map unit 61 is found on the morainic landforms which serve as a criterion for separation from many other map units. Occasionally map units 141 and 142 may be difficult to distinguish from map unit 61 but the continuity of the slope and the loose coarse character of the material in the former should allow separation. Map unit 64 differs from 61 by having soils with very distinctive brownish Bf horizons. Map unit 57 can be distinguished from map unit 61 by fewer boulders, gravels and cobbles as well as the lack of eroded patches. The B region of the soils of map unit 52 is generally

redder than the B region in map unit 61. Map unit 52 also does not have the high content of gravels, cobbles and boulders of map unit 61. Soils of map unit 55 are Regosolic in character and do not contain the very high content of gravels, cobbles and boulders associated with map unit 61.

Vegetation

Vegetation associated with this map unit is characterized by 20 to 40% cover with 20 to 40 foot tall Abies lasiocarpa (alpine fir), Picea glauca (white spruce) and/or Picea engelmannii (Engelmann spruce). In some areas Pinus flexilis (limber pine), Abies lasiocarpa (alpine fir) and Pseudotsuga menziesii (Douglas fir) comprise a significant proportion of the vegetation less than 10 feet tall. Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet) and Berberis repens (creeping mahonia) are significant members of the shrub layer. Dominant herbs include Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed), and Gramineae (grasses).

Pedon Description (C192)

Classification: Orthic Gray Luvisol (Typic Cryoboralf).

Described by: Gerald Coen.

Date: August 22, 1972.

Location: at the base of the northeast corner of Sofa Mountain (Fig.22).

Climate: continental.

Parent Material: stony medium and coarse textured local till.

Landform: moraine.

Slope: 15% in the vicinity of the pedon and ranging from 10 to 60% in the map unit.

Elevation: 5,600 feet ASL.

Relief: about 500 feet.

Aspect: 15 degrees.

Estimated drainage: well drained.

Water Table: probably rarely within 90 cm of the surface.

Vegetation: Abies lasiocarpa (alpine fir) and Pinus flexilis (limber pine) provided about 20% cover with shrubby trees less than 20 feet high. Arctostaphylos uva-ursi (kinnickinnick), Juniperus horizontalis (creeping juniper) and

Shepherdia canadensis (Canadian buffalo-berry) comprised the dominant shrubs. Herbs were characterized by Potentilla fruticosa (shrubby cinquefoil) and Castilleja miniata (common red paintbrush). Few grasses or mosses were evident. Bare patches of gravel covered soils were reasonably common.

Notes: The soil temperature at 50 cm was 13° C. There were abundant stones, cobbles and gravels both on the soil surface and within the pedon. Rock outcrops are prevalent in the area. The soil was in a virgin condition.

- L 1.5 to 0 cm ; black (10YR 2/1 m) slightly decomposed leaves; abrupt wavy boundary; 0 to 5 cm thick.
- Ae 0 to 5 cm ; brown (10YR 5/3 m) gravelly silt loam; moderate fine granular with some evidence of platy tendency; friable; common fine and coarse roots; many fine pores; no clay films; no effervescence; estimated coarse fragments 50%; clear wavy boundary; 0 to 10 cm thick.
- Bt 5 to 23 cm ; yellowish brown (10YR 5/6 m) very gravelly silty clay loam with brownish yellow (10YR 6/6 m) blotches; weak large subangular blocky breaking to moderate fine granular; friable; common medium roots; many fine pores; few very thin clay films; no effervescence; estimated coarse fragments 80%; clear wavy boundary; 13 to 20 cm thick.
- C 23 to 50 plus cm ; pale brown (10YR 6/3 m) very gravelly silt loam to gravelly sandy loam; single grain; friable; few roots; pores not observed; no clay films; weak effervescence probably associated with sand grain size materials; estimated coarse fragments 80%.

COMMENTS:

Where there is a stone pavement-like layer of gravel sized stones and essentially a bare mineral surface no Ae is evident. Wind erosion appears to play a significant role in the formation of these bare patches of mineral soil.

MAP UNIT NO.64. (Orthic Humo-Ferric Podzol)

The soils of this map unit generally have finer textures (SiL) in the upper 45 cm and coarser textures (SL) below this depth. The texture break appears to result from surficial post pleistocene loess and/or post pleistocene volcanic ash deposits. There has,

however, been extensive mixing of the underlying till with the overlying finer textured deposit so that stones are found throughout the upper material as well. The bulk density of the silty surficial deposit is much less than the till below which will greatly influence the response of these soils to any superimposed use. In general, these soils are found at elevations greater than 5000 feet ASL and far enough west into the mountains that there is a significant increase in precipitation relative to the prairies at lower elevations. As a result they have the most distinct horizons of any soils in the Park. The distinct ashy horizon near the surface and the bright reddish horizon below are distinctive for this map unit. Map unit 64 is geographically located near the western boundary of the Park.

Associated Map Units

Map units 53 and 156 are found associated with map unit 64. Map unit 156 is found on fairly steep slopes of colluvial material and may have less profile development. Map unit 53 is characterized by poorly drained soils found in depressions and areas where water collects. They are found on till material.

Competing Map Units and Differentiae

Map unit 64 can be separated from most other map units in the Park because the major soil has a very red (5YR hue or redder) B horizon. Map unit 156 is an exception in that it also has a reddish B horizon but it is found on steep colluvial slopes. Map unit 57 is found on till but differs in that it is characterized by soils that have a textural B horizon rather than the "mellow" reddish B horizon of map unit 64.

Vegetation

Vegetation characteristic of this map unit is quite variable changing with both elevation and stand history. Except for areas of blowdown or burn there is generally a good cover of large trees. At the highest elevations where these soils have been mapped (6,500 feet ASL) 0 to 20% coverage of 80 to 100 foot tall Abies lasiocarpa (alpine fir) and Larix lyallii (alpine larch) is often encountered. The understory vegetation at these high elevations is comprised of a shrub association providing about 40% coverage with Menziesia ferruginea (false huckleberry), Vaccinium membranaceum (tall bilberry) and Vaccinium scoparium (grouse berry) and of a herb association providing about 60% coverage with Luzula glabrata (wood rush), Arnica spp. (arnica),

Mitella breweri (bishop's cap) and Xerophyllum tenax (bear grass). Alpine fir is common to all the areas mapped as map unit 64. There are varying amounts of Pinus albicaulis (whitebark pine), Pinus contorta (lodgepole pine) as well as Picea glauca (white spruce), and Picea engelmannii (Engelmann spruce). The stands are generally mature, 40 to 100 feet tall and provide less than 60% cover. The understory vegetation is generally similar varying mainly in amount of coverage provided by the herb and shrub associations. The main shrubs are the same as the above. The main herbs are Xerophyllum tenax (bear grass) and Arnica cordifolia (heart-leaved arnica).

Pedon Description (C139)

Classification: Orthic Humo-Ferric Podzol (Typic Cryorthod)¹.

Described by: W. D. Holland and Gerald Coen.

Date: September 27, 1971.

Location: about 100 yards west of Cameron Lake and about 100 yards south of the northwest corner of the lake (Fig.22).

Climate: continental.

Parent Material: there are probably two parent materials, the upper part of the solum being developed on a silt loam surficial material and the lower solum being developed on sandy loam till.

Landform: glaciated mountain side.

Slope: ranges from 20% to 55% and is about 12% across the face of the pit.

Elevation: about 5500 feet ASL.

Relief: about 500 feet or more.

Aspect: 90degrees.

Estimated drainage: well drained.

Water table: probably below the solum throughout the year.

Vegetation: about 10% coverage with Abies lasiocarpa (alpine fir) and 25% coverage with Picea glauca (white spruce). There are many fallen and rotting trees in the area. Regeneration is mainly alpine fir. Shrubs evident in the vicinity of the pit were Vaccinium membranaceum (tall bilberry), Menziesia ferruginea,

¹

The classification of soils into the Spodosol Order in the American Classification System is tentative.

(false huckleberry) and Sorbus spp. (mountain ash). Herbs include Arnica spp., Xerophyllum tenax (bear grass), Petasites spp. (coltsfoot) and Pyrola spp. (winter-green). A few grassy and mossy plants were observed.

Notes: The soil temperature at 50 cm. was 4° C. There were some stones evident on the surface and many within and below the solum. The soil was in a virgin condition.

- L-H 2.5 to 0 cm ; very dark grayish brown (10YR 3/2 d) slightly decomposed and undecomposed organic material.
- Ae 0 to 2.5 cm ; gray (10YR 4/1 m) silt loam; moderate coarse platy; friable; plentiful coarse, fine and medium roots; common fine and very fine pores; estimated coarse fragments less than 5%; abrupt, discontinuous boundary; 0 to 10 cm thick.
- Bf1 2.5 to 13 cm ; dark reddish brown (5YR 3/3 m) and dark reddish brown to dark red (2.5YR 3/4 to 3/6 m) gravelly loam; weak medium subangular blocky; friable; plentiful medium and coarse roots; common medium pores; estimated coarse fragments 40 to 50%; clear wavy boundary; 2.5 to 10 cm thick.
- Bf2 13 to 23 cm ; yellowish brown (10YR 5/6 m) gravelly loam; coarse weak subangular blocky; friable; plentiful medium and coarse roots; estimated coarse fragments 40 to 50%; clear, wavy boundary; 8 to 25 cm thick.
- C1 28 to 71 cm ; yellowish brown (10YR 5/4 m) very gravelly loam to gravelly sandy loam; massive; friable, brittle; few medium roots; few fine pores; estimated coarse fragments 50 to 60%; gradual, wavy boundary; 41 to 46 cm thick.
- C2 71 to 97 plus cm ; yellowish brown (10YR 5/4 m) very gravelly sandy loam; massive; friable, brittle; few fine pores; estimated coarse fragments 50 to 60%.

COMMENTS:

The Ae horizon is somewhat discontinuous probably as a result of tree throw causing disruption of the soil surface. The C1 and C2 horizons are quite firm in place and brittle when moist even though once removed from the pit clods are friable.

MAP UNIT NO. 66 (Orthic Eutric Brunisol)

The soils of this map unit are fine textured with moderate amounts of coarse fragments. They have formed on a thin mantle of continental till, having a bedrock controlled landform. Occasional rock outcroppings can be seen throughout the map

unit. In general, the till mantle is thick enough that the soils are only occasionally lithic. However, the shallow depth to bedrock results in considerably more coarse fragments in these soils than in the associated soils on Continental tills. Regosolic soils are a common inclusion in this map unit. Map unit 66 is geographically located in the Lakeview Ridge area.

Associated Map Units

Map units 58, 61, 101, 141, 142, Rock and Talus are found in association with map unit 66. Map unit 58 is generally found down slope from map unit 66 in the draws and swales where the till is somewhat thicker to bedrock. Map unit 61 is found at higher elevations where the contact between the till and the mountain front itself occurs. Here very stony, Gray Luvisol soils develop rather than Brunisolic. Map unit 101 is sometimes found associated in valley draws where a significant amount of water erosion has occurred. Map units 141 and 142 are found on associated colluvial slopes at higher elevations.

Competing Map Units and Differentiae

Map unit 52 differs because its soils have coarser textures and a greater amount of calcium carbonate. Soils of map unit 55 differ from map unit 66 because of their Regosolic character. Soils of map units 57, 58 and 61 are considerably coarser textured and higher in lime than those of map unit 66. Soils of map units 57 and 61 also have a Luvisol character, whereas map unit 58 has a Dark Gray Luvisol character. The bright reddish Bf of soils characteristic of map unit 64 should separate this Podzolic profile from the Brunisolic soils of map unit 66. Soils of map unit 67 have a deep well-developed Chernozemic Ah horizon allowing relatively easy separation from map unit 66.

Vegetation

The vegetation associated with this map unit is characterized by scrubby, stunted stands of Populus tremuloides (trembling aspen), Pinus flexilis (limber pine) and Abies lasiocarpa (alpine fir). Occasional stands of Pseudotsuga menziesii (Douglas fir) are found. In some areas Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose)

and Rubus parviflorus (thimbleberry) are common. Common herbs include Gramineae (grasses), Carex spp. (sedge), Veratrum eschcholtzii (false hellebore) and Achillea millefolium (common yarrow).

Pedon Description (C196)

Classification: Orthic Eutric Brunisol (Typic Cryochrept).

Described by: Gerald Coen.

Date: August 24, 1972.

Location: about $1\frac{1}{4}$ miles east of the Oil Basin cabin along the Park boundary, and then 100 yards south (Fig.22).

Climate: continental.

Parent Material: shallow deposit of fine textured till, probably Continental in origin.

Landform: bedrock controlled morainic landform.

Slope: 20% in the vicinity of the pedon and 10 to 40% on the map unit.

Elevation: 5,100 feet ASL.

Relief: 300 to 500 feet.

Aspect: 25 degrees.

Estimated Drainage: well drained.

Water Table: probably continuously greater than 90 cm from the surface.

Vegetation: clumps of Abies lasiocarpa (alpine fir) 15 to 20 feet tall are found scattered throughout the map unit. Scrubby Populus tremuloides (trembling aspen) and Pinus flexilis (limber pine) constitutes the other major tree species. A variety of shrubs such as Potentilla fruticosa (shrubby cinquefoil), Betula occidentalis (water birch), Shepherdia canadensis (Canadian buffaloberry), Amelanchier alnifolia (saskatoon) and Rosa acicularis (prickly rose) were noted. The herbs noted were Thalictrum venulosum (veiny meadow-rue) and Aster spp. Gramineae (grasses) provided up to 70% cover in many places.

Notes: The soil temperature at 50 cm was 13° C. There were few stones on the surface near the pedon, but in some places the surface was very stony. Within the solum, stones occupied a considerable portion of the volume, particularly large boulders. The soil was in a virgin condition.

- Ah 0 to 2.5 cm ; very dark grayish brown (10YR 3.5/2 m) loam to clay loam; moderate fine granular; friable; abundant fine roots; pores unobserved; no clay films; no effervescence; coarse fragments not estimated; clear wavy boundary; 1.5 to 4 cm thick.
- Bm 2.5 to 28 cm ; dark brown (10YR 4/3 m) clay loam; weak to moderate large subangular blocky; friable; plentiful fine roots; common fine pores; no clay films; no effervescence; estimated coarse fragments 20%; clear wavy boundary; 20 to 30 cm thick.
- Ck 28 to 66 plus cm ; yellowish brown (10YR 5/4 m) gravelly clay loam; massive to fine subangular blocky; friable; few fine roots; many very fine pores; no clay films; strong effervescence around sand size fragments; estimated coarse fragments 40%.

COMMENTS:

A 2 to 5 cm thick layer of C horizon material was found overlaying the Ah horizon, and appeared to be the result of very recent water erosion. The occurrence of this sort of buried horizon was somewhat unusual for the area as a whole.

MAP UNIT NO. 67 (Orthic Black Chernozemic)

The soils of this map unit are fine textured but have occasional well-rounded coarse fragments within the solum and on the surface. They have formed from fairly dark coloured fine textured tills containing erratics from the Canadian Shield and, thus, the till is assumed to be Continental in origin. These soils are found in the Prairie-Woodland Tension Zone and hence are vegetated with both grasses and deciduous trees. The well-developed deep Chernozemic Ah is in contrast with the Chernozemic Ah found on the Cordilleran tills. The Continental tills are more mellow, less stoney, and have a lower lime content than the Cordilleran tills. The complex interfingering of the Continental and Cordilleran tills where map unit 67 is found means that the map units are sporadically located without any specific distribution pattern. Map unit 67 is geographically located along the north boundary of the Park in the Kesler Lake and Lakeview Ridge areas.

Associated Map Units.

Map units 29, 38, 50, 52, 66 and 101 are found associated with map unit 67. Map unit 29 is found on the somewhat poorly drained, sandy lower portions of fans.

Map unit 38 is found on the non-forested fans associated with map unit 67. Map unit 50 is found on the grassy humpy Cordilleran till knobs associated with map unit 67. Map unit 52 and map unit 66 are Brunisolic soils developed on till associated with map unit 67. However, map unit 52 is found on the high lime stoney Cordilleran tills whereas Map unit 66 is found on the finer textured Continental tills. Map unit 101 is found on water worked and translocated fine textured dark coloured soils found in local valleys and draws associated with map unit 67.

Competing Map Units and Differentiae

Map unit 41 differs from map unit 67 because of the stony Cordilleran till found at shallow depths beneath the surficial deposit of nearly stone free water worked material in map unit 41. Map unit 50 differs because its soils have more brownish, shallower Chernozemic Ah horizons and a high lime stony Cordilleran till parent material. Soils of map unit 57 differ from map unit 67 mainly because of their well developed eluvial and illuvial horizons and the high lime stony Cordilleran till as parent material. Map unit 58 is similar to the forested end member of map unit 67 but can be separated by the occurrence of the earthworm-modified eluvial horizons. Soils of map unit 66 are mapped on fine textured till parent material somewhat similar to map unit 67 but can be separated by the lack of a well developed Chernozemic Ah horizon. Map units 100 and 101 differ from map unit 67 in that there are very few stones within the pedon or on the soil surface and they do not exhibit any horizon differentiation.

Vegetation

Vegetation associated with this map unit is characterized by both grasslands and deciduous trees. Immature stands of less than 40 foot tall Populus tremuloides (trembling aspen) cover about half of the areas mapped as map unit 67. In these areas shrubs found as understory are characterized by the association made up of Amelanchier alnifolia (saskatoon), Rosa acicularis (prickly rose), Rubus parviflorus (thimbleberry) and the herb association made up of Gramineae (grasses), Hedysarum sulphurescens (yellow hedysarum), Heracleum lanatum (cow parsnip) and Thalictrum venulosum (veiny meadow rue). Dominant shrubs in the grassy areas (Stringer, 1969¹), include Rosa woodsii (common wild rose), Amelanchier alnifolia (saskatoon) and Potentilla fruticosa (shrubby cinquefoil). Herbs

1

Stringer, P. W. 1969. An ecological study of grasslands at low elevations in Banff, Jasper and Waterton Lakes National Parks. Ph.D. Thesis. Univ. of Alberta, Edmonton.

in these areas include Danthonia parryi (Parry oat grass), Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue) and various other non-grasses.

The following two pedon descriptions provide an idea of the range of characteristics under the two vegetation types.

Pedon Description (C182)

Classification: Orthic Black Chernozem (Typic Cryoboroll).

Described by: W. D. Holland and Gerald Coen.

Date: August 14th, 1972.

Location: about $\frac{1}{4}$ mile south of Kesler Lake along the Park boundary (Fig.22).

Climate: continental.

Parent Material: fine textured, fairly dark coloured, relatively stone free Continental till.

Landform: moraine.

Slope: about 17% in the vicinity of the pedon and from 12 to 40% associated with map unit.

Elevation: 5100 feet ASL.

Relief: about 500 to 700 feet.

Aspect: 90 degrees.

Estimated Drainage: well drained.

Water Table: probably rarely within the pedon.

Vegetation: a few patches of scrubby Populus tremuloides (trembling aspen) dot the landscape.

Occasional Abies lasiocarpa (alpine fir) and Pinus flexilis (limber pine) were also seen in the area. Shrubs observed include Amelanchier alnifolia (saskatoon), Potentilla fruticosa (shrubby cinquefoil), Rosa acicularis (prickly rose), and Elaeagnus commutata (silver berry). Herbs observed include Lupinus sericeus (Pursh's silky lupine), Geranium viscosissimum (sticky purple geranium), Aster, spp. Solidago decumbens (mountain goldenrod), Campanula rotundifolia (common bluebell), and Monarda fistulosa var. menthaefolia (horse mint), Festuca idahoensis (bluebunch fescue), and Calamagrostis rubescens (pine grass) were the dominant grass species observed.

Notes: The soil temperature at 50 cm was 13° C. There were few stones on the soil surface or within the pedon. The soil was in a virgin condition although the area may have been grazed by domestic cattle at one time.

- Ah 0 to 23 cm ; very dark brown (10YR 2/2 m) loam; weak fine granular; very friable; plentiful fine roots; no pores; no clay films; no effervescence; estimated coarse fragments 5%; clear wavy boundary; 18 to 25 cm thick.
- Bm 23 to 43 cm ; dark brown & 7.5YR 4/3 m) clay loam; moderate medium subangular blocky; very friable; plentiful fine roots; common very fine pores; no clay films; no effervescence; estimated coarse fragments greater than 5%; clear wavy boundary; 18 to 23 cm thick.
- BC 43 to 97 cm ; dark brown (10YR 4/3 m) clay; moderate medium subangular blocky; friable; few fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments greater than 5%; abrupt wavy boundary; 51 to 56 cm thick. This horizon shows weathered "blotchy" yellowish red (5YR 4/6 m) limestone "ghosts".
- C 97 to 115 cm plus; dark gray to very dark gray (10YR 4/1 to 3/1 m) clay; moderate medium subangular blocky; friable; few fine roots; many medium pores; few thin clay films; no effervescence; estimated coarse fragments 5%. Some limestone pendants or coatings on the underside of rocks were evident in this horizon.

COMMENTS:

A few rodent burrows were evident within the pedon. Map unit 67 includes mainly Orthic Black Chernozemic soils but because of its occurrence in the forest-grassland transition zone there is an appreciable area of Eluviated Black Chernozemic soils.

Pedon Description (C194)

Classification: Orthic Black Chernozem (Typic Cryoborall).

Described by: Gerald Coen.

Date: August 24, 1972.

Location: about 1½ miles east of the Oil Basin cabin along the Park boundary and then ¼ mile south (Fig.22).

Climate: continental.

Parent Material: fine textured, fairly dark coloured, relatively stone free Continental till.

Landform: moraine.

Slope: 10% in the vicinity of the pedon and from 5 to 20% in the Map unit.

Elevation: 5050 feet ASL.

Relief: about 300 feet.

Aspect: 40 degrees.

Estimated drainage: moderately well drained.

Water table: 115 cm below the surface.

Vegetation: about 20% cover with scrubby diseased 30 foot tall Populus balsamifera

(balsam poplar). Shrubs observed include Betula occidentalis (water birch),

Rosa acicularis (prickly rose), Amelanchier alnifolia (saskatoon), Ribes

viscosissimum (sticky currant), Ribes oxycanthoides (wild gooseberry), Ribes

triste (wild red currant) and Symphoricarpos occidentalis (western snowberry).

A dense understory was rich in species such as the shrubs above and herbs such as Heracleum lanatum (cow parsnip), Thalictrum venulosum (veiny meadow rue) and Smilacina racemosa var. amplexicaulis (false solomon's seal).

Notes: The soil temperature at 50 cm was 12° C. There were a few stones on the surface and an increasing amount of stones with depth within the pedon. The soil was in a virgin condition.

H 8 to 0 cm ; black (5YR 2/1 m); well decomposed deciduous leaves; fluffy; abundant medium roots; abrupt wavy boundary; 5 to 13 cm thick.

Ah 0 to 23 cm ; very dark gray (10YR 3/1 m) clay loam; moderate, fine granular; friable; abundant medium roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 5%; abrupt wavy boundary; 20 to 43 cm thick.

Bm1 23 to 48 cm ; brown (10YR 5/3 m) clay with blotches of yellowish red (5YR 4/6 m) and reddish yellow (7.5YR 7/8 m); moderate medium prismatic breaking to moderate medium subangular blocky; firm; few medium roots; common very fine pores; common thin clay films; very weak effervescence associated with sands; estimated coarse fragments 5%; gradual wavy boundary; 23 to 33 cm thick.

- Bm2 48 to 66 cm ; dark grayish brown; (2.5Y 4/2 m) clay with few medium distinct brownish yellow (10YR 6/8 m) mottles; moderate medium subangular blocky; firm; plentiful medium roots; common very fine pores; few thin clay films; very weak effervescence associated with sand grains; estimated coarse fragments 15%; clear wavy boundary; 15 to 20 cm thick.
- C1 66 to 74 cm ; dark grayish brown (10YR 4/2 m) clay loam; moderate medium subangular blocky; friable; very few very fine roots; few fine pores; few thin clay films; slight effervescence in pockets and associated with sand grains; estimated coarse fragments 10%; clear wavy boundary; 8 to 10 cm thick.
- Cg 74 to 115 plus cm ; grayish brown (2.5Y 5/2 m) clay loam with very fine distinct strong brown (7.5YR 5/8 m) mottles; massive; friable; few to no roots, common fine pores; few thin clay films; slight effervescence in pockets associated with sand grains; estimated coarse fragments 15 to 20%.

COMMENTS:

The species of vegetation indicate that there is ample moisture for good vegetative growth and yet the expression of standing stagnant water by the presence of mottles is nearly absent within the profile. This pedon is less well drained than many of the pedons within this map unit and probably defines the more poorly drained end member.

MAP UNIT NO. 100 (Cumulic and Orthic Regosols)

The soils of this map unit are fine textured with very few coarse fragments. They have formed on dark coloured fine textured materials which are probably derived from weathered local shale. These fine textured materials are susceptible to large rotational slumps which often disturb the surface soil preventing profile development. In the areas where map unit 100 is common the slumps appear to have removed a thin (10 to 30 feet) covering of till exposing the weathered shales. Thus, there is a complex pattern of soils derived from till and soils derived from the shales. Shallow burial of the Ah horizon is quite evident in the pedons examined. This burial appears to be a continuing process and probably has occurred repeatedly since the last glaciation. Map unit 100 is geographically located east of Sofa Mountain in the Belly River area of the Park.

Associated Map Units

Map units 52, 53, 57, 61 and 101 are found in association with map unit 100. Map unit 52 is sometimes associated with map unit 100 at higher elevations where the till and fine textured materials adjoin each other. Poorly drained soils of map unit 53 may occasionally be found in depressional areas adjacent to the well drained, fine textured soils of map unit 100. Map unit 57 is the major associate of map unit 100. There are often inclusions of the Gray Luvisolic soils developed on till (the major soil in map unit 57) within map unit 100 and vice versa. There are also some areas where the major soils of map units 57 and 100 are so intimately mixed (through the slumping process mentioned earlier) that they are both recognized as a complex within a single mapping delineation. Map unit 61 is generally situated between map unit 100 and the Talus and colluvial slopes at the foot of mountains. Map unit 101 is again intimately mixed and associated with map unit 100.

Competing Map Units and Differentiae

Map units 101, and 107 are similar to map unit 100 except that, in general, they are forested and 101 is slightly coarser and 107 is finer in texture. Map units 102 and 106 differ because of their Luvisolic horizon sequence. Map unit 103 is steep, shallow and calcareous near the surface. Many other Regosolic soils are found in the Park but most are much coarser than map unit 100.

Vegetation

Vegetation associated with this map unit is characterized by two main groups of associated species. At higher elevations and on steeper slopes shrubs are characterized by the association made up of Amelanchier alnifolia (saskatoon), Abies lasiocarpa (alpine fir) and Populus tremuloides (trembling aspen) and herbs characterized by the association made up of Graminae (grasses), Veratrum eschscholtzii (false hellebore), Achilleae millefolium (common yarrow) and Heuchera cylindrica (alum root). On less steep slopes and at lower elevations shrubs are characterized by the association made up of Rosa woodsii (wood's rose) and Potentilla fruticosa (shrubby cinquefoil) and herbs are characterized by the association made up of Phleum pratense (timothy), Poa pratensis (Kentucky blue grass), Bromus interme (awnless brome), and taraxacum officinale (dandelion).

Pedon Description (C136)

Classification: Cumulic Regosol (Typic Cryorthent)¹

Described by: W. D. Holland and Gerald Coen.

Date: September 24, 1971.

Location: about 1¼ miles southeast from the Blood Timber Limit along the trail
along the north fork of the Belly River (Fig.22).

Climate: continental.

Parent Material: dark colored fine textured (silty clay) materials, probably of weathered
shale origin.

Landform: dissected valley wall with many slump scars.

Slope: ranges from 9 to 30%, with about 9% across the pit.

Elevation: 4900 feet ASL.

Relief: about 400 to 500 feet.

Aspect 90 degrees.

Estimated drainage: well drained.

Water Table: probably rarely within 90 cm of the surface.

Vegetation: patches of Picea (spruce) and Populus tremuloides (trembling aspen) are
found within the dominantly grassy area. Symphoricarpos occidentalis (western
snowberry) is evident as well as Heracleum lanatum (cow parsnip), Veratrum
eschsoltzii (false hellebore) and Rubus parviflorus (thimbleberry).

Notes: The soil temperature at 50 cm was 4° C. There were essentially no coarse
fragments or stones within the pedon or on the surface. The soil was in a
virgin condition.

Pedon Description (C134)

C1 0 to 18 cm ; very dark grayish brown (10YR 3/2 m) clay; moderate fine granular;
friable; abundant medium roots; common fine pores; diffuse, wavy boundary; 15
to 20 cm thick.

C2 18 to 28 cm ; very dark grayish brown (10YR 3/2 m) clay; moderate fine granular;
friable; few fine and abundant coarse roots; few medium pores; clear, wavy
boundary; 8 to 13 cm thick.

¹ Classification in the American Classification system is tentative because
we are unable to establish whether the Btb1 and Btb2 horizons are argillic
horizons. Probably the best representation of the "kind" of soil is to class-
ify them into the Entisol order but these soils may have a high fossil
carbon content which would exclude them from the Fluvents.

- Btb1 28 to 58 cm ; very dark grayish brown (10YR 3/2 m) and dark grayish brown (10YR 4/2 m) clay; moderate coarse columnar and strong medium subangular blocky; firm; few coarse and fine roots; common fine pores; continuous moderately thick clay films; diffuse, wavy boundary; 25 to 36 cm thick.
- Btb2 58 to 102 cm ; dark grayish brown (10YR 4/2 m) clay with few very fine distinct strong brown (7.5YR 5/6 m) mottles increasing to common medium with depth; strong very coarse columnar to very coarse subangular blocky; firm; few coarse and fine roots; common fine pores; continuous thin clay films; diffuse, wavy boundary; 38 to 46 cm thick.
- BCb 102 to 122 plus cm ; dark gray (10YR 4/1 m) and very dark gray (10YR 3/1 m) clay with few fine distinct strong brown (7.5YR 5/6 m) mottles; strong coarse prismatic; firm; very few fine roots; common fine pores; continuous thin clay films.

COMMENTS:

There is about 1 to 2 cm of undecomposed grassy organic remains on the surface of the mineral horizons. The horizon nomenclature Btb1 and Btb2 indicates structure and consistence of a Bt but there is no method for identifying the amount of textural increase from the Ae to the Bt horizon because the Ae horizon has presumably been disrupted and lost through natural geologic processes. Thin sections or other supporting evidence are not available to assist in substantiating the buried Bt designation.

MAP UNIT NO. 101 (Cumulic and Orthic Regosols).

The soils of this map unit are fine textured with few coarse fragments. They are formed on dark coloured, fine textured materials which are probably derived from weathered local shales. Location of map unit 101 is mainly within draws and other areas of local erosion and thus prevents substantial profile formation. Exposures of fine textured shales at higher elevation sometimes allows the erosion and deposition of this fine material resulting in a till being buried by map unit 101. Thus, a complex pattern of soils developed on till and soils developed on weathered shale is sometimes observed. Shallow burial of the Ah and/or L-H horizons is common and indicating the cumulic character of these soils. Map unit 101 is geographically located east of Sofa Mountain in the Belly River area of the Park and small areas in the Oil Basin region.

Associated Map Units

Map units 36, 37, 57, 61, 100 and 105 are found associated with map unit 101 north of Sofa Mountain and map units 58, 66 and 67 are found associated with map unit 101 in the Oil Basin area. Where hill slopes change to fans map units 36 and 37 have common boundaries with map unit 101. Map unit 57 occurs at higher elevations where till materials are exposed above the fine-textured materials of 101. Map unit 61 is found at higher elevations and on steeper till slopes adjoining map unit 101. Map unit 100 is found in association with 101 where the lack of trees prevents the formation of L-H horizons in the former. Map unit 105 is found in poorly drained areas associated with map unit 101. In the Oil Basin area map units 58, 66 and 67 are found on the morainic landforms adjoining the shallow valleys where map unit 101 is found.

Competing Map Units and Differentiae

Map units 38 and 39 differ from map unit 101 by the abundant coarse fragments in the fine gravel sizes. Map unit 41 differs because of a till contact within the solum within 75 cm. of the surface. Map unit 67 is fine textured but does have a till parent material and has a well developed Chernozemic Ah horizon. Map unit 100 differs mainly because it is characterized by soils with a fairly well developed Ah horizon on occasion or buried Ah horizon and the lack of a L-H horizon. Soils of map units 102 and 106 differ from 101 because of the Luvisolic horizons. Map unit 103 has high lime Cca horizons coming very near the surface and often exposures of limestone bedrock which differentiates it from map unit 101. Map unit 105 is poorly drained and can be separated on this basis. Map unit 107 as well as map unit 101 is a Regosol but map unit 107 is of considerably finer texture.

Vegetation

Vegetation associated with this map unit is characterized in some areas by Pinus contorta (lodgepole pine) and in other areas by Populus tremuloides (trembling aspen). In both cases they are generally less than 40 feet high and provide less than 50% cover. Shrubs vary considerably depending upon the overstory species and the aspect, and slope

characteristics of the landform. Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet) and Berberis repens (creeping mahonia) are three of the more common shrub species. Herbs include Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed) and Gramineae (grasses).

Pedon Description (C191)

Classification: Cumulic Regosol (Typic Cryofluvent).

Described by: Gerald Coen.

Date: August 22, 1972.

Location: about $1\frac{1}{4}$ miles south along the Park boundary where it adjoins the west side of the Blood timber limit and then $\frac{3}{4}$ mile west (Fig.22).

Climate: continental.

Parent Material: fairly fine water translocated, weathered shale materials.

Slope: 12% in the vicinity of the pedon and ranging from 10 to 40% on the landform.

Elevation: about 5500 feet ASL.

Aspect: 330 degrees.

Estimated drainage: well to moderately well drained.

Water Table: below the pedon but may be near the surface in the spring. There are many springs in the vicinity.

Vegetation: about 50% canopy density of 20 to 40 foot tall Pinus contorta (lodgepole pine) and Picea glauca (white spruce). There is little evidence of regeneration in the area. Symphoricarpos occidentalis (western snowberry) was the main shrub noted. Arnica cordifolia (heart-leaved arnica) and Thalictrum venulosum (veiny meadow rue) were the main herb species noted. Mosses were a common component of the understory.

Notes: The soil temperature at 50 cm was 8° C. There were very few stones within the pedon or on the surface of the ground. The soil was in a virgin condition.

L-H 2.5 to 0 cm ; somewhat decomposed organic matter comprised of rotting needles and twigs; 1.5 to 5 cm thick.

- C1 0 to 10 cm ; brown (10YR 4/3 m) silt loam; massive breaking to weak fine granular; friable; abundant large roots; many fine pores; no clay films; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 1.5 to 13 cm thick.
- Ahb 10 to 25 cm ; dark brown (10YR 3/3 m) silt loam; massive to moderate fine granular; friable; common medium roots; many fine pores; no clay films; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 13 to 23 cm thick.
- C2 25 to 41 cm ; dark grayish brown (10YR 4/2 m) clay loam; strong medium subangular blocky; firm; few medium roots; few fine pores; thin continuous clay film; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 10 to 18 cm thick.
- C3 41 to 58 cm ; brown (10YR 4/3 m) with weak red (2.5YR 5/2 m) blotches, clay; strong medium subangular blocky; firm; few medium roots; many fine pores; continuous thin clay films; no effervescence; estimated coarse fragments less than 2%; clear wavy boundary; 5 to 20 cm thick.
- C4 58 to 74 cm ; weak red (2.5YR 5/2 to 4/2 m) clay loam; strong medium subangular blocky; firm; few medium roots; many fine pores; thin continuous clay films; no effervescence; estimated coarse fragments less than 5%; clear wavy boundary; 10 to 18 cm thick.
- C5 74 to 100 plus cm ; weak red (2.5YR 5/2 m) with reddish brown (5YR 4/3 m) blotches, clay loam; moderate medium subangular blocky; firm; very few to no roots; few fine pores; few discontinuous clay films; no effervescence; estimated coarse fragments 10%.

COMMENTS:

Many springs originate in the vicinity of this pedon. The entire area of the map unit is probably frequently "washed" by running water.

MAP UNIT NO. 102 (Orthic Gray Luvisol)

The soils of this map unit are fine textured with very few coarse fragments. They have formed on dark coloured fine textured materials of either eroded local lacustrine or weathered shale origin. The fine textured sediments in the Belly River area are susceptible to large rotational slumps which often disturb the surface soils preventing profile development. In areas where map unit 102 is found the soils have been fairly stable for a sufficient period prior to present to form profile development. Map unit 102 is geographically located mainly east of the Belly River.

Associated Map Units

Map units 57, 101, 103 and 105 are found in association with map unit 102. Map unit 103 is found on the steeper slopes where erosion prevents profile development. Map unit 105 is in depressions where run-off and groundwater cause wet conditions for significant periods. Map unit 57 is the Orthic Gray Luvisol member on till and is located at generally higher elevations than map unit 102. Map unit 101 is located in shallow draws and basins where profile development is prevented by accretion through deposition of eroded material.

Competing Map Units and Differentiae

Map units 100 and 107 have similar parent materials to map unit 102 but the former are characterized by soils with Regosolic rather than Luvisolic profile development. Soils of map units 101, 103 and 105 differ from 102 in that they are Regosolic or Gleyed Regosols rather than Luvisolic.

Vegetation

Vegetation characteristic of this map unit is mainly 40 to 60 foot tall Pinus contorta (lodgepole pine) which has approximately 60% canopy density. In general, stand conditions are thrifty and mature although some stands are overmature. Occasionally areas dominated by Populus tremuloides (trembling aspen) and Picea sp. (spruce) are found. In general the understory vegetation consists of 30% cover with the shrub association of Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet) and Berberis repens (creeping mahonia) and the 70% cover with the herb association of Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed), and Gramineae (grasses).

Pedon Description (C125)

Classification: Orthic Gray Luvisol (Typic Cryoboralf)

Described by: W. D. Holland and Gerald Coen.

Date: September 21, 1971.

Location: about 1.7 miles north along the trail east of the Belly River bridge (Fig.22).

Climate: continental.

Parent Material: dark coloured fine textured materials of either eroded local lacustrine or weathered shale origin.

Landform: dissected lacustrine plain or shale bedrock.

Slope: ranges from 0 to 30% in the immediate vicinity and is about 5% across the pit.

Elevation: about 4650 feet ASL.

Relief: about 200 feet on the map unit.

Aspect: about 180 degrees on a ridge with a crown about 40 feet across and sloping east and west on either side of the pit and to the south across the pit.

Estimated drainage: well drained.

Water Table: probably perched near the surface in the spring for short periods.

Vegetation: at this site a predominance of Pseudotsuga menziesii (Douglas fir) was noted along with considerable Pinus contorta (lodgepole pine). Populus tremuloides (trembling aspen) were noted on the steeper slopes. The understory vegetation noted (not necessarily in order of prevalence because of snow) included Amelanchier alnifolia (saskatoon), Rubus parviflorus (thimbleberry), Symphoricarpos occidentalis (western snowberry), Rosaceae (roses) Spiraea lucida (white meadowsweet), Aqueligia sp. (columbine), Clematis sp. (clematis) and Graminae (grasses).

Notes: The soil temperature at 50 cm was 3° C and in the L-H horizon was 0° C. There were essentially no stones within the pedon or on the surface. The soil was in virgin condition.

L-H 5 to 0 cm ; dark brown (7.5YR 3/2 - 4/2 d) slightly to moderately decomposed organic matter; abrupt, wavy boundary; 2.5 to 5 cm thick.

Ae1 0 to 13 cm; light gray (10YR 6/1 d) silt loam; weak, medium platy; friable; many large roots; common medium pores; abrupt, wavy boundary; 8 to 13 cm thick.

Ae2 13 to 23 cm ; light brownish gray (10YR 6/2 d) silt loam; coarse platy to moderate large subangular blocky; friable; many large roots; common medium pores; diffuse, wavy boundary; 8 to 20 cm thick.

AB 23 to 33 cm ; grayish brown (10YR 5/2 d) silt loam with light brownish gray (10YR 6/2 d) silans on ped surfaces; strong medium subangular blocky; firm; plentiful large roots; common medium pores; clear, wavy boundary; 2.5 to 10 cm thick.

- Bt1 33 to 56 cm ; dark grayish brown (10YR 4/2 m) silt loam with light brownish gray (10YR 6/2 m) silans covering 50% of the ped surfaces; strong medium subangular blocky with prismatic tendency; firm; few medium and large roots; many medium pores; many moderately thick clay films; clear, wavy boundary; 20 to 25 cm thick.
- Bt2 56 to 94 cm ; dark grayish brown (10YR 4/2 m) clay loam with light brownish gray (10YR 6/2 m) silans covering about 10% of the ped surfaces; strong medium subangular blocky and moderate coarse prismatic; firm; few medium and large roots; common fine pores; continuous moderately thick clay films; clear, wavy boundary; 30 to 43 cm thick.
- BC 94 to 117 cm ; yellowish brown (10YR 5/4 m) clay loam; massive to weak medium subangular blocky (a few ped faces are evident); friable; few to no roots; common to many fine pores; common moderately thick clay films; clear, wavy boundary; 18 to 25 cm thick.
- Ck 117 to 150 plus cm ; brown and light grayish brown (10YR 5/3 and 6/3 slightly m) silt loam; massive; very friable; moderate effervescence.

MAP UNIT NO. 103 (Lithic Orthic and Orthic Regosols)

The soils of this map unit are fine textured with varying amounts of limestone bedrock fragments within the first 50 cm. They have formed on relatively unweathered limestone bedrock which has a thin mantle (of varying thicknesses) of silt loam material covering it. The soils are found on steep slopes which appear to be caused by a limestone layer in the soft shale formation. This situation results in Lithic and Orthic Regosols being found intimately mixed within this map unit depending on how near the limestone is to the surface. The steep slopes and relatively constant downslope movement of soil materials prevents appreciable horizon development and often there is CaCO_3 to the surface. This map unit is located mainly east of the Belly River.

Associated Map Units

Map unit 102 is found on the more gently sloping areas adjacent to this map unit. Map unit 101 is located in shallow draws and basins where profile development is prevented by accreting materials through downslope wash. Map unit 105 is located in associated depressions where run-off and groundwater cause wet conditions for significant periods of the year. Map unit 57 is characterized by Orthic Gray Luvisol soils developed on till at elevations generally higher than map unit 103. Map unit 11 is found in recent alluvial channels derived from the coarse gravels.

Competing Map Units and Differentiae

Map units 100 and 107 have similar parent materials to map unit 103 but do not have lime at or near the surface. They are also silty clay rather than silt loam in texture. Map units 102 and 106 are dominantly Orthic Gray Luvisol soils without free carbonates near the surface which serves to distinguish them from map unit 103. Map unit 105 is gleyed and found in areas where excess water may accumulate. Map unit 101 is also characterized by Regosolic soils but generally does not have free carbonates near the surface and is located on more gentle slopes all of which serves to separate it from map unit 103.

Vegetation

Vegetation characteristic of this map unit is dominated by Picea glauca (white spruce), Picea engelmannii (Engelmann spruce) and Populus tremuloides (trembling aspen) in generally quite open and often scrubby stands. Shrub vegetation is characterized by an association containing Spiraea lucida (white meadowsweet), Rubus parviflorus (thimbleberry), and Amelanchier alnifolia (saskatoon). Herbs are characterized by an association containing Thalictrum venulosum (veiny meadow-rue), Graminae (grasses) and Epilobium angustifolium (fireweed).

Pedon Description (C126)

Classification: Lithic Orthic Regosol (Lithic Cryorthent).

Described by: W. D. Holland and Gerald Coen.

Date: September 21, 1971.

Location: about 1.7 miles north along the trail east of the Belly River ridge and then downslope (west) from the sampling site for map unit 102 (Fig. 22).

Climate: continental.

Parent Material: fine textured calcareous silt loam, probably eroding shale materials and residual limestone and shales.

Landform: bedrock controlled valley wall.

Slope: ranges from 60 to 80% with slope across the pit about 70%.

Elevation: about 4,550 feet ASL.

Relief: about 200 feet on the map unit.

Aspect: about 250 degrees.

Estimated drainage: well drained.

Water Table: probably deep, but lateral flow may be near the surface in the spring.

Vegetation: the area is generally dominated by grasses and shrubs with 10 to 20% coverage with scrubby Pseudotsuga menziesii (Douglas fir) and Populus tremuloides (trembling aspen). Shrubs include Amelanchier alnifolia (saskatoon), Rosaceae (roses), Arctostaphylos uva-ursi (kinnikinnick), Shepherdia canadensis (Canadian buffaloberry) and Potentilla fruticosa (shrubby cinquefoil). Herbs noted included Aster spp. (asters) and Spiraea lucida (white meadowsweet). Gramineae (grasses) are common covering about 10% of the area. There are also a fair number of bare spots.

Notes: The soil temperature at 50 cm was 3° C and at 1 cm (in L-H) was 1° C.

There are occasional stones on the surface, apparently fragments of fractured bedrock. The soil is in virgin condition.

- L-F 1 to 0 cm ; relatively undecomposed leaf litter; few roots; abrupt, smooth boundary; 0.6 to 1.3 cm thick.
- AC 0 to 2.5 cm ; dark grayish brown (10YR 4/2 m) silt loam; weak fine granular; very friable; plentiful medium roots; no effervescence; estimated coarse fragments less than 5%. clear, wavy boundary; 0 to 5 cm thick.
- Ck 2.5 to 25 cm ; very dark grayish brown (10YR 3/2 m) silt loam; weak fine granular; very friable; plentiful medium roots; strong effervescence; estimated coarse fragments 5%.
- R 25 to 64 plus cm. of fractured limestone bedrock containing about 90% coarse fragments and 10% silt loam.

MAP UNIT NO. 105 (Gleyed Cumulic Regosol)

The soils of this map unit are fine textured with very few coarse fragments. They have formed on local alluvial deposition areas where accumulations of fine textured material have been carried in from the adjacent shale parent materials. Within this map unit there are seepage and depressional areas which are subject to saturation with water for significant portions of the year. Thus, the dominant feature of the soils in this map unit is their cumulic nature and their poorly drained characteristics. The pedons are quite variable because of the stratified nature of the materials

upon which they are developed. Map unit 105 is geographically located generally in the area east of the Belly River and is associated with soils having map unit numbers between 100 and 107.

Associated Map Units

Map units 55, 57, 67, 100, 101, 102, 106, 107 and 141 are found in association with map unit 105. Map units 55, 57 and 67 are found on the morainic materials at the margins of the depressional areas or seepage areas where map unit 105 is located. Where the till mantle is not continuous map units 100, 101, 102, 106 and 107 are found at the margins of the areas of map unit 105. Map unit 141 is found where steep colluvial slopes adjoin the depressional areas where map units 105 are located.

Competing Map Units and Differentiae

The characteristic fine texture and imperfect drainage serves to distinguish map unit 105 from most other map units within the Park. Map units 100, 101, 102, 106 and 107 are all fine textured with very few coarse fragments but differ because of their well drained character. Map unit 14 differs mainly because of the river terrace material upon which it is formed. It is also more poorly drained than map unit 105. Map units 29, 31 and 32 differ because of their coarser texture and in the case of the latter two map units because of their more poorly drained characteristics. Map unit 44 is developed on fan material and differs significantly by its amount of coarse fragments and by its more poorly drained attributes. Map unit 53 differs because of its till parent material containing many coarse fragments.

Vegetation

Vegetation associated with this map unit varies from sparse to dense stands of 40 to 60 foot tall trees varying from associations of Populus tremuloides (trembling aspen) and Picea glauca (white spruce) to Pseudotsuga menziesii (Douglas fir) and mixtures of the above with Pinus contorta (lodgepole pine). The shrubs Rubus parviflorus (thimbleberry) and Spiraea lucida (white meadowsweet) are common to most of the areas. Other shrubs such as Acer glabrum (mountain maple), Alnus crispa (green alder) and Amelanchier alnifolia (saskatoon) were located on map units variously

distributed throughout the Belly River region. Berberis repens (creeping mahonia) and Lonicera involucrata (bracted honeysuckle) are also variously associated with this map unit. Herbs such as Thalictrum venulosum (veiny meadow rue), Arnica cordifolia (heart-leaved arnica), Epilobium angustifolium (fireweed) and Gramineae (grasses) are variously found associated with this map unit. In the Oil Basin region of the Park an area mapped as 105 has as its dominant vegetative cover mainly shrubs including such species as Alnus crispa (green alder), Populus tremuloides (trembling aspen) and Salix spp. (willows). Festuca and Danthonia grasses as well as Veratrum eschscholtzii (false hellebore) and Heracleum lanatum (cow parsnip) are the herb species associated with this map area.

Pedon Description (C218)

Classification: Gleyed Cumulic Regosol (Aquic Cryorthent).

Described by: Gerald Coen.

Date: September 9, 1972.

Location: about 3/4 of a mile north, along a trail on the east side of the Belly River, from where the chief mountain highway crosses the river and then 200 yards east of the trail (Fig. 22).

Climate: continental.

Parent Material: stratified fine textured alluvial type sediments accumulating by erosion and deposition of the weathered shales found commonly in the Belly River region.

Landform: depressional basin or slightly sloping seepage area of confined fan shaped alluvium.

Slope: about $\frac{1}{2}\%$ in the vicinity of the pedon and ranging up to 5% on the landform.

Elevation: 4,500 feet ASL.

Relief: about 30 feet.

Aspect: none.

Estimated Drainage: imperfectly drained.

Water Table: below 90 cm at the time of sampling but probably above this on several occasions during the season.

Vegetation: About 30 to 40% cover with 40 to 50 foot tall Populus tremuloides (trembling aspen), Pseudotsuga menziesii (Douglas fir) and an occasional patch of Picea glauca (white spruce) or Populus balsamifera (balsam poplar). Shrub species observed included Cornus stolonifera (red osier dogwood), Lonicera involucrata (bracted honeysuckle), Salix spp. (willows), Alnus crispa (green alder) and Symphoricarpos occidentalis (western snowberry). Herbs observed included Heracleum lanatum (cow parsnip), Veratrum eschscholtzii (false hellebore), Streptopus amplexifolus (twisted stalk), Equisetum arvense (common horsetail) and Pyrola sp. (wintergreen). Few grasses and mosses were observed.

Notes: The soil temperature at 50 cm was 8.5° C. There were essentially no stones within the pedon or on the surface. The soil was in a virgin condition.

L 1.5 to 0 cm ; dark grayish brown (10YR 4/2 m) slightly decomposed needles; clear wavy boundary; 0 to 2.5 cm thick.

Ah 0 to 8 cm ; very dark grayish brown (10YR 3/2 m) loam; strong medium granular; friable; plentiful fine and medium roots; pores unobserved; no clay films; no effervescence; no coarse fragments; abrupt wavy boundary; 5 to 13 cm thick.

C 8 to 15 cm ; grayish brown (10YR 5/2 m) silt loam with very dark grayish brown (10YR 3/2 m) blotches around earthworm holes and common fine distinct yellowish brown (10YR 5/6 m) mottles; massive to single grain; very friable; plentiful fine roots; many medium and coarse pores resulting from earthworm activity; no clay films; no effervescence; no coarse fragments; abrupt wavy boundary; 5 to 10 cm thick.

Ahb 15 to 28 cm ; black (10YR 2/1 m) and very dark grayish brown (10YR 3/2 m) loam to clay loam with no evident mottles; moderate medium subangular blocky; very friable; few fine roots; many medium and coarse pores; no clay films; no effervescence; no coarse fragments; abrupt wavy boundary; 10 to 15 cm thick.

- Cg1 28 to 66 cm ; light olive brown (2.5Y 5/4 m) silt loam with many fine distinct yellowish brown (10YR 5/6 m) mottles; massive; very friable; few fine roots; many medium and fine pores; no clay films; no effervescence; no coarse fragments; abrupt wavy boundary; 36 to 41 cm thick.
- Ahbg 66 to 74 cm ; black (10YR 2/1 m) grading with depth to very dark grayish brown (10YR 3/2 m) clay loam with few coarse distinct yellowish brown (10YR 5/4 m) mottles; moderate fine granular near the top grading to weak large subangular blocky near the bottom; friable; very few medium roots; common fine pores; no clay films; no effervescence; no coarse fragments; abrupt wavy boundaries; 5 to 25 cm thick.
- Cgk 74 to 81 cm ; grayish brown (10YR 5/2 m) clay loam with many medium distinct yellowish brown (10YR 5/8 m) mottles; massive; friable; very few medium roots; many fine pores; no clay films; slight effervescence; no coarse fragments; abrupt wavy boundary; 5 to 10 cm thick.
- Cg2 81 to 94 plus cm ; brown (7.5YR 4/2 m) silt loam with many medium distinct strong brown (7.5 YR 5/6 m) mottles; massive; friable; very few medium roots; common fine pores; no clay films; no effervescence; no coarse fragments.

COMMENTS:

In this pedon earthworms were very active. Soils within this map unit fall both within the Gleyed Regosol and Gleysolic classifications depending upon their position within the depressional or seepage area. In the Horseshoe Basin area one map unit labelled as 105 has the poorly drained characteristics but the materials are derived from the redder shales and the whole profile is thus quite reddish clay loam. Effervescence slow to begin, probably dolomitic flour.

MAP UNIT NO. 106 (Orthic Gray Luvisol)

The soils of this map unit are fine textured with very few coarse fragments. They have formed on dark coloured fine textured materials of either eroded local lacustrine or weathered shale origin. These fine textured materials are susceptible to large rotational slumps and thus the surface soils are often disturbed preventing profile development. In areas where map unit 106 is found the soils have been fairly stable allowing profile development. Map unit 106 is geographically located mainly east of the Belly River.

Associated Map Units

Map units 57, 101, 102 and 103 are found in association with map unit 106. Map unit 103 is found on the steep bedrock controlled slopes associated with this map unit. Map unit 101 is Regosolic found on more gentle slopes and in areas where an unstable condition results in accumulation of downslope wash. Map unit 105 is found in depressional areas where run-off and water table cause wet conditions for significant periods. Map unit 57 is characterized by Orthic Gray Luvisol soils developed on till and is located at generally higher elevations than map unit 106. Map unit 102 is found on essentially the same landscape but is somewhat finer textured.

Competing Map Units and Differentiae

Map units 100 and 107 have essentially the same parent material but are characterized by soils with Regosolic profile development. Map units 101, 103 and 105 have soils which have somewhat coarser textured parent materials and are Regosolic or Gleyed Regosols; map unit 102 is essentially the same as 106 except it is somewhat coarser textured.

Vegetation

Vegetation characteristic of this map unit is dominated by thrifty mature stands of 40 to 60 foot tall Pinus contorta (lodgepole pine) which has around 40 to 60% canopy density. Areas of somewhat less dense coverage have 40 to 60 foot tall Pseudotsuga menziesii (Douglas fir) mixed with the lodgepole pine. The odd open area is dominated by Populus tremuloides (trembling aspen) 20 to 40 feet tall. The under-story vegetation consists of 30% cover by the shrub association of Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), and Berberis repens (creeping mahonia) and 70% cover by a herb association consisting of Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue) and Epilobium angustifolium (fireweed).

Pedon Description (C127)

Classification: Orthic Gray Luvisol (Typic Cryoboralf).

Described by: W. D. Holland and Gerald Coen.

Date: September 21, 1971.

Location: about $\frac{1}{2}$ mile north along the trail east of the Belly River bridge and then $\frac{1}{4}$ mile east into the woods (Fig. 22).

Climate: continental.

Parent Material: dark coloured fine textured materials of either eroded local lacustrine or weathered shale origin.

Landform: dissected lacustrine plain or eroded weathered sedimentary materials.

Slope: ranges from 25 to 35% and is about 30% in the vicinity of the pit.

Elevation: 4,600 feet ASL.

Relief: about 200 feet on the map unit.

Aspect: about 270 degrees.

Estimated Drainage: well drained.

Water table: probably perched near the surface for short periods in the spring.

Vegetation: this site is dominated by Pinus contorta (lodgepole pine) having 60% cover and 40 to 60 feet tall in thrifty mature stands. Lower vegetation noted included the shrubs Rubus parviflorus (thimbleberry), Shepherdia canadensis (Canadian buffalo-berry) and Spiraea lucida (white meadow-sweet) and the herbs Asterspp. (aster) and Smilacina racemosa (false Solomon's seal).

Notes: The soil temperature at 50 cm. was 4° C. There were essentially no stones within the pedon or on the surface. The soil was in a virgin condition.

L-H 2.5 to 0 cm ; slightly to moderately decomposed organic matter; abrupt, wavy boundary; 1.5 to 5 cm thick.

Ae1 0 to 10 cm ; light gray (10YR 7/2 m) silt loam; moderate coarse platy; friable; abundant fine and coarse roots; few very fine pores; no clay films; abrupt, smooth boundary; 8 to 13 cm thick.

Ae2 10 to 18 cm ; grayish brown (10YR 5/2 m) silt loam; moderate coarse platy and moderate coarse subangular blocky; friable to firm; abundant fine roots; common medium and fine pores; about 2% thin clay films; abrupt irregular to discontinuous boundary; 0 to 8 cm thick.

Bt1 18 to 36 cm ; grayish brown (10YR 5/2 m) clay loam matrix with light grayish brown (10YR 6/2 m) silan coatings on most ped surfaces; strong medium subangular blocky; firm; plentiful coarse and fine roots; common very fine pores; about 20% clay films; clear, wavy boundary; 8 to 18 cm thick.

- Bt2 36 to 64 cm ; dark brown (10YR 3/3 m) clay matrix with grayish brown (10YR 5/2 m) silan coatings on some ped surfaces; strong medium subangular blocky; firm; plentiful, coarse and fine roots; few fine pores; continuous moderately thick clay films except where silans are present; gradual, wavy boundary; 25 to 30 cm thick.
- BC 64 to 152 cm ; very dark grayish brown (10YR 3.5/2 m) clay matrix with brown (10YR 4/3 m) coatings on some peds; strong coarse subangular blocky; firm; few coarse roots and few fine roots concentrated along ped faces; very few to no pores; continuous moderately thick clay films; gradual, wavy boundary; 89 cm thick.
- C 152 to 188 plus cm ; yellowish brown (10YR 5/4 m) clay loam; massive; friable; few fine pores; no clay films; effervescence questionable.

COMMENTS:

Somewhat discontinuous varv or varv like features were noted just below 64 cm with fragments of apparently distorted varvs below this point.

MAP UNIT NO. 107 (Orthic and Cumulic Regosols)

The soils of this map unit are very fine textured with very few coarse fragments. They have formed on grayish, fine textured materials which appear to be slightly weathered residual shale. Most of the strong structure exhibited by these soils appears to be inherited from the parent shales. This map unit occurs in small local pockets where the weathered bedrock has not been appreciably modified through slumping or erosion. Map unit 107 is geographically located east of Sofa Mountain in the Belly River area of the Park.

Associated Map Units

Map units 57, 100 and 106 are found in association with map unit 107. Map unit 57 is found on the shallow till mantle which covered the shales of the area. Map unit 100 is a slightly coarser textured Regosolic soil found randomly associated with 107, but probably results from local erosion and weathering giving it a translocated appearance. The fine textured Luvisolic soils of map unit 106 are found associated with map unit 107 on areas where the surface few inches has not been disturbed by continuous sheet erosion.

Competing Map Units and Differentiae

Most map units in the Park differ from map unit 107 because of the medium and coarse textured soils which characterize them. Map unit 67 has fine textured soils,

but differs because of its till parent material. Map units 100 and 101 are both found on fine textured materials, but differ by being coarser textured than map unit 107. Map units 102 and 106 differ because of their well-developed Luvisolic profiles. Map unit 103 is located on steep limestone outcroppings, unlike the low lime parent material of 107. Map unit 105 differs from 107 because of its gleyed characteristics.

Vegetation

Vegetation associated with this map unit is characterized mainly by 40 to 60% cover with 40 to 60 foot tall Pinus contorta (lodgepole pine). Pseudotsuga menziesii (Douglas fir) and Picea glauca (white spruce) are common associates. The understory shrub vegetation is characterized by varying amounts of the species Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), and Berberis repens (creeping mahonia). Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed), and Gramineae (grasses), comprise the dominant members of the herb association.

Pedon Description (C200)

Classification: Orthic Regosol (Typic Cryothent).

Described by: Gerald Coen.

Date: August 25, 1972.

Location: about 3/4 of a mile east of where the Belly River enters the Park, and then about 1 mile north of the International boundary.

Climate: continental.

Parent Material: fine textured gray residual shale.

Landform: Dissected valley wall.

Slope: 30% in the vicinity of the pedon and ranging from 20 to 50% associated with the map unit.

Elevation: 5,000 feet ASL.

Relief: about 500 feet.

Aspect: 90 degrees.

Estimated Drainage: well drained.

Water Table: rarely within 90 cm of the surface.

Vegetation: about 50% cover with 60 foot tall Pinus contorta (lodgepole pine) as well as the odd Picea glauca (white spruce) and Pseudotsuga menziesii (Douglas fir) regeneration. Symphoricarpos occidentalis (western snowberry) provides about 25% cover with shrubs. The odd Rubus parviflorus (thimbleberry) was noted. Herbs included Thalictrum venulosum (veiny meadow-rue), Arnica cordifolia (heart-leaved arnica), Lathyrus ochroleucus (wild sweet pea) and Veratrum eschscholtzii (false hellebore). There were few grasses or mosses in the vicinity of the pedon.

Notes: The soil temperature was 10.5° C. at 50 cm There were essentially no stones within the pedon or on the soil surface. The soil was in a virgin condition.

- L-H 2.5 to 0 cm ; very dark grayish brown (10YR 3/2 m) partly decomposed leaf litter with many white mycelia; plentiful medium roots; clear wavy boundary; 1.5 to 5 cm thick.
- C1 0 to 20 cm ; brown (10YR 5/3 m) silty clay loam; strong coarse platy or strong fine subangular blocky; firm; plentiful medium roots; common fine pores; no clay films; no effervescence; no coarse fragments; clear wavy boundary; 18 to 23 cm thick.
- C2 20 to 33 cm ; grayish brown (10YR 5/2 m) silty clay; strong medium subangular blocky (probably a pseudo structure inherited from the parent material); firm; few fine and medium roots; common, very fine pores; discontinuous, very thin clay films; no effervescence; no coarse fragments; clear wavy boundary; 10 to 15 cm thick.
- C3 33 to 50 cm ; grayish brown (10YR 5/2 m) clay with common medium distinct yellowish brown (10YR 5/6 m) mottles; massive (no real pedes but looks like large subangular blocky); firm; few fine roots; common very fine pores; continuous very thin clay films; no effervescence; no coarse fragments; gradual wavy boundary; 15 to 20 cm thick.
- C4 50 to 100 plus cm ; gray (10YR 5/1 m) and strong brown (7.5YR 5/6 m) clay with few fine distinct yellowish red (5YR 4/6 m) mottles; massive; firm; few roots; few fine pores; continuous, very thin clay films; no effervescence; no coarse fragments.

COMMENTS:

The very blocky appearance in the lower C horizons of this pedon appears to be inherited from soft shales which are somewhat weathered in situ.

MAP UNIT NO. 141 (Orthic Regosol)

The soils of this map unit are coarse textured with variable amounts of coarse fragments generally greater than 50 or 60%. They have formed on loose variously coloured colluvial materials, the colour depending upon the rock outcrops in the immediate area. In general, map unit 141 is found on uniformly sloping steep slopes. Constant downslope creep and erosion contributes to the loose nature of the soils and to the lack of horizon development. The majority of these soils are found at higher elevations but they do also occur at lower elevations and wherever rock cliffs allow the occurrence of significant colluvial slopes. Map unit 141 is geographically located throughout the mountainous regions of the Park.

Associated Map Units

Map units 11, 22, 38, 64, 100, 142, 156, Chutes, Rock and Talus are found in association with map unit 141. Where the steep colluvial deposits directly adjoin the stream channels map unit 141 is found in association with map unit 11. Depending upon the region of the Park, map units 22 or 38 are found on fans associated with the toe of the slopes where map unit 141 is located. Map unit 64 is found associated with map unit 141 in the western half of the Park where till moraine deposits abut the steeper colluvial slopes. In the Belly River area the fine textured soils of map unit 100 may at times adjoin map unit 141 where the steep colluvial slopes are tending to inundate the softer shale materials upon which map unit 100 is located. Map unit 142 and 156 are found associated with map unit 141 on similar landforms but differ somewhat in the surface L-H and Ah horizons in the case of 142, and in the brighter Bf horizons in the case of 156. Chutes are generally found beneath areas of snow accumulation and dividing similar areas of map unit 141. Rock and Talus are both generally found at the extreme upper slopes of map unit 141.

Competing Map Units and Differentiae

Map units 38, 39 and 48 may at times be similar to map unit 141 but in general are differentiated because of their less steeply sloping fan shaped landforms. Map unit 142 differs by the lack of a significant L-H horizon and the presence of a reasonably well-developed Ah horizon. Soils of map unit 150 differ by the intermittent presence of fairly bright coloured B horizons indicating a tendency toward Brunisolic development. Map units 156 and 160 differ from map unit 141 by having soils with Podzolic B and Luvisolic B horizons respectively.

Vegetation

Vegetation associated with map unit 141 is dominantly evergreen forests generally about 40 to 60 feet tall decreasing in height with increasing elevation and providing about 40 to 60% cover. The dominant species is probably Abies lasiocarpa (alpine fir) and is associated with Pinus ablicaulis (white-bark pine) at higher elevations and Pinus contorta (lodgepole pine) at lower elevations. However, areas having dominantly Larix lyallii (alpine larch) are often found near the timber line and areas having Pseudotsuga menziesii (Douglas fir) are common at about 5,000 to 4,000 feet ASL. Commonly occurring shrubs associated with map unit 141 include Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), Berberis repens (creeping mahonia) and at higher elevations such species as Menziesia ferruginea (false huckleberry), Vaccinium membranaceum (tall bilberry) and Ribes viscosissimum (sticky currant). Commonly occurring herbs include Thalictrum venulosum (veiny meadow rue), Arnica cordifolia (heart-leaved arnica), Clintonia uniflora (one-flowered clintonia) and at higher elevations Xerophyllum tenax (bear grass) and Lazula glabrata (wood rush).

Pedon Description (C247)

Classification: Orthic Regosol (Typic Cryorthent)

Described by: Gerald Coen.

Date: September 15, 1972.

Location: about 200 yards northwest of the abattoir (Fig. 22).

Climate: continental.

Parent Material: coarse textured colluvium containing abundant coarse fragments generally composed of fine gravel sized red and green shales.

Landform: steep colluvial slopes.

Slope: 65% in the vicinity of the pedon and ranging 50 to 70% in the area.

Elevation: 4,500 feet ASL.

Relief: about 500 feet.

Aspect: 260 degrees.

Estimated Drainage: well drained.

Water Table: probably never within three feet of the surface.

Vegetation: about 60 to 70% cover with 30 to 40 foot tall Pseudotsuga menziesii (Douglas fir). Shrubs noted included Acer glabrum (mountain maple), Symphoricarpos occidentalis (western snowberry), Berberis repens (creeping mahonia), and Spiraea lucida (white meadowsweet). Herbs noted included Veratrum eschscholtzii (false hellebore), Disporum trachycarpum (fairybells), Aster sp., and Thalictrum venulosum (veiny meadow rue). A few grasses and mosses were observed.

Notes: The soil temperature at 50 cm was 10 degrees C. Cobble sized coarse fragments and some larger stones were common on the surface and within the pedon. Fine gravel sized coarse fragments were very prominent within the pedon. The soil was in a virgin condition.

- L-H 5 to 0 cm; very dark brown (10YR 2/2 m) well to slightly decomposed leaf material; abrupt wavy boundary; 2.5 to 10 cm thick.
- C1 0 to 58 cm; dark brown (10YR 3/3 m) gravelly loamy coarse sand; single grain; loose; few fine and plentiful medium roots; no pores observed; no clay films; no effervescence; estimated coarse fragments 50% (mainly fine gravels); diffuse wavy boundary; 50 to 64 cm thick.
- C2 58 to 81+ cm; grayish brown (2.5Y 5/2 m) gravelly loamy coarse sand; single grain; loose; few roots; no pores; no clay films; no effervescence; estimated coarse fragments 50% (mainly fine gravels).

COMMENTS:

The depth of the L-H horizon varies considerably, increasing in thickness with greater amounts of protection from downslope creep. Thicknesses of 13 and 15 cm are reached behind old, well established trees.

The C horizons are very loose and the plate like gravel sized shales are laying with their longest axis parallel to ground surface and appear in many cases somewhat shingled.

The above pedon description typifies but a small range of the fairly heterogeneous concept embodied in map unit 141. When this map unit is found associated with the very red shales such as those near Red Rock Canyon and elsewhere in the Park, some of the soil colours have hues as red as 10R. Coarse fragments can vary from as little as 20% up to 80 or 90% depending upon the slope position and the amount of weathering that occurs in the process of the downslope creep. In some cases sloughing of large boulders allows

a component of this size coarse fragments within the generally finer matrix. In general the map unit is set up to recognize Orthic Regosols and possibly Cumulic Regosols having fairly well developed L-H horizons with little or no Ah and a fairly coarse C horizon and is associated with the steep colluvial slopes.

MAP UNIT NO. 142 (Orthic Regosol)

The soils of this map unit are coarse textured often with many cobbles and boulders within the solum. They have formed on coarse textured colluvium (but not chutes, talus or scree) on steep slopes. The fine gravels are dominated by flat shaped red and green argillites. Coarser gravels and larger sizes contain angular limestone fragments with minor amounts of sandstone. The parent material is very loose. This map unit is found on G and H slopes and thus geologic erosional forces are quite active, preventing significant profile development. Most of the soils should be classed as Orthic Regosols although some Cumulic Regosols may be present. Geographically, these soils are found on the steep, non-forested slopes throughout the Park.

Associated Map Units

Map units 38, 39, 50, 57, 64, 141, 156, Talus and Rock are found in association with map unit 142. Map units 38 and 39 are associated on fans and modified fans generally at the lower margins of map unit 142. Map units 50, 57 and 64 are mapped on the till landscapes generally associated with the bare slopes of map unit 142 in the grassland area, the northeastern portion of the Park and the western portion of the Park respectively. Map unit 141 is associated with, and occasionally intimately mixed with map unit 142 wherever less exposure, or fewer snow slides allow significant forest cover to establish. In the western half of the Park, where fairly stable colluvial slopes permit the development of soil horizons, map unit 156 is associated with map unit 142 which is on the more unstable slope positions. Map units Rock and Talus are generally associated with the upper slopes of map unit 142 and provide much of the source material for the colluvial slopes.

Competing Map Units and Differentiae

Map unit 38 is separated from many other map units in the Park mainly on the basis of landform (fan) and slope (15 - 20%). Map unit 141 differs from map unit 142 mainly in that it is forested indicating a slightly different moisture regime. Map unit

150 differs in that it is loam textured and contains few red and green argillites and mostly dolomitic limestones. Slopes are somewhat more variable and the unconsolidated material is often less than 4 feet to bedrock.

Vegetation

Vegetation characteristic of this map unit is comprised of 5% coverage with a shrub association of Potentilla fruticosa (shrubby cinquefoil) and 100% coverage of a herb association consisting of Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue), Danthonia parryi (parry oat grass) and Lupinus sericeus (pursh's silky lupine). There are also some areas where the vegetation association provides 40% coverage with shrubs such as Amelanchier alnifolia (saskatoon), Abies lasiocarpa (alpine fir) and Populus tremuloides (trembling aspen). Herb coverage in these areas amounts to 60% with associations consisting of Gramineae (grasses), Veratrum eschscholtzii (false hellebore), Achillea millefolium (common yarrow) and Heuchera cylindrica (alum-root).

Pedon Description (C124)

Classification: Orthic Regosol (Typic Cryorthent)

Described by: Gerald Coen.

Date: September 15, 1971.

Location: south of the fire tower about 1 mile and above the fan (map unit 38) located at the base of Sofa Mountain (Fig. 22).

Climate: continental.

Parent Material: loose, coarse colluvium.

Landform: mountain side.

Slope: 58 - 60%.

Elevation: 6300 feet ASL.

Relief: about 1000 feet on the landform.

Aspect: about zero degrees.

Estimated drainage: well drained.

Water table: below 100 cm.

Vegetation: few trees or shrubs close to pit other than Potentilla fruticosa (shrubby cinquefoil). Lupinus sericeus (pursh's silky lupine) was also noted. About 40 - 60% of the soil surface was covered with fescues and about 10 - 15% of the soil surface was bare.

Notes: Surface stones are very variable, and dependent considerably on the distance to the rock outcrop above. There are few coarse fragments greater than 5 cm in diameter in the pit but some areas mapped have up to 40 - 60% by volume of coarse fragments with many larger than 5 cm. The soil was in a virgin condition.

- Ah 0 to 10 cm; dark brown (7.5YR 3.5/2 d) gravelly sandy loam; single grain (held together by roots); loose to very friable; plentiful fine roots; estimated coarse fragments 40%; diffuse, wavy boundary; 8 to 13 cm thick.
- C1 10 to 74 cm; dark brown (7.5YR 3.5/2 d) gravelly sandy loam; single grain; loose to friable; plentiful fine roots; estimated coarse fragments 40%; diffuse, wavy boundary; 56 to 69 cm thick.
- C2 74 to 87+ cm; dark brown (7.5YR 4/2 d) dark reddish brown (5YR 3/4 m) gravelly sandy loam; single grain; loose; few, fine roots; estimated coarse fragments 40%.

COMMENTS:

The horizons are very poorly differentiated and organic matter seems to be present even into the C2 to give a fairly dark colour.

MAP UNIT NO. 150 (Orthic Regosol and Degraded Eutric Brunisol)

The soils of this map unit are coarse textured with abundant gravel sized coarse fragments within the solum. Cobbles are common within the solum and on the surface. Large coarse fragments are much less common. Because of the fairly steep colluvial slopes, on which these soils are formed, there is a considerable tendency for soil creep, which causes disruption on the surface horizons. Soil accumulation on the upslope side of old trees is evidence for the prevalence of downslope creep. Map unit 150 is geographically located in the more mountainous regions of the Park, particularly on the east side of upper Waterton Lake in the vicinity of the Hell-Roaring Valley.

Associated Map Units

Map units 52, 91R, Chutes, Talus and Rock are found in association with map unit 150. At generally lower elevations where till remains uncovered, map unit 52 adjoins map unit 150. Map unit 91R is commonly found adjoining map unit 150 at lower elevations where the bedrock controlled landform has not yet been covered by the colluvium. Where accumulations of snow and runoff tend to follow shallow depressions, the map unit Chute is associated with the colluvial materials of map unit 150. Rock and

Talus are generally found associated with map unit 150 at higher elevations and on steeper landforms.

Competing Map Units and Differentiae

Map unit 141 differs from 150 mainly because of the abundance of gravel sized plate shaped red and green shales. Soils of map unit 141 do not have evidence of B horizon development in any of the areas. Soils of map unit 142 have no leaf litter and a reasonably well developed, fairly thick Ah horizon which serves to separate it from map unit 150. Map units 156 and 160 differ from map unit 150 in that they are found on fairly stable steep slopes and have soils with Podzolic and Luvisolic profile development respectively.

Vegetation

Vegetation associated with this map unit is characterized by forests dominated by Pinus contorta (lodgepole pine) and sometimes a mixture of Pinus contorta and Pseudotsuga menziesii (Douglas fir). These stands provide 40 to 60% cover with 20 to 40 foot tall trees. Occasionally where this map unit is found at higher elevations, species such as Abies lasiocarpa (alpine fir) and Larix lyallii (alpine larch) are also observed. Some of the shrub species associated with this map unit are Rubus parviflorus (thimbleberry), Acer glabrum (mountain maple) and Shepherdia canadensis (Canadian buffalo-berry). Herbs include Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed), and Aster sp.

Pedon Description (C202)

Classification: Orthic Regosol (Typic Cryorthent).

Described by: Gerald Coen.

Date: August 26, 1972.

Location: about 1 mile towards Crypt Lake from Crypt Landing and just north of the trail.

Climate: continental.

Parent Material: Loose slightly weathered somewhat unstable colluvium.

Landform: fairly steep upper mountain sides.

Slope: 55% in the vicinity of the pedon, and from 50 to 65% on the landform.

Elevation: 5,000 feet ASL.

Relief: about 500 feet.

Aspect: 180 degrees.

Estimated Drainage: well drained.

Water Table: probably rarely within 150 cm of the surface.

Vegetation: about 40% cover with 40 to 60 foot tall Pinus contorta (lodgepole pine).

There was some regeneration with Pseudotsuga menziesii (Douglas fir). Shrubs included Rubus parviflorus (thimbleberry), Symphoricarpos occidentalis (western snowberry) and Berberis repens (creeping mahonia). Thalictrum venulosum (veiny meadow rue) was the herb species noted. Ferns were common component of the understory. Very few grasses or mosses were observed.

Notes: The soil temperature at 50 cm was 12 degrees C. Stones of gravel and cobble sizes were fairly common within the solum and upon the soil surface. The soil was in a virgin condition.

- L-F 2.5 to 0 cm.; very dark gray (10YR 3/1 m) partly decomposed organic matter; few fine roots; abrupt wavy boundary; 1.5 to 5 cm thick.
- Ah 0 to 13 cm; dark brown (10YR 3/3 m) gravelly sandy loam; weak large subangular blocky; friable; abundant fine and medium roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 25%; clear wavy boundary; 8 to 18 cm thick.
- C 13 to 30 cm; brown (10YR 5/3 m) gravelly sandy loam; single grain; loose; abundant fine and medium roots; pores unobserved; no clay films; estimated coarse fragments 25%; clear wavy boundary; 10 to 20 cm thick.
- Bfb 30 to 56 cm; strong brown (7.5YR 5/6) gravelly loam; very weak fine subangular blocky; friable; plentiful fine roots; the fluffy material was so easily crushed pores could not be observed; no clay films; no effervescence; estimated coarse fragments 30%; clear broken boundary; 0 to 36 cm thick.
- Cb 56 to 100+ cm; light yellowish brown (10YR 6/4 m) gravelly coarse sandy loam; single grain; loose; plentiful fine and medium roots; fluffy material in which pores could not be observed. no clay films; no effervescence; estimated coarse fragments 50%, mostly fine gravel size.

COMMENTS:

The Bfb horizon appears to be a remnant of a more stable situation which was somewhat catastrophically disturbed resulting in a mixing of horizons. There was a buried charred log at the upper margin of one of the pockets of Bfb indicating that the catastrophic change may have been initiated by fire and is at present reasonably

well stabilized. Some, and probably many of the pedons mapped as 150 will not show a Bfb horizon or a Bfj horizon. The preceding evidence indicates, however, that there is a strong tendency toward Podzolic or Brunisolic profile development which may be prevented from expressing itself by the unstable surface soil conditions.

MAP UNIT NO. 156 (Orthic Humo-Ferric Podzols and Degraded Eutric Brunisols)

The soils of this map unit are coarse textured with relatively common coarse fragments mostly in the gravel and cobble sizes. They have formed on steep and very steep colluvial slopes comprised of debris from the local bedrock. Because of the relatively good tree and vegetative cover and possibly other factors these soils are not subject to appreciable downslope creep or erosion. Thus, they are able to develop distinctive profile characteristics. Podzols and some weakly developed Podzols or Brunisols are common in this map unit. There are extensive areas of this map unit along the steeper mountain sides in the western half of the Park. Map unit 156 is geographically located in the more humid mountainous areas west of the Waterton Lakes.

Associated Map Units

Map units 38, 48, 53, 64, 141, 142, Rock, Talus and Chutes are found in association with map unit 156. Depending on the vegetative cover map units 38, or 48 are found near the lower margins of map unit 156 where the colluvial slopes abut the fan landforms. Map unit 53 is found occasionally at the lower slope positions of map unit 156 in the depressional areas having till parent materials. Map unit 64 is commonly found on the lower valley walls or lower mountain sides where the morainic deposits are still exposed to the surface and map unit 156 is found above these areas where colluvium has moved downslope and partially inundated the morainic landform. Map units 141 and 142, where they are found in association with map unit 156, are generally at higher elevations and in otherwise unstable slope positions where the Podzolic or Luvisolic characteristic is not allowed to form. Rock and Talus map units are generally found at somewhat higher elevations where colluvium abuts the rock outcroppings. Chutes are found somewhat randomly dividing fairly large areas of map unit 156 by traversing them in downslope narrow bands.

Competing Map Units and Differentiae

Map unit 156 has pedons similar to both map unit 47 and 49 but the latter map units differ by the fan shaped landforms on which they are found and by their somewhat more compact nature. Map unit 64 differs from map unit 156 because of its development on till rather than colluvium. Map units 90R and 91R differ from map unit 156 mainly because of their lithic character. Map units 141, 142 and 150 are all found on colluvial slopes but differ because they are characterized by soils with Regosolic characteristics. Map unit 160 is also found on colluvial slopes and associated with colluvial materials but is characterized by soils with Gray Luvisol horizon development rather than a Podzolic development as in map unit 156.

Vegetation

Vegetation associated with this map unit varies from Pinus contorta (lodgepole pine) and Abies lasiocarpa (alpine fir) at lower elevations to Pinus albicaulis (white-bark pine) and Larix lyallii (alpine larch) at above 6,500 feet. Picea glauca (white spruce) and Picea engelmannii (Engelmann spruce) are also found occasionally associated with this map unit. In general trees become more stunted with elevation although there are some notable areas of Larix lyallii (alpine larch) at around 7,000 feet which are 40 to 50 feet tall. The major shrubs associated with this map unit include Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), Berberis repens (creeping mahonia) and Shepherdia canadensis (Canadian buffalo-berry). At higher elevations Vaccinium spp. (blueberries) and Menziesia ferruginea (false huckleberry) are also quite common. The associated herbs include Xerophyllum tenax (bear grass), Arnica spp. (arnica), Angelica dawsonii (yellow angelica) and Thalictrum venulosum (veiny meadow rue).

Pedon Description (C237)

Classification: Orthic Humo-Ferric Podzol (Typic Cryorthod¹).

Described by: Gerald Coen.

Date: September 13, 1972.

Location: adjacent to the small tributary joining Cameron Creek from the east at a point about $\frac{1}{2}$ mile south from Little Cameron Lake (Fig. 22).

Climate: continental.

¹ The classification of soils into the Spodosol Order in the American Classification System is tentative.

Parent Material: coarse textured fine gravelly loose colluvium.

Landform: colluvial slope.

Slope: 30% in the vicinity of the pedon and varying from 30 to 50% or more on the immediate landform.

Elevation: 5,900 feet ASL.

Relief: about 500 to 1,000 feet.

Aspect: 270 degrees.

Estimated Drainage: well drained.

Water Table: below the pedon for most if not all of the year.

Vegetation: 40 to 50% cover was provided by 40 to 60 foot tall Pinus contorta (lodgepole pine) and Abies lasiocarpa (alpine fir). Dominant shrubs included about 40% cover with Menziesia ferruginea (false huckleberry) as well as various amounts of Symphoricarpos occidentalis (western snowberry). Xerophyllum tenax (bear grass), Pyrola spp. (wintergreen) and Arnica cordifolia (heart-leaved arnica). Mosses were fairly prevalent.

Notes: The soil temperature at 50 cm was 6 degrees C. There were few stones on the surface but many mainly gravel and cobble sizes within the pedon increasing with depth. The soils was in a virgin condition.

- L-F 4 to 0 cm; very dark brown (10YR 2/2 m) slightly decomposed organic litter; abrupt wavy boundary; 1.5 to 7 cm thick.
- Ae 0 to 10 cm; reddish gray (5YR 5/2 m) gravelly sandy loam; weak medium platy; very friable; abundant fine and medium roots; pores unobserved; no clay films; no effervescence; estimated coarse fragments 40%; abrupt wavy boundary; 2.5 to 18 cm. thick.
- Bf 10 to 41 cm; yellowish red (5YR 4/6 m) gravelly sandy loam; weak fine subangular blocky; friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 40%; abrupt wavy boundary; 18 to 30 cm thick.
- C 41 to 75+ cm; reddish brown (5YR 4/3 m) gravelly sandy loam; single grain; loose; few fine roots; no pores observed; no clay films; no effervescence; estimated coarse fragments 50%.

COMMENTS:

The gravels, particularly the fine gravels, are dominantly plate shaped and occur oriented horizontal to the surface of the soil in a fashion somewhat resembling the way in which shingles are placed on a roof. Some tree throw is evident giving

fairly well developed micro-topography. A fair amount of variation in the depth of the Ae horizons can be expected because of the disturbance caused by falling trees. The variation in the depth of the Ae horizons will be greater at higher elevations and on steeper slopes.

MAP UNIT NO. 160 (Orthic Gray Luvisol)

The soils of this map unit are coarse to medium textured with plentiful coarse fragments mostly less than six inches in diameter within the pedon and less common coarse fragments on the surface. They have formed from loose, fairly stable colluvium high in weathered limestone. The slope of the landforms associated with map unit 160 appears in general to be somewhat less steep than adjacent colluvial landforms upon which Regosol soils have developed. A very small percentage of the colluvial slopes within the Park are stable enough to allow the development of Orthic Gray Luvisols. Geographically map unit 160 is located in the Horseshoe Basin area of the Park.

Associated Map Units

Map units 17, 37, 38, 57, 58, 61, 66, 141, 142, Rock and Talus are commonly found associated with map unit 160. Map unit 17 is found in stream courses at lower elevations where there is an abrupt drop from the steep mountain slope to the creek bottom. Map units 37 and 38 are found where fans are adjoining the steep mountain slopes, generally near the base of these slopes. Depending on the horizon development map units 57, 58, 61 and 66 are found on morainic areas associated with the lower portions of the slopes upon which map unit 160 is found. Map units 141 and 142 are found on similar colluvial slopes to those of map unit 160 but because of their steepness or landscape position the soils of the former two do not have the Luvisolic horizon development. Rock and Talus are often found near the upper margins of the colluvial slopes upon which map unit 160 is located.

Competing Map Units and Differentiae

Map unit 46 differs from map unit 160 in that it has developed on a fan shaped landform and has somewhat finer textured material. Map units 57, 58 and 61 are dominantly characterized by Luvisolic soils but developed on till which separates them

from map unit 160. Map units 141, 142, 150 and 156 are all characterized by soils developed on colluvial slopes but the first three are Regosolic soils and 156 is a Podzol so the separation between these and 160 is fairly evident.

Vegetation

Vegetation associated with this map unit is characterized by 40 to 60% coverage with 20 - 40 foot tall Pinus contorta (lodgepole pine). Some areas have a significant component of Abies lasiocarpa (alpine fir). In some areas shrubby Pinus flexilis (limber pine) and Pseudotsuga menziesii (Douglas fir) are found as well as shrubby members of the previously mentioned species. In many areas shrubs such as Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet) and Berberis repens (creeping mahonia) are common. Herbs include Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed) and Gramineae (grasses).

Pedon Description (C211)

Classification: Orthic Gray Luvisol (Typic Cryoboralf).

Described by: Gerald Coen.

Date: August 30, 1972.

Location: about 1 mile west of the Buffalo paddocks and 300 yards south of the trail in the Horseshoe Basin area where it has levelled off after climbing out of the main Waterton Valley (Fig. 22).

Climate: continental.

Parent Material: medium textured, fairly loose colluvium.

Landform: colluvial mountain sides with fairly simple slopes.

Slope: 45% in the vicinity of the pedon and between 40 and 50% on the landform associated with this map unit.

Elevation: 5,200 feet ASL.

Relief: about 400 feet.

Aspect: 10 degrees.

Estimated drainage: well drained.

Water Table: rarely, if ever within the pedon.

Vegetation: about 40% cover with 30 foot tall Pinus contorta (lodgepole pine).

Shrubs noted included Alnus crispa (green alder), Shepherdia canadensis (Canadian buffalo-berry) and Rubus parviflorus (thimbleberry). Herbs observed included Geranium viscosissimum (sticky geranium) Veratrum eschscholtzii (false hellebore), Disporum oreganum and Disporum trachycarpum (fairybells), Arnica cordifolia (heart-leaved arnica) and Aralia nudicaulis (wild sarsaparilla).

Notes: The soil temperature at 50 cm was 9 degrees C. There were few stones on the surface and common stones within the pedon. The soil was in a virgin condition.

- L-H 7 to 0 cm; very dark gray and black (10YR 3/1 and 2/1 m) relatively well decomposed organic litter; plentiful fine roots; abrupt wavy boundary; 4 to 8 cm. thick.
- Ae 0 to 8 cm; pale brown (10YR 6/3 m) gravelly loam; weak coarse platy; very friable; plentiful fine and coarse roots; few medium pores; no clay films; no effervescence; estimated coarse fragments 40% mostly gravel sizes; clear wavy boundary; 5 to 10 cm thick.
- Bt1 8 to 20 cm; yellowish brown (10YR 5/6 m) gravelly clay loam; weak large subangular blocky; friable; plentiful fine roots; common fine pores; few thin clay films; no effervescence; estimated coarse fragments 40%; gradual wavy boundary; 10 to 20 cm thick.
- Bt2 20 to 38 cm; yellow (10YR 7/6 m) gravelly clay loam; weak medium subangular blocky; friable; few fine roots; few fine pores; few thin clay films; no effervescence; estimated coarse fragments 40%; clear wavy boundary; 15 to 20 cm thick.
- Ck 38 to 100+ cm; yellowish brown (10YR 5/4 m) gravelly clay loam; massive; friable; few roots; very few fine pores; no clay films; moderate effervescence; estimated coarse fragments 40%.

COMMENTS:

There are many highly weathered non-effervescent limestone remnants or ghosts in the Bt1 and Bt2 horizons. Some of these are fairly firm but of low bulk density. Some of the coarse fragments in the Ck horizon had limestone pendants indicating appreciable downward leaching of calcium carbonate. The areal extent

of this map unit within the Park is very small and even within the area there are profiles in which the Ae has been significantly disturbed and thus they look like Brunisolics.

MAP UNIT NO. 170 (Orthic Regosol)

The soils of this map unit are coarse textured with essentially no coarse fragments. They have formed on light coloured wind-blown sand. The dunes are currently stabilized with a reasonably good growth of shrubby vegetation. However, the lack of soil profile development indicates that there is probably some accretion annually. Map unit 170 is geographically located in a single area on the southeast corner of Knight's Lake.

Associated Map Units

Map units 17, 31 and 171 are found in association with map unit 170. Map unit 31 is found at the extreme margin of the Sofa Creek fan where the fan material is inundated by water for significant periods of the year and map unit 170 has a common boundary at this point. Map unit 171 occupies the tension zone between map unit 17 and map unit 170. Downwind from map unit 170 accretion of windblown material on top of map unit 17 causes it to become a buried paleosol which is mapped as map unit 171.

Competing Map Units and Differentiae

Map unit 170 is the only soil developed on dune sand within the Park and differentiation of this unit from most others should not be difficult. Map unit 171 is a shallow surficial deposit over river terrace material without the dune landform and as such should easily be separated from map unit 170. Map unit 25 has a similar texture and somewhat similar profile development but the very characteristic fan landform should serve as a differentiating feature. The relatively well developed Ah and/or Ae horizons characteristic of soils of map unit 36 as well as its landscape position should serve to differentiate it from map unit 170.

Vegetation

Vegetation associated with this map unit is characterized by patches of very scrubby Populus tremuloides (trembling aspen). Common shrubs include Amelanchier

alnifolia (saskatoon), Rosa woodsii (common wild rose) and Symphoricarpos occidentalis (western snowberry). Common herbs include Lupinus argentus (perennial lupine), Artemezia frigida (pasture sage), Artemezia biennis (wormwood) and Erigeron glabellus var. pubescens (smooth fleabane). Gramineae (grasses) are a common component of the vegetation. The most dominant grass species were Bromus inermis (awnless brome) and Festuca spp. (fescues).

Pedon Description (C233)

Classification: Orthic Regosol (Typic Cryorthent)

Described by: Gerald Coen.

Date: September 12, 1972.

Location: sand dunes on the southeast corner of Knight's Lake.

Climate: continental.

Parent Material: light coloured coarse textured fairly well sorted windblown materials probably having a very local source.

Landform: sand dunes.

Slope: about 10% in the vicinity of the pedon and short steep complex slopes of from 5 to 40% on the landform.

Elevation: 4,200 feet ASL.

Relief: 30 to 40 feet.

Aspect: not applicable.

Estimated Drainage: rapidly drained.

Water Table: greater than 5 feet below the surface.

Vegetation: see above.

Notes: The soil at 50 cm was 10 degrees C. There were essentially no stones within the pedon or on the surface. The soil was in a virgin condition.

C 0 to 130+ cm; brown (7.5YR 4/2 m) loamy coarse sand; single grain; friable; many fine and medium roots; pores unobserved; no clay films; no effervescence; no coarse fragments.

COMMENTS:

There is seldom if ever any grass or leaf mat on the surface of the soil. The dunes are, however, for the most part stabilized. There was little evidence of buried organic matter or horizons so there is probably a fairly continuous accretion of sand. In the fall the water level at the south end of Knight's Lake appears to be low enough that deflation

of sands can occur. The distance involved is about $\frac{1}{4}$ of a mile so the size fraction distribution would not be characteristic of loess.

MAP UNIT NO. 171 (Cumulic Regosol)

The soils of this map unit are coarse textured with very few coarse fragments in the upper part of the solum and many coarse fragments in the lower part of the solum. They have formed on a thin mantle of windblown sand deposited over top of river terrace alluvium. There is for the most part a Chernozemic paleosol developed in the lower river terrace material. This paleosol is very similar to the major soils comprising map unit 17. The depth of the overlaying surficial deposit decreases to the northeast as the distance from the sand dunes increases. Because of the fairly frequent occurrence of winds from the south blowing out of the Waterton valley this supports the concept of the material being windblown. The occurrence of a fairly well developed Chernozemic profile beneath the overlaying surficial deposit suggests that for a significant period of time the source material for the windblown sand must have been unavailable through some natural phenomena, thus allowing a stable landscape in which soil horizons could develop. There presently appears to be a continuous accretion of surficial sandy material preventing the development of horizons leading to the Regosol classification. Map unit 171 is geographically located near the southeast corner of Knight's Lake.

Associated Map Units

Map units 1, 17, 31, 50 and 170 are found in association with map unit 171. At the north end of map unit 171 there is a small kame-like deposit of outwash material upon which there is some accretion of windblown sand. The boundary between these two units constitutes the adjoining of map unit 1 to map unit 171. As the overlaying surficial deposits thin out toward the north it eventually grades into map unit 17. The line between map unit 171 and 17 is arbitrarily placed at the approximate point where the surficial deposit becomes less than 15 cm deep. Map unit 31 is found in the wet depressions adjacent to map unit 171. The till landscape associated with the drumlin to the north and the moraine to the east has a common boundary with map unit 170 and is slightly influenced by the surficial deposit. Map unit 170 grades into map unit 171 and the

boundary between the two is arbitrarily placed where the surficial deposit reaches depths of greater than 75 cm. This corresponds reasonably well with the margin of the dune landform.

Competing Map Units and Differentiae

The position of the boundary between map unit 17 and map unit 171 is arbitrarily placed when the surficial deposit over the paleochnozem becomes less than 15 cm. For practical purposes map unit 17 has the same morphological characteristics as the paleochnozem recognized beneath the surficial deposit in map unit 171. At the other extreme, map unit 171 is separated from map unit 170 when the depth of the surficial deposit reaches greater than 75 cm. This corresponds reasonably well with the dune landform boundary. Map units 25 and 36 are similar in texture but differ in that they do not have a paleo (buried) profile.

Vegetation

The major vegetation associated with this map unit is Gramineae (grasses). Festuca idahoensis (bluebunch fescue), Festuca scabrella (rough fescue) and Danthonia parryi (parry oat grass) are the dominant species. Other herbs such as Lupinus sericeus (perennial lupine), and Erigeron glabellus var. pubescens (smooth fleabane) are found. Shrubs include Rosa acicularis (prickly rose) and Symphoricarpos occidentalis (western snowberry). Selaginella densa (little clubmoss) is also found (Stringer, 1969)¹.

Pedon Description (C234)

Classification: Orthic Regosol (Typic Cryofluvent).

Described by: Gerald Coen.

Date: September 12, 1972.

Location: between the Y.M.C.A. Camp and Knight's Lake.

Climate: continental.

Parent Material: coarse textured wind transported surficial deposit of sandy material over a paleochnozem developed in river terrace alluvium.

Landform: river terrace.

Slope: $\frac{1}{2}$ % in the vicinity of the pedon and ranging up to 5% in the map unit.

Elevation: 4,200 feet ASL.

¹ Stringer, P.W. 1969. An ecological study of grasslands at low elevations in Banff, Jasper and Waterton Lakes National Parks. Ph.D. Thesis, U. of A. Edmonton.

Relief: about 10 feet.

Aspect: none.

Estimated Drainage: rapidly drained.

Water Table: probably rarely within 90 cm of the surface.

Vegetation: few trees except the occasional Populus tremuloides (trembling aspen) at the margins of the map unit. The main shrub observed was Symphoricarpos occidentalis (western snowberry) providing less than 5% cover. Herbs observed included Lupinus argentus (perennial lupine) Artemesia frigida (pasture sage), Campanula rotundifolia (common bluebell), Achillea lanulosa (common wild yarrow), Erigeron glabellus var. pubescens (smooth fleabane), Linum lewisii (wild blue flax) and Oxitropis splendens (showy loco weed). Nearly 100% of the cover was provided by Gramineae (grasses) such as Festuca sp. (fescues) and Phelum pratense (timothy).

Notes: The soil temperature at 50 cm was 11 degrees C. There were essentially no stones on the surface and only stones in the alluvium lower in the profile. The soil appeared to be in a virgin condition, although the vegetation may have been harvested for forage.

- C 0 to 41 cm; dark brown (7.5YR 3/2 m) loamy sand; massive to single grain; very friable; plentiful fine roots; common fine pores; no clay films; no effervescence; no coarse fragments; abrupt wavy boundary; 38 to 43 cm thick.
- IIAhb 41 to 66 cm; dark reddish brown (5YR 2/2 m) sandy loam; medium subangular blocky; friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 15%; clear wavy boundary; 23 to 28 cm thick.
- IIBmb 66 to 91 cm; dark reddish brown (5YR 3/4 m) gravelly sandy loam; weak large subangular blocky; very friable; plentiful fine roots; pores unobserved; no clay films; occasional effervescence associated with the surface of gravels; estimated coarse fragments 25%; gradual wavy boundary; 23 to 28 cm thick.
- IICb 91 to 100+ cm; dark yellowish brown (10YR 4/4 m) very gravelly loamy sand; single grain; loose; very few roots; many interstices unfilled by fines; no clay films; effervescence associated with limestone pendants; estimated coarse fragments 90%, all gravel sized.

COMMENTS:

In the C horizon the occurrence of slightly darker layers suggests that intermittent inundation may bury the grass mat on the surface. Much rodent activity may contribute to the loss of evidence of buried horizons. The coarse fragments in the paleo pedon are almost entirely restricted to gravel sizes.

MAP UNIT NO. 190 (Silvo-Fibrisol)

The soils of this map unit are comprised of relatively undecomposed mosses with about 20 to 40% of the identifiable organic remains comprised of sedges and shrubs. Sphagnum mosses were not identified in the relatively undecomposed peaty material. These soils have slightly acid to neutral reaction. They are saturated throughout the season and in most areas are greater than 150 cm deep to mineral material. There are few areas within the Park where appreciable amounts of organic soils are found. The largest area is about 1 mile east of the fire tower south of Highway 6. This area is taken as the type area. However a small area was mapped north of Cameron Lake. In this area the soils are slightly more oxidized and probably fall within the Mesic Fibrosol or Fibric Mesisol Great Groups. Small areas of organic soils were also mapped in the Galway Creek area and the Belly River area.

Associated Map Units

Map units 12, 19, 25, 29, 31, 32, 36, 41, 50, 53, 57, 58, 64, 156 and Bp are found in association with map unit 190. In the Belly River area, map unit 12 is sometimes found on the morainic landforms associated with map unit 190. In the Maskinonge area map unit 19 is sometimes found on the river floodplains associated with map unit 190 developed in hollows or ox-bow areas. Map units 25, 29, 31 and 32 are found on the lower margin of fans where they abut the depressional areas in which map unit 190 is developed. Occasionally north of Sofa Mountain the Gray Luvisol sandy, non-stony, soils of map unit 36 are found on the well drained landforms associated with map unit 190. In the Belly River area map unit 41 is associated with some of the draws entering the depressional areas where map unit 190 is found. Map units 50, 53, 57 and 58 are found on morainic landforms associated with map unit 190 north of Sofa Mountain. In the Cameron Lake area map units 64 and 156 may be found associated with map unit 190 where morainic or colluvial landforms respectively abut the depressional deposits. Map unit Bp is often found associated with map unit 190 where beaver ponds impound streams either entering or leaving the depressional areas where the organic deposits are formed.

Competing Map Units and Differentiae

There are very few organic soils within Waterton Park and thus competing map units are not particularly prevalent. Occasionally peaty areas of map unit 53 may cause a problem of separation. The problem is a practical mapping problem of being able to estimate thickness of the organic deposition and not one of classifying given pedons. Occasionally Bp map units may be very peaty and thus difficult to distinguish from map unit 190. In these cases wherever the beaver activity was particularly evident the symbol Bp was used, otherwise the symbol 190 was used.

Vegetation

Vegetation associated with this map unit is characterized by non-sphagnum mosses which comprise 60 to 70% of the coverage. Shrub species such as Salix spp. (willows) and Alnus tenuifolia (river alder) are also present. Herb species such as Carex aquatilis (water sedge), Carex flava, Carex rostrata (beaked sedge), Calamagrostis canadensis (marsh reed grass) and Petasites sagittatus (arrow-leaved coltsfoot).

Pedon Description (C239)

Classification: Silvo Fibrisol (Typic Brrofibrist¹).

Described by: Gerald Coen.

Date: September 14, 1972.

Location: in the wet area about $\frac{1}{2}$ mile west of where Highway 6 enters the Blood timber limit. (Fig.22).

Climate: continental.

Parent Material: relatively undecomposed accumulated organic material.

Landform; level organic landform.

Slope: less than $\frac{1}{2}$ % over the area.

Elevation: 5,000 feet ASL.

Relief: probably less than 150 cm.

Aspect: none.

Estimated Drainage: very poorly drained.

Water Table: at the soil surface.

¹ These soils may fall into the Cryofibrists, but insufficient data is available to verify the temperature regime.

Vegetation: an occasional stunted Picea glauca (white spruce) less than 5 feet (150 cm) high was noted. 1 to 2 foot (30 to 60 cm) tall Betula occidentalis (water birch) were quite prominent. Salix spp. (willows) less than 5 feet (150 cm) tall and Potentilla fruticosa (shrubby cinquefoil) were also noted in the area. Carex spp. (sedges) and Gramineae (grasses) were fairly common. The major portion of the surface, however, was covered by mosses.

Notes: The soil was in a virgin condition.

- Of1 0 to 33 cm; brown (7.5YR 4/2 m) broken, brown (7.5YR 4/4 m) crushed and dark brown (7.5YR 3/2 m) rubbed organic matter; felt-like in appearance; composed of about 70% unrubbed fiber and about 30% rubbed fiber; pyrophosphate color of about 10YR 8/2 to 8/1; bulk density equals 0.2; liquid very nearly clear when wet soil squeezed; diffuse smooth boundary.
- Of2 33 to 89 cm; reddish brown (5YR 4/4 m) broken, yellowish red (5YR 4/6 m) crushed, and dark reddish brown (5YR 3/4 m) rubbed organic matter; coarser felt-like in appearance than Of1; comprised of about 95% unrubbed fiber & 70% rubbed fiber; pyrophosphate color lighter than 10YR 8/1; bulk density of 0.1; liquid very nearly clear when wet soils squeezed; diffuse smooth boundary.
- Of3 89 to 132+ cm; dark reddish brown (5YR 3/4 m) broken, yellowish red (5YR 4/5 to 4/6 m) crushed, and dark reddish brown (5YR 3/3 m) rubbed organic matter; somewhat less felt-like than the above two horizons; comprised of 90% unrubbed and 40% rubbed fiber; pyrophosphate colour of lighter than 10YR 8/1; bulk density equals 0.1; liquid nearly clear when wet soil squeezed.

COMMENTS:

This pedon represents the most common and largest areal extent of organic soils within the Park. However, organic soils found in smaller pockets in other parts of the Park are slightly more oxidized and some may contain more woody fiber.

MAP UNIT NO. 90R (Lithic Orthic Regosol)

The soils of this map unit are coarse textured with very variable amounts of coarse fragments. They have formed on less than 50 cm of unconsolidated till debris or weathered rock over various kinds of bedrock. The rock beneath the pedon ranges from resistant dolomite through fine and medium sandstones to fissile red shales. Rock outcrop is often of larger surface area distribution than is the soil material on this map unit. Hence the "R" in the symbol. Map unit 90R is located throughout the Park at higher elevations and on steeper slopes.

Associated Map Units

Map units 61, 64, 141, 142, 150, 156, Chutes, Rock and Talus are found in association with map unit 90R. Map units 61 and 64 occur in the easterly and westerly portions of the Park respectively where morainic landforms adjoin the steeper mountain slopes. Map units 141, 142, 150 and 156 are found variously associated with map unit 90R in locations where the landform contours favour accumulation of weathered rock or till debris to depths greater than 50 cm. Chutes, Rock and Talus are also variously associated with map unit 90R at either higher or lower elevations depending mainly upon the surface contours being unfavourable for the accumulation of unconsolidated mineral debris stable enough to support vegetation.

Competing Map Units and Differentiae

Map unit 91R differs from map unit 90R only by the very friable reddish yellow development in the region above the bedrock. Map units 141, 142, 150 and 156 all differ from map unit 90R in that they are greater than 50 cm in depth to consolidated bedrock. The map unit Rock is occasionally broken and fractured as described in this report and as such it differs from 90R mainly by not having sufficient fine materials to be considered capable of horizon development and hence it is considered "not-soil".

Vegetation

Depending on the area within the Park and the elevation within the Park, the vegetation associated with map unit 90R is very variable. Where shallow soils are found on steeper slopes at lower and intermediate elevations the dominant tree species are Pinus contorta (lodgepole pine), Pseudotsuga menziesii (Douglas fir), and Abies lasiocarpa (alpine fir). Shrubs associated with the above trees are represented by species such as Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), Berberis repens (creeping mahonia) and Shepherdia canadensis (Canadian buffalo-berry). The corresponding herbs include Thalictrum venulosum (veiny meadow rue), Arnica cordifolia (heart-leaved arnica), Clintonia uniflora (one-flowered clintonia), Heuchera cylindrica (alum root) and Gramineae (grasses). When map unit 90R is found at higher elevations, generally greater than 6,500 feet, Pinus albicaulis (white-bark pine) Larix lyallii (alpine larch) as well as Abies lasiocarpa (alpine fir) are common components of the vegetation. The understory associated with the higher elevation tree species is characterized, at least in part, by shrubs such as Vaccinium spp. (blueberries), Menziesia ferruginea (false huckleberry)

and Alnus crispa (green alder). Accompanying herb species include Xerophyllum tenax (bear grass), Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue) and Veratrum eschscholtzii (false hellebore). Occasionally areas mapped as 90R are vegetated only with stunted tree species such as Abies lasiocarpa (alpine fir) or Pinus albicaulis (white-bark pine) and shrubs such as Amelanchier alnifolia (saskatoon), Juniperus communis (ground juniper) and Juniperus horizontalis (creeping juniper).

Pedon Description (C256)

Classification: Lithic Orthic Regosol (Lithic Cryorthent)

Described by: Gerald Coen.

Date: Sept. 16, 1972.

Location: about $\frac{1}{4}$ mile north of the picnic area which is located north of the Red Rock Canyon Road and northwest of the Crandell Mountain Campground turnoff (Fig.22).

Climate: continental.

Parent Material: very variable unconsolidated mineral debris some of which is possibly till in origin but greatly modified by downslope creep and erosion.

Landform: the shape of the landform is entirely controlled by the bedrock contours which are very variable depending upon the forces of glaciation or weathering.

Slope: 45% across the pit and varying from 30 to 70% in the vicinity.

Elevation: 4800 feet ASL.

Relief: 500 feet.

Aspect: 180 degrees.

Estimated Drainage: well drained.

Water Table: below the pedon.

Vegetation: scrubby Pseudotsuga menziesii (Douglas fir) and Populus tremuloides (trembling aspen) comprise the major trees. Shrubs observed include Symphoricarpos occidentalis (western snowberry), Spiraea lucida (white meadowsweet) and Shepherdia canadensis (Canadian buffalo-berry). Herbs observed include Lupinus argenteus (perennial lupine), Artemisia frigida (pasture sage), Oxytropis splendens (showy locoweed) and Selaginella densa (little club moss). About 70 to 80% cover was provided by Gramineae (grasses) such as Festuca spp. (fescues) and Danthonia spp. (oat grasses).

Notes: Rock outcrop was prevalent occupying 20 to 50% of the surface area of the map area from which this sample was taken. The soil contained few boulder sized coarse fragments. The soil was in a virgin condition.

- Ah 0 to 2.5 cm; dark reddish brown (2.5YR 2/4 m) sandy loam; weak fine granular; very friable; plentiful fine roots unable to observe pores; no clay films; no effervescence; estimated coarse fragments 10%; clear wavy boundary; 1.5 to 5 cm thick.
- C 2.5 to 30 cm; dusky red (10R 3/4 m) gravelly sandy loam; single grain; loose; plentiful fine roots; unable to observe pores; no clay films; no effervescence; estimated coarse fragments greater than 10%, variable; 23 to 38 cm thick.
- R 30+ cm; red shale, relatively unfractured.

COMMENTS:

The colour of this pedon is dominated by the colour of the parent material. Many other pedons and map areas have been called 90R even though their colour is in the 10YR hues or duller, as long as they are colluvial and lithic in nature, and show no B horizon development. The rock component in this map unit is very variable, and sometimes comprises as much as 80 to 90% of the area of the landscape.

MAP UNIT NO.91R (Lithic Orthic Eutric Brunisol)

The soils of this map unit are medium textured with moderate amounts of coarse fragments. They have formed in shallow deposits (less than 50 cm) of what appears to be ground up and weathered limestone bedrock left by the glacier. The brown and strong brown B horizons often extend to the bedrock contact. The soils are very friable and mellow and probably have a low bulk density. The shape of the landform is entirely bedrock controlled and a very surprisingly few pedons are deeper than 50 cm. Rock outcrop often comprises greater than 50% of the surface area of a given map delineation and sometimes up to 90%, hence the "R" in the symbol. Map unit 91R is geographically located along the east valley wall of upper Waterton Lake.

Associated Map Units

Map units 27, 47, 52, 150, Talus and Rock are found in association with map unit 91R. Near the base of the valley wall, where fans form, map units 27 and 47

adjoin map unit 91R. Occasionally where the till deposition over the bedrock is greater than 50 cm deep, map unit 52 is found associated with map unit 91R. Map unit 150 is found at higher elevations where the steep colluvial slopes encroach upon the more gently sloping bedrock controlled landforms of map unit 91R. Where the preceding transition is abrupt and very steep, Talus and Rock abut map unit 91R.

Competing Map Units and Differentiae

The bedrock controlled landform and the shallowness of the deposits separates the soils of map unit 91R from many of the other map units in the Park. Map units 52 and 64 may occasionally appear similar to map unit 91R, but differ by being greater than 50 cm to bedrock. The Regosolic soils of map unit 90R differ in that they are somewhat coarser textured and somewhat less friable than the Brunisolic soils of map unit 91R. Map units 141, 142, 150, 156 and 160 differ in that they are all formed on colluvial landscapes and are all generally coarser in texture than is map unit 91R.

Vegetation

Vegetation associated with this map unit is characterized by 20 to 40 foot tall stands of Pinus contorta (lodgepole pine) providing 40 to 60% cover. Mixed stands of Pinus contorta (lodgepole pine) and Pseudotsuga menziesii (Douglas fir) as well as some pure stands of Pseudotsuga menziesii (Douglas fir) are also common in this map unit. Common shrub species include Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet) and Berberis repens (creeping mahonia). The herbs associated with this map unit are characterized by Arnica cordifolia (heart-leaved arnica), Thalictrum venulosum (veiny meadow rue), Epilobium angustifolium (fireweed), and Gramineae (grasses).

Pedon Description (C201)

Classification: Lithic Orthic Eutric Brunisol (Lithic Cryochrept)

Described by: Gerald Coen.

Date: August 26, 1972.

Location: about $\frac{1}{2}$ mile towards Crypt Lake from Crypt Landing then 100 yards south of the trail (Fig.22).

Climate: continental.

Parent Material: a thin mantle of crushed and ground up weathered dolomitic limestone left by the glacier.

Landform: relatively steep valley side with bedrock controlled land surface.

Slope: about 20% across the pedon and 15 to 50% in the landform.

Elevation: 4,800 feet ASL.

Relief: about 500 feet.

Aspect: 290 degrees.

Estimated drainage: well drained.

Water table: never within the solum.

Vegetation: about 40% cover with 30 to 40 foot tall Pinus contorta (lodgepole pine).

The per cent cover is less on the south facing slopes. Some Betula papyrifera (white birch) was also noted. Abundant shrub species were noted, including Shepherdia canadensis (canadian buffalo-berry), Arctostaphylos uva-ursi (kinnickinnick), Symphoricarpos occidentalis (western snowberry), Rubus parviflorus (thimbleberry), Spiraea lucida (white meadowsweet), and some Juniperus horizontalis (creeping juniper). Herbs noted included Thalictrum venulosum (veiny meadow rue), and Clematis verticellaris (purple clematis).

Few grasses or mosses are associated with this map unit.

Notes: The soil temperature at 35 cm was 10 degrees C. Stones were common within the solum, increasing with depth and of variable content on the landform, depending somewhat on the amount of bedrock outcropping. The soil was in a virgin condition.

- L-F 5 to 0 cm; dark reddish brown (5YR 2/2 m) partly decomposed organic material; many white mycelia; many very fine pores; abrupt wavy boundary; 1.5 to 7 cm thick.
- Bm 0 to 13 cm; yellowish red (5YR 4/6 m) to reddish brown (5YR 4/4 m) loam; weak, medium subangular blocky; very friable (fluffy); abundant fine roots; many very fine and micro pores; no clay films; no effervescence; estimated coarse fragments 20%; clear wavy boundary; 10 to 15 cm thick.
- C 13 to 36 cm; strong brown (7.5YR 5/6 m) silt loam; massive to weak fine subangular blocky; very friable; plentiful fine roots; few fine pores; no clay films; no effervescence; estimated coarse fragments 40% (mostly fractured dolomite); abrupt irregular boundary; 10 to 38 cm thick.

R 36+ cm; resistant light coloured dolomite.

COMMENTS:

In these pedons there is often little morphological change with depth between the L-F and the rock resulting in difficulty in determining whether this brownish soil region is in fact a B horizon or a C horizon. Thus, the difficulty in determining whether the classification should be Brunisolic or Regosolic.

MISCELLANEOUS MAP UNITS

MAP UNIT ROCK

This map unit is comprised of consolidated rock of all kinds found within the Park. It also includes extensive areas of fractured and broken rock such as that which occurs on the top of Mount Hawkins. Often the mountain tops and rock outcrops are bare. However, in several instances there are stunted trees growing in cracks and shallow pockets of soil. In alpine areas vegetation may cover 10 to 20% of the surface and the area will still be mapped as Rock because of the small amount of "non-rock" material. In general if the fractured rock is not subject to continued gravitational movement the areas were mapped as Rock. If the fractured rock is moving down slope at an appreciable rate it was mapped as Talus.

MAP UNIT Bp

This map unit is comprised of beaver ponds, beaver dams and very poorly drained soils associated with beaver activity. If the beavers have recently vacated a site it may be partially drained, mucky and wet. In other cases recently constructed dams change previously well drained soils to soils inundated with water. The soils may vary from Organic to Gleysolic and Gleyed Regosols. Much of the surface areas mapped as Bp is flooded.

Vegetation associated with this map unit is dominantly grasses, sedges and shrubs. Shrub species such as Alnus tenuifolia (river alder) and Salix spp. (willows) are common. Herbs such as Carex flava, Carex aquatilis (water sedge), Carex rostrata (beaked sedge),

Petasites sagittatus (arrow-leaved coltsfoot), Calamagrostis canadensis (marsh reed grass) and Habenaria dilatata (tall white orchid) are also associated with map unit Bp.

The parent material associated with those soils found on Bp map units are not restricted or defined. However, the most common parent material is alluvium of varying textures. Occasionally the water levels will be raised by beaver dams sufficient to encroach upon some of the tills on either side of the stream channels.

MAP UNIT RD

This map unit identifies areas used as "refuse disposal" areas or pits. The abandoned gravel pit north of the golf course is the only area mapped as RD. There may be smaller areas within the Park where refuse is dumped but these are small enough that they are mapped as inclusions in other map units.

MAP UNIT TALUS

This map unit is comprised of fractured rock which is actively moving downslope, mainly as the result of gravitational forces. The rock debris generally has a slope equal to the angle of repose. Thus, the landform is typical scree or Talus. In many cases the rate of weathering of the cliffs which feed the talus is fast enough to prevent appreciable vegetative growth. However, in other cases the rate of accretion and movement is slow enough that the surface may have a greenish appearance in late spring when observed from a distance. Vegetation gets a foothold in small pockets of fines which probably occurs as a result of accumulation through frost action on weathered rock. There is, of course, a continuum between Rock, Talus and Colluvium. For the purposes of this report when accretion and movement is slow enough that the surface supports appreciable vegetation the landform is considered colluvium. Otherwise the gravitational slopes are considered Talus.

MAP UNIT PIT

This map unit identifies areas where soil has been removed or excavated for top soil, rock quarries, and/or road construction. Several areas of the Park have been stripped of their top soil. Other areas have been excavated for gravel used in roads and/or

building construction. Several borrow pits were made when the Chief Mountain highway was constructed.

MAP UNIT CHUTE (Mainly Regosolic soils)

This map unit identifies areas where periodic snow slides remove the trees and render the denuded soil more susceptible to erosion in the spring and summer. There is often an abrupt change in soils found in the chutes versus those found in the adjacent forested areas. Most chutes are characterized by Regosolics. There are some, however, which have sufficient B horizon development to be considered Brunisolics. Some chutes have thick accumulations of humified organic matter over the mineral material. Others (or soils of the same chute) have the mineral material exposed at the surface. Since these are areas of snow accumulation, and generally also areas where rivulets flow, chutes are often more moist than adjacent soils.

About the only consistent feature of the vegetation in Chutes is the stunted, scrubby, twisted nature of any shrubs or trees. Alnus crispa (green alder) and Salix spp. (willows) are commonly associated with map unit Chutes. Scrubby Populus spp. (poplars) are common at lower elevations and scrubby Abies lasiocarpa (alpine fir) is common at higher elevations. Most species vary in accordance with the vegetative and climatic zones of the Park.

Common Names of Common Trees in
WLNP and their Latin Equivalent

Common Name	Latin Name ¹
Alpine fir	<i>Abies lasiocarpa</i>
Alpine Larch	<i>Larix lyallii</i>
Aspen, trembling	<i>Populus tremuloides</i>
Balsam poplar	<i>Populus balsamifera</i>
Birch, water	<i>Betula occidentalis</i>
Birch, white	<i>Betula papyrifera</i>
Black cottonwood	<i>Populus tricarpa</i>
Douglas fir	<i>Pseudotsuga menziesii</i>
Maple, mountain	<i>Acer glabrum</i>
Pine, limber	<i>Pinus flexis</i>
Pine, lodgepole	<i>Pinus contorta</i>
Pine, whitebark	<i>Pinus albicaulis</i>
Spruce, Engelmann	<i>Picea engelmannii</i>
Spruce, white	<i>Picea glauca</i>

Common Names of Common Shrubs in
WLNP and their Latin Equivalent

Common Name	Latin Name
Alder, green	<i>Alnus crispa</i>
Alder, river	<i>Alnus tenuifolia</i>
Canadian buffalo-berry	<i>Shepherdia canadensis</i>
Choke cherry	<i>Prunus virginiana</i>
Creeping mahonia	<i>Berberis repens</i>
Currant, sticky	<i>Ribes viscosissimum</i>
Currant, wild black	<i>Ribes hudsonianum</i>
Currant, wild red	<i>Ribes triste</i>
Dogwood, red osier	<i>Cornus stolonifera</i>
Gooseberry, wild	<i>Ribes oxycanthoides</i>
Grouse-berry	<i>Vaccinium scoparium</i>
Honeysuckle bracted	<i>Lonicera involucrata</i>
Huckleberry, false	<i>Menziesia ferruginea</i>
Juniper, creeping	<i>Juniperus horizontalis</i>
Juniper, ground	<i>Juniperus communis</i>
Kinnikinnick	<i>Arctostaphylos uva-ursi</i>
Prince's pine	<i>Chimaphila umbellata</i> var. <i>occidentalis</i>
Rose, common wild	<i>Rosa woodsii</i>
Rose, prickly	<i>Rosa acicularis</i>

(cont.)

¹ Latin names correspond to Moss (1959).

(2)

Saskatoon
Shrubby cinquefoil
Silver-berry
Snowberry, western
Tall bilberry
Thimbleberry
Twin-flower
White meadowsweet
Willow

Amelanchier alnifolia
Potentilla fruticosa
Elaeagnus commutata
Symphoricarpos occidentalis
Vaccinium membranaceum
Rubus parviflorus
Linnaea borealis var. *americana*
Spiraea lucida
Salix sp.

Common Names of Common Herbs in
WLNP and their Latin Equivalent

Common Name	Latin Name
Alum-root	<i>Heuchera cylindrica</i>
Angelica, yellow	<i>Angelica dawsonii</i>
Arnica, heart-leaved	<i>Arnica cordifolia</i>
Arrow-leaved coltsfoot	<i>Petasites sagittatus</i>
Aster	<i>Aster</i> sp.
Bear grass	<i>Xerophyllum tenax</i>
Bedstraw, northern	<i>Galium boreale</i>
Bishop's cap	<i>Mitella breweri</i>
Bluebell, common	<i>Campanula rotundifolia</i>
Brome, awnless	<i>Bromus inermis</i>
Brome, awnless northern	<i>Bromus pumpellianus</i>
<i>Carex flava</i>	<i>Carex flava</i>
Clematis, purple	<i>Clematis verticellaris</i>
Clintonia, one-flowered	<i>Clintonia uniflora</i>
Cow parsnip	<i>Heracleum lanatum</i>
Dandelion, common	<i>Taraxacum officinale</i>
Daisy, ox-eye	<i>Chrysanthemum leucanthemum</i>
Fairybells	<i>Disporum oreganum</i>
Fairybells	<i>Disporum trachycarpum</i>
Fescue, bluebunch	<i>Festuca idahoensis</i>
Fescue, rough	<i>Festuca scabrella</i>
Fireweed	<i>Epilobium angustifolium</i>
Fleabane (wild daisy)	<i>Erigeron glabellus</i> var. <i>pubescens</i>
Flax, wild blue	<i>Linum lewisii</i>
Geranium, sticky purple	<i>Geranium viscosissimum</i>
Goldenrod, mountain	<i>Solidago decumbens</i>
Grass family	Gramineae
Hedysarum, yellow	<i>Hedysarum sulphurescens</i>
Hellebore, false	<i>Veratrum eschscholtzii</i>
Horse mint	<i>Monarda fistulosa</i> var. <i>menthaefolia</i>
Horsetail, common	<i>Equisetum arvense</i>
Kentucky bluegrass	<i>Poa pratensis</i>
Larkspur, low	<i>Delphinium bicolor</i>

(cont.)

(3)

Lily, glacier
Loco-weed, showy
Lupine, perennial
Lupine, Pursh's silky
Marigold, marsh
Marsh reed grass
Oat grass, parry
Oat grass, timber
Onion, prairie
Orchid, tall white
Paint-brush, common red
Pine grass
Plantain, rattlesnake
Sage, pasture
Sarsaparilla, wild
Sedge, beaked
Sedge, water
Solomon's seal, false
Solomon's seal, star-flowered
Strawberry
Sweetpea, wild
Timothy
Twisted stalk
Veiny meadow rue
Vetch, wild
Western spring beauty
Wild heliotrope
Wintergreen
Wormwood
Wood rush
Yarrow, common
Yarrow, common wild

Erythronium grandiflorum
Oxytropis splendens
Lupinus argenteus
Lupinus sericeus
Caltha palustris
Calamagrostis canadensis
Danthonia parryi
Danthonia intermedia
Allium textile
Habenaria dilatata
Castilleja miniata
Calamagrostis rubescens
Goodyera oblongifolia
Artemisia frigida
Aralia nudicaulis
Carex rostrata
Carex aquatilis
Smilacina racemosa var. *amplexicaulis*
Smilacina stellata
Fragaria sp.
Lathyrus ochroleucus
Phleum pratense
Streptopus amplexifolius
Thalictrum venulosum
Vicia americana
Claytonia lanceolata
Valeriana sitchensis
Pyrola sp.
Artemisia biennis
Luzula glabrata
Achillea millefolium
Achillea lanulosa

Latin Names of Common Shrubs in WLNP and their Common Equivalents

(cont.)

(5)

<i>Ribes viscosissimum</i>	Sticky currant
<i>Rosa acicularis</i>	Prickly rose
<i>Rosa woodsii</i>	Common wild rose
<i>Rubus parviflorus</i>	Thimbleberry
<i>Salix</i> sp.	Willow
<i>Shepherdia canadensis</i>	Canadian buffalo-berry
<i>Spiraea lucida</i>	White meadowsweet
<i>Symphoricarpos occidentalis</i>	Western snowberry
<i>Vaccinium membranaceum</i>	Tall bilberry
<i>Vaccinium scoparium</i>	Grouse-berry

Latin Names of Common Herbs in
WLNP and their Common Equivalents

Latin Name	Common Name
<i>Achillea lanulosa</i>	Common wild yarrow
<i>Achillea millefolium</i>	Common yarrow
<i>Allium textile</i>	Prairie onion
<i>Angelica dawsonii</i>	Yellow angelica
<i>Aralia nudicaulis</i>	Wild sarsaparilla
<i>Arnica cordifolia</i>	Heart-leaved arnica
<i>Artemisa biennis</i>	Wormwood
<i>Artemisa frigida</i>	Pasture sage
<i>Aster</i> sp.	Aster
<i>Bromus inermis</i>	Awnless brome
<i>Bromus pumpellianus</i>	Northern awnless brome
<i>Calamagrostis canadensis</i>	Marsh reed grass
<i>Calamagrostis rubescens</i>	Pine grass
<i>Caltha palustris</i>	Marigold, marsh
<i>Campanula rotundifolia</i>	Common bluebell
<i>Carex aquatilis</i>	Water sedge
<i>Carex flava</i>	Carex flava
<i>Carex rostrata</i>	Beaked sedge
<i>Castilleja miniata</i>	Common red paint-brush
<i>Chrysanthemum leucanthemum</i>	Ox-eye daisy
<i>Claytonia lanceolata</i>	Western spring beauty
<i>Clematis verticellaris</i>	Purple clematis
<i>Clintonia uniflora</i>	One flowered clintonia
<i>Danthonia parryi</i>	Parry oat grass
<i>Danthonia intermedia</i>	Timber oat grass
<i>Delphinium bicolor</i>	Low larkspur
<i>Disporum oreganum</i>	Fairybells
<i>Disporum trachycarpum</i>	Fairybells
<i>Epilobium angustifolium</i>	Fireweed
<i>Equisetum arvense</i>	Common horsetail

(cont.)

(6)

<i>Erigeron glabellus</i> var. <i>pubescens</i>	Fleabane (wild daisy)
<i>Erythronium grandiflorum</i>	Glacier lily
<i>Festuca idahoensis</i>	Bluebunch fescue
<i>Festuca scabrella</i>	Rough fescue
<i>Fragaria</i> sp.	Strawberry
<i>Galium boreale</i>	Northern bedstraw
<i>Geranium viscosissimum</i>	Sticky purple geranium
<i>Goodyera oblongifolia</i>	Rattlesnake plantain
Gramineae	Grass family
<i>Habenaria dilatata</i>	Tall white orchid
<i>Hedysarum sulphurescens</i>	Yellow hedysarum
<i>Heracleum lanatum</i>	Cow parsnip
<i>Heuchera cylindrica</i>	Alum-root
<i>Lathyrus ochroleucus</i>	Wild sweetpea
<i>Linum lewisii</i>	Wild blue flax
<i>Lupinus argenteus</i>	Perennial lupine
<i>Lupinus sericeus</i>	Pursh's silky lupine
<i>Luzula glabrata</i>	Wood rush
<i>Mitella breweri</i>	Bishop's cap
<i>Monarda fistulosa</i> var. <i>menthaefolia</i>	Horse mint
<i>Oxytropis splendens</i>	Showy loco-weed
<i>Petasites sagittatus</i>	Arrow-leaved coltsfoot
<i>Phelum pratense</i>	Timothy
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Pyrola</i> sp.	Wintergreen
<i>Smilacina racemosa</i> var. <i>amplexicaulis</i>	False solomon's seal
<i>Smilacina stellata</i>	Star-flowered solomon's-seal
<i>Solidago decumbens</i>	Mountain goldenrod
<i>Streptopus amplexifolius</i>	Twisted stalk
<i>Taraxacum officinal</i>	Common dandelion
<i>Thalictrum venulosum</i>	Veiny meadow rue
<i>Valeriana sitchensis</i>	Wild heliotrope
<i>Veratrum eschscholtzii</i>	False hellebore
<i>Vicia americana</i>	Wild vetch
<i>Xerophyllum tenax</i>	Bear grass