

Soil Genesis

“Saskatchewan Style”

Terry Tollefson
College of Agriculture and Bioresources
University of Saskatchewan

Soil Genesis (formation)

Soil formation is ultimately the result of the exposure of surface rock and mineral material to a weathering environment. A combination of physical, chemical and biological processes transform this material into soil.

Soil Genesis

Saskatchewan examples



Soil formation in Saskatchewan, “key issues”

1. The nature of the original geologic material (parent material) from which our soils are formed. Was this material always here? If not, when and how did this material find its way to Saskatchewan.
2. What process/es have produced our modern day soils from the original parent materials ?

The processes of soil formation

I. Physical weathering

II. Chemical weathering

III. Biological influence - organic matter
accumulation

IV. Materials translocation

V. Soil structure development

1. Physical weathering

Processes which produce a reduction in mineral particle size but no change in chemical composition.

Forms of physical weathering include:

- Wetting-drying
- Freeze-thaw
- Abrasion, wind or water



2. Chemical weathering

Processes that change the chemical structure of soil minerals. These chemical changes generally softened minerals and make them easier to breakdown.

Examples of chemical weathering include:

- hydrolysis
- hydration
- carbonation
- oxidation-reduction
- dissolution

3.0 Soil formation-biological influence

- Plants are major contributors of organic matter influencing soil color, structure, water holding capacity and fertility.
- Root activity accelerates physical and chemical weathering



3.0 Biological influence (macro-organisms)

Soil mixing caused by macro fauna activity can influence soil profile characteristics and fertility.

Feeding activity of soil macro fauna fragments plant residue producing accelerated organic matter decomposition and nutrient cycling.



4. Soil material translocation

Profile formation is accelerated in moist soil environments where water movement is sufficient to produce leaching. Physical transport of soil constituents accentuates horizontal development (soil profile development).



4. Profile development of fine textured soils

In contrast heavy clay soils tend to have reduced horizon development. Low levels of leaching and a strong shrink-swell behavior during wet/dry cycles causes a churning action that limits soil profile development.



5. Structure formation

- The development of soil structure tends to accentuate horizon development.
- Soil structure varies with depth and is generally more well developed in mature soil profiles.



Factors affecting (modifying) the rate and nature of soil formation

- Parent material
- Climate and vegetation
- Topography
- Time

Parent material and soil formation

Coarse parent material



Fine textured parent material

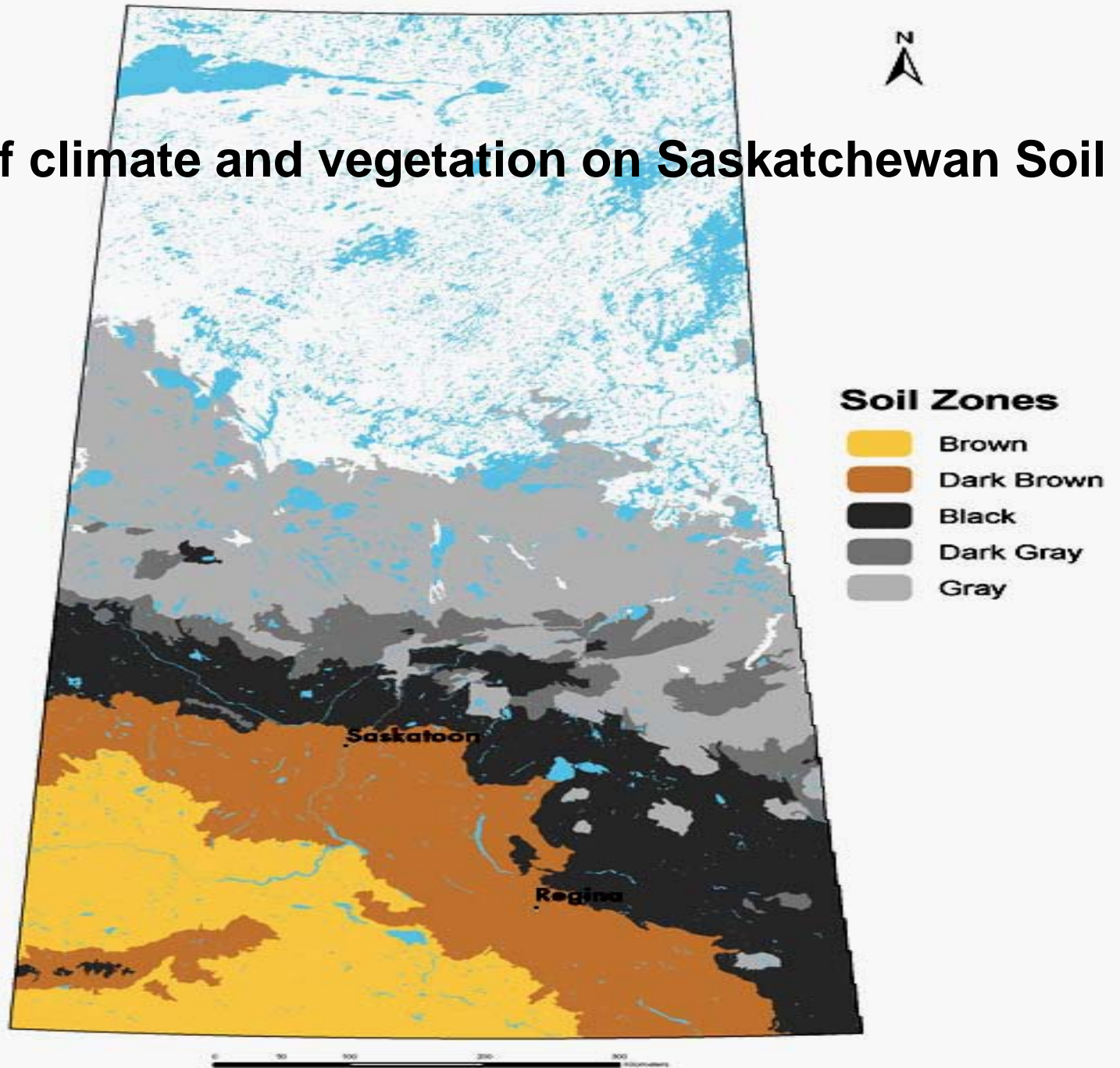


Soil formation and climate

Water and temperature play a dominant role in soil formation. High temperature coupled with high moisture produce intense weathering and rapid soil formation



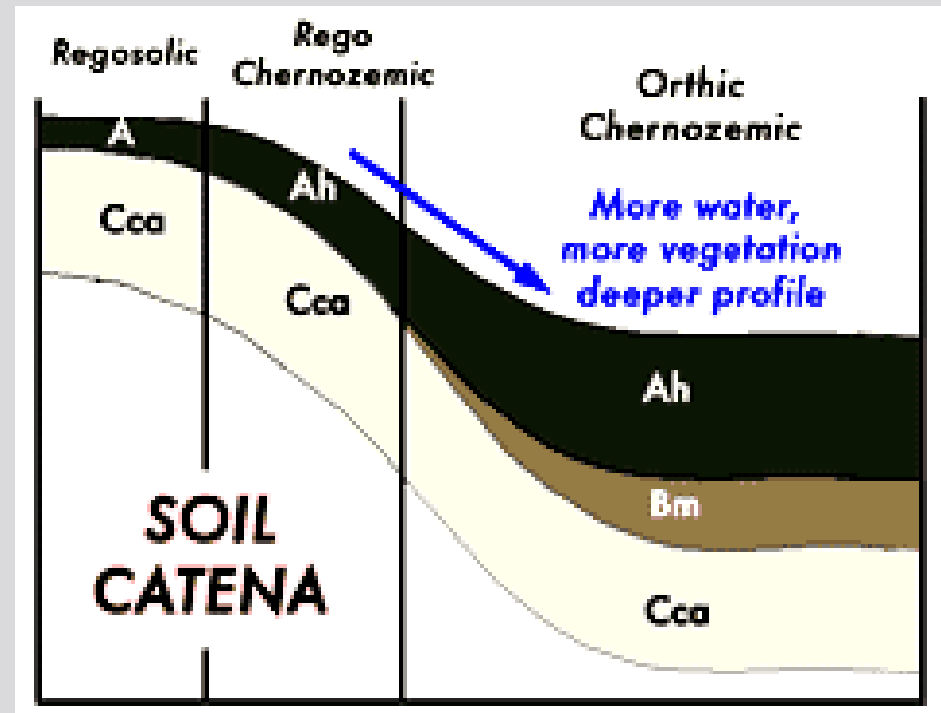
Impact of climate and vegetation on Saskatchewan Soil



Topography and soil formation

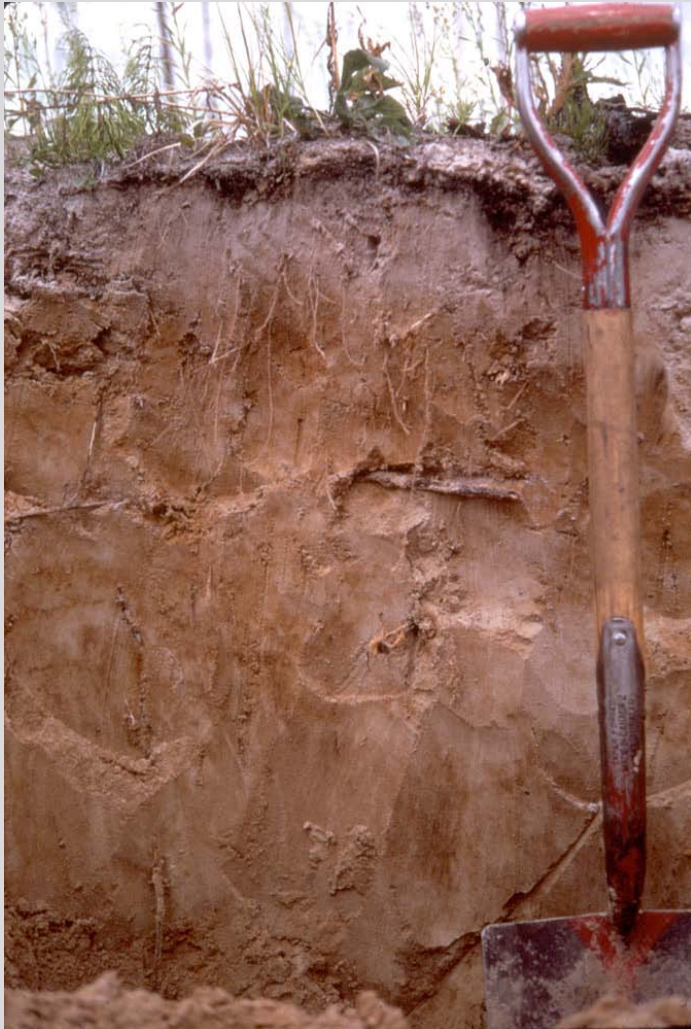
Topography modifies climate primarily by redistributing water

Soil formation more intense at wetter lower slope positions



Time and soil formation

Recent parent material deposition



Mature soil profile



Parent material deposition

What is the origin of geological material from which our soils evolved?

The melt phase of the last glacier to occupy Western Canada is called the Wisconsin deglaciation period. Events of this period strongly shaped the nature of Saskatchewan soils.

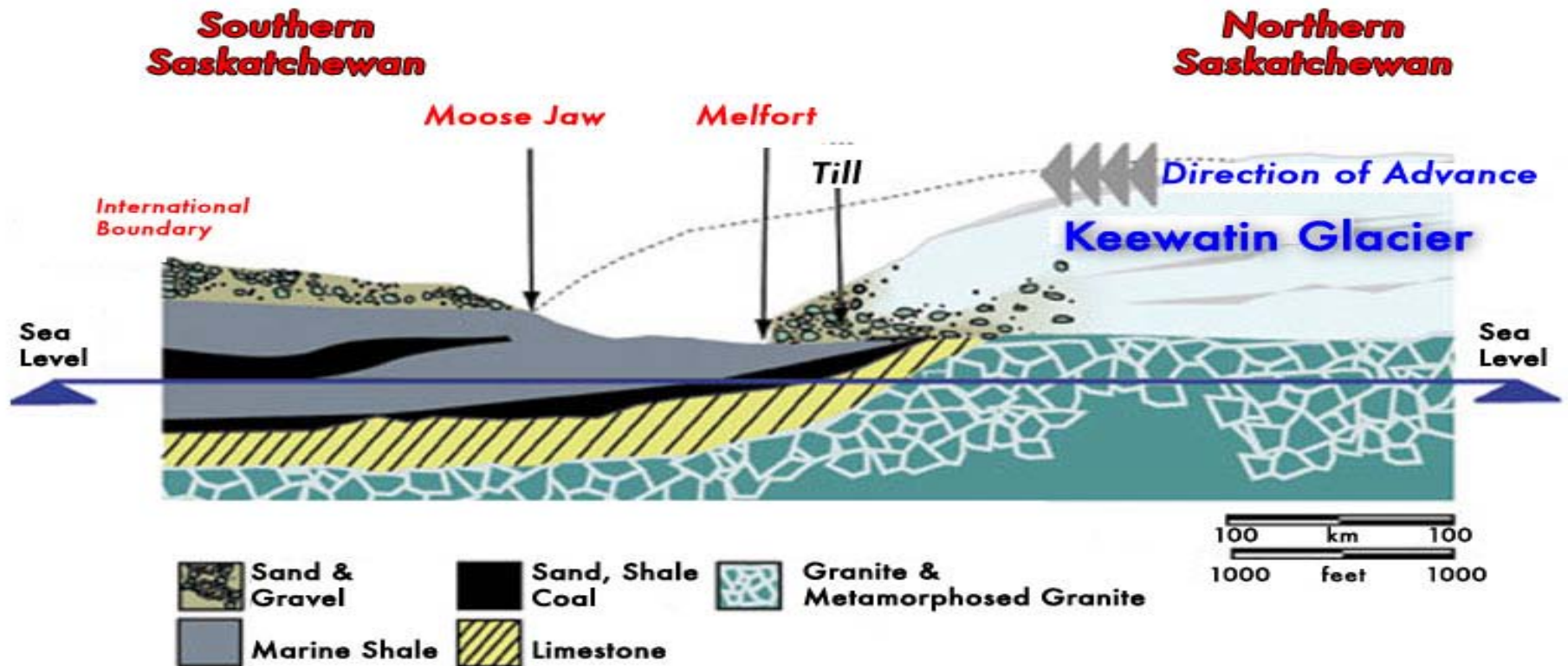


Last glacial advance over North America

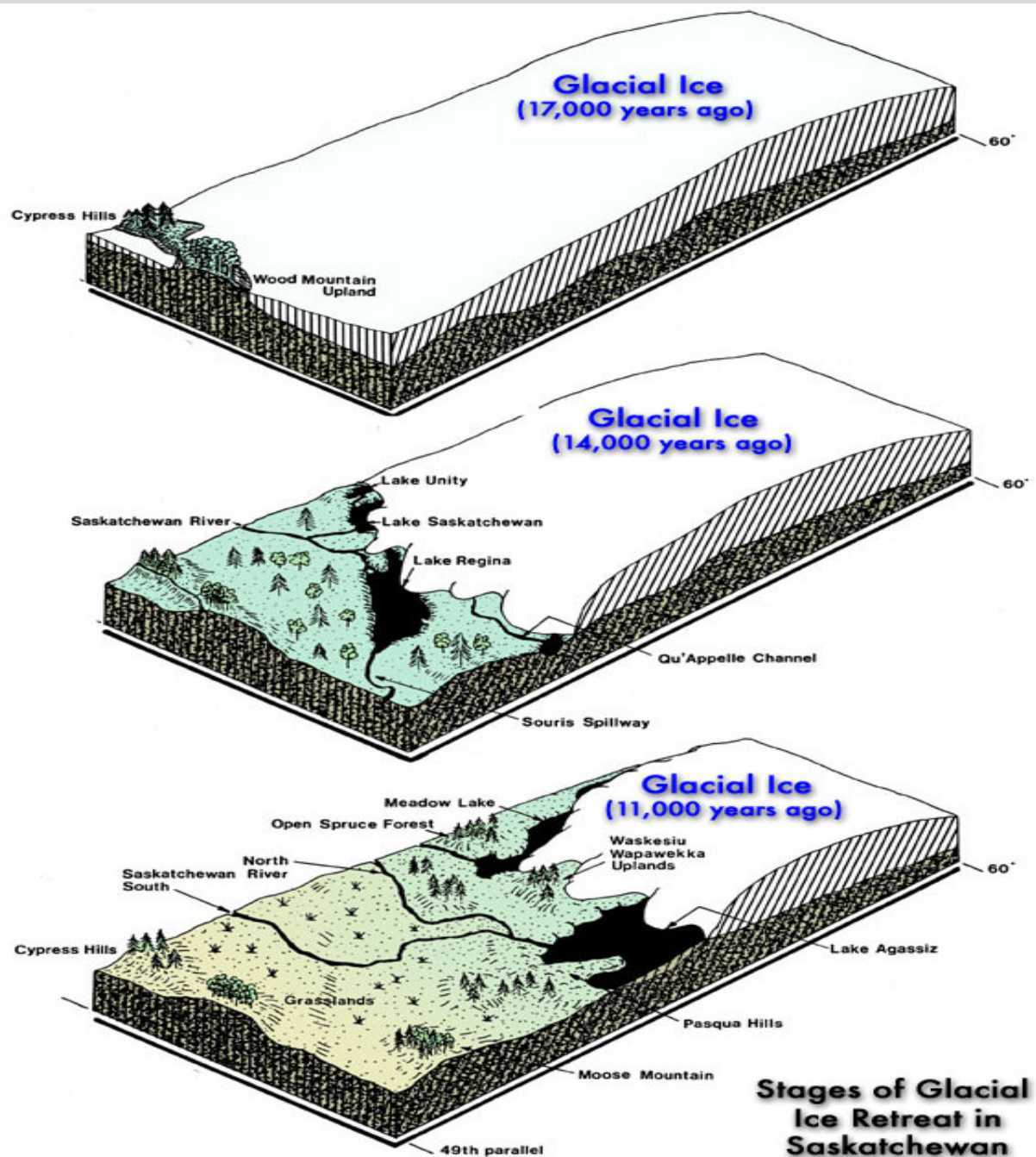


Glacial advance in Saskatchewan

Bedrock Encountered by Advancing Keewatin Glacier



Stages of glacial retreat



Parent materials deposited by glacial action

- Glacio-fluvial: coarse material (sand to coarse gravel) deposited by swift flowing melt water from glaciers.
- Glacial till: mixed materials (clay to boulders) dropped from ice sheet during melt phase. Till parent material accounts for 60% of the agricultural soils of Saskatchewan
- Glacio-lacustrine: fine materials (silt and clay) settled in glacial lakes.

Fluvial parent material

- Texture from sand to gravel.
- Low productivity
- Topography variable



Glacial till

Till material contains a wide range of particle size. During its southward progression, the ice sheet gathered up all manner of material it encountered and then dropped it during the subsequent melt phase.

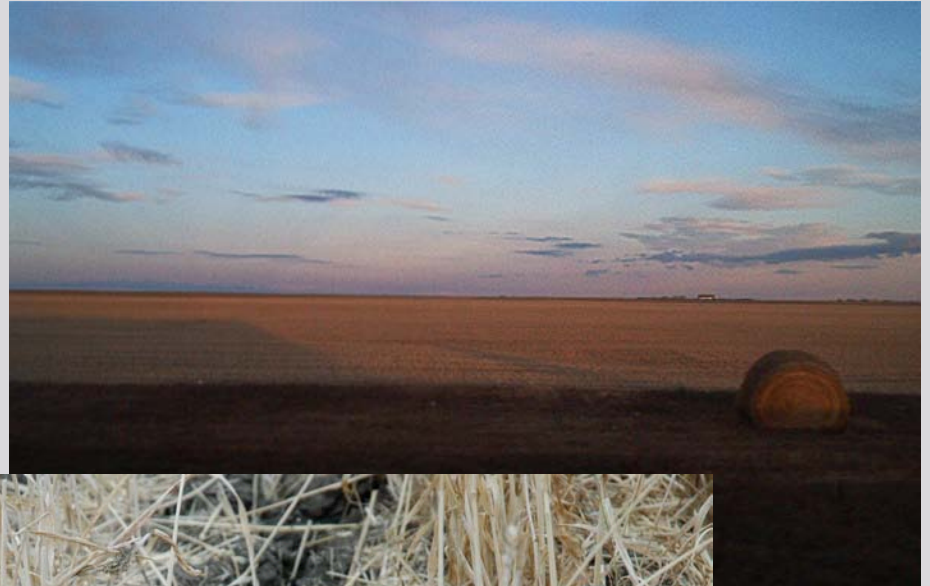
Topography: gently to strongly rolling.

Texture: loam to clay loam

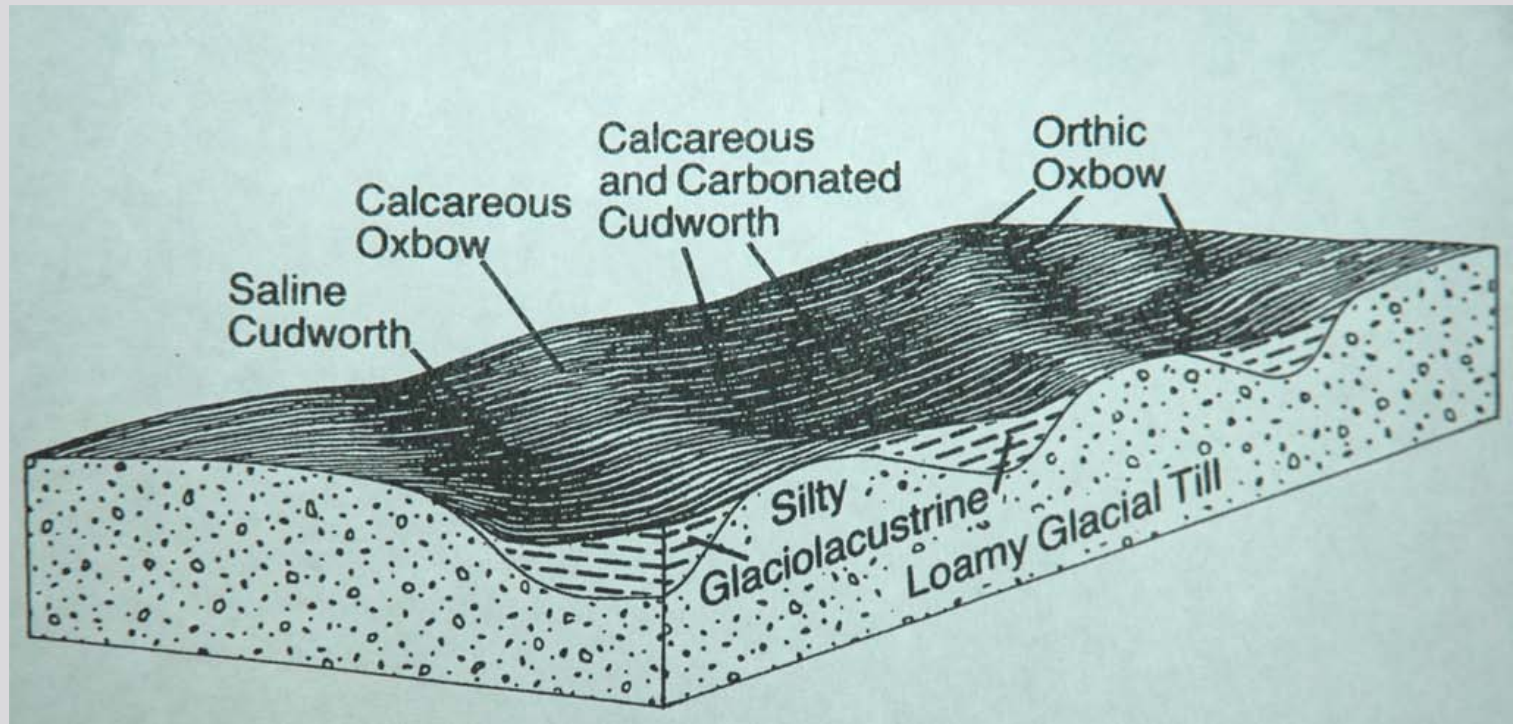


Lacustrine parent material

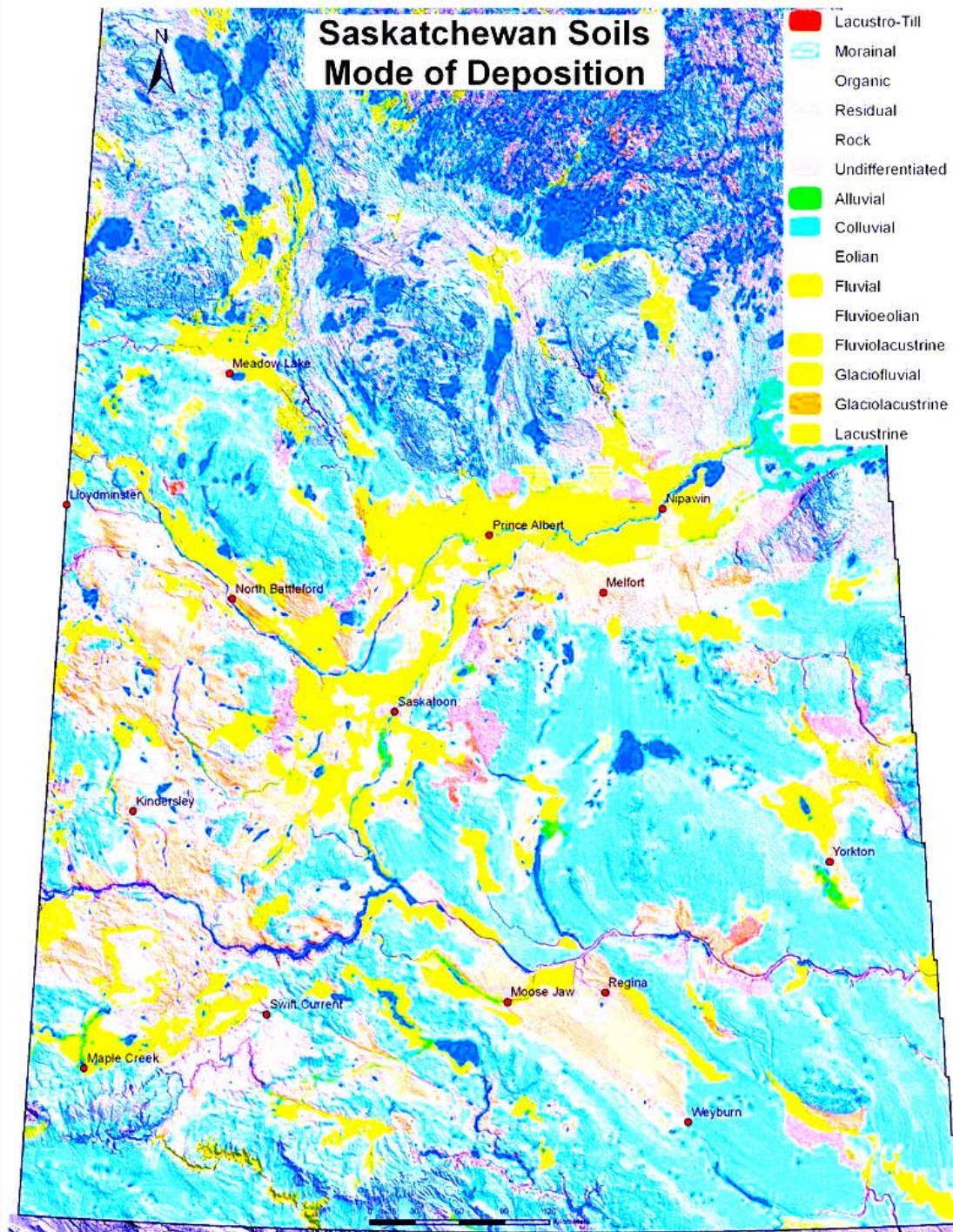
- Dominantly silts and clays
- Topography flat
- Stone free
- Shrink swell behavior



Mixed parent material

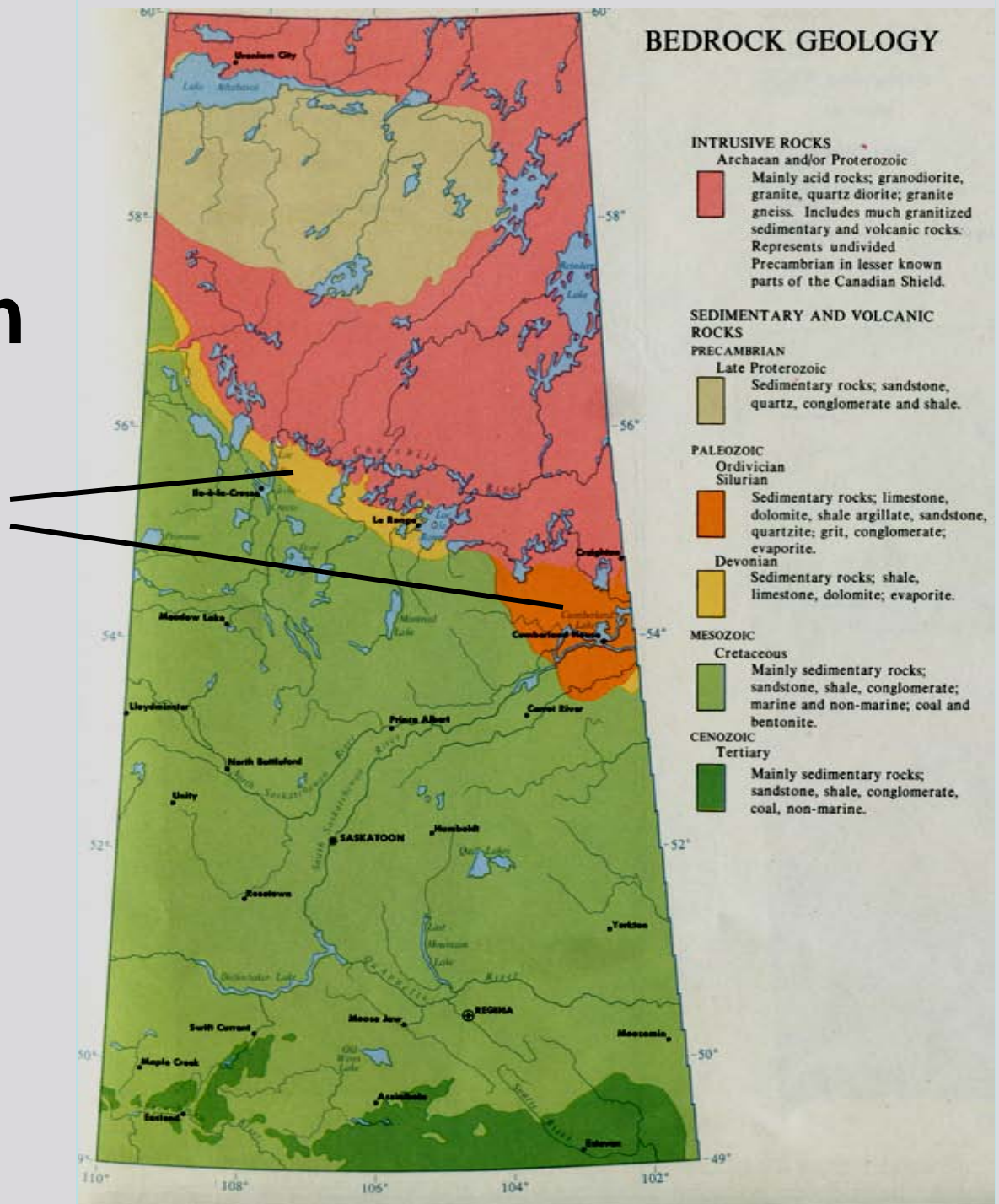


- Complex mixtures of soil materials often arise when the original till material is overlain by the subsequent action of water



Bedrock Geology of Saskatchewan

Limestone outcroppings



pH of Saskatchewan soils

