GEOCHEMICAL BUDGETING IN COLD CLIMATES: EXAMPLES FROM SWEDISH LAPLAND AND THE COLORADO FRONT RANGE.

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Geochemical Budget Components

- Inputs
- Throughputs/Storages
- Outputs

INPUTS

- Precipitation
- Dust
- Chemical Weathering

Precipitation

Dominant ions

- Ca, Na, K, Mg, Cl, Fe, Al, Mn
- SO_4, HCO_3 , NO_3

Dry Deposition

Chemical additions

- Si, Al, Fe, Mg, Ca, Na, K

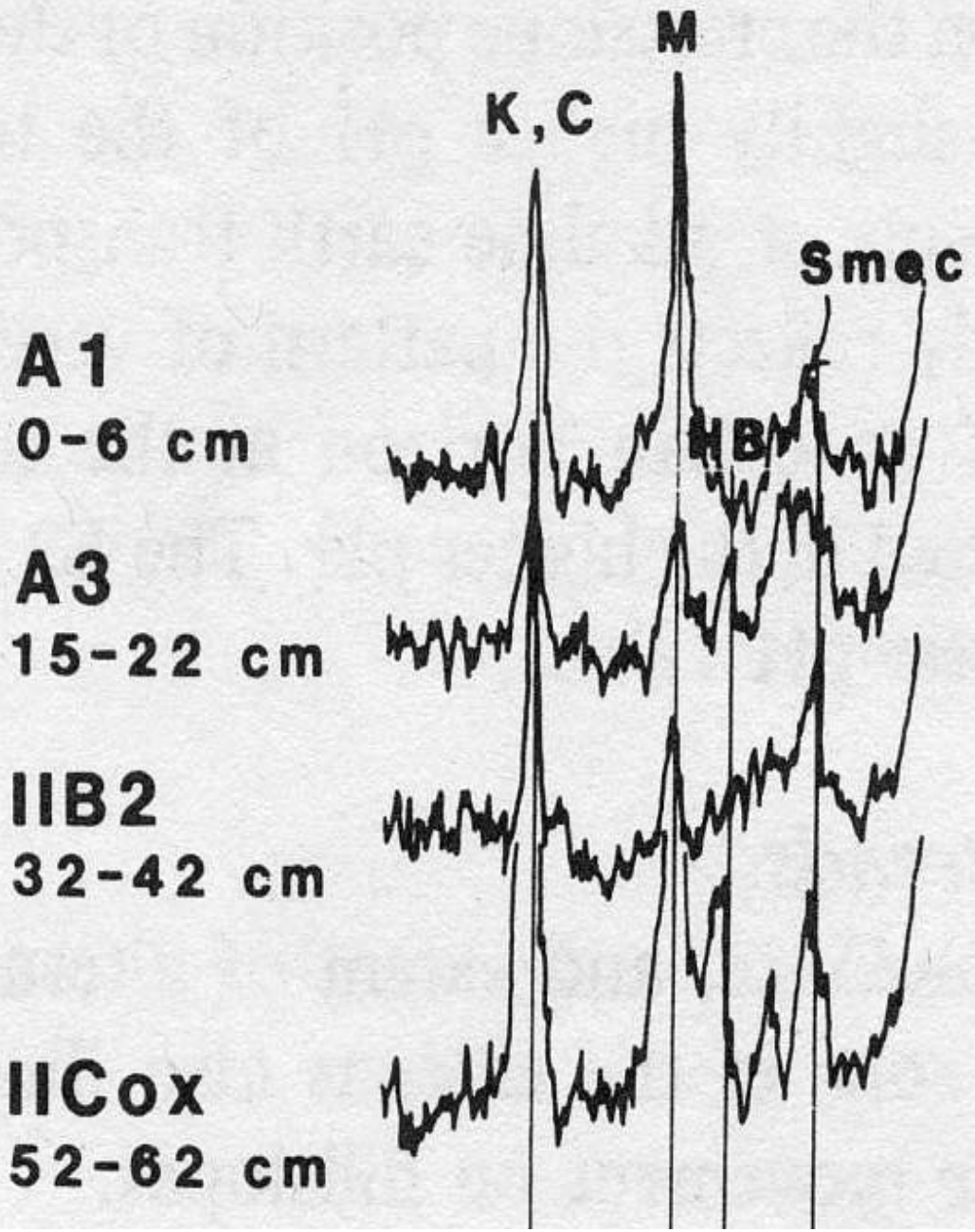
Table 7.2 Grain size and pH distributions in the soils of the Caribou Lake cirque catena.

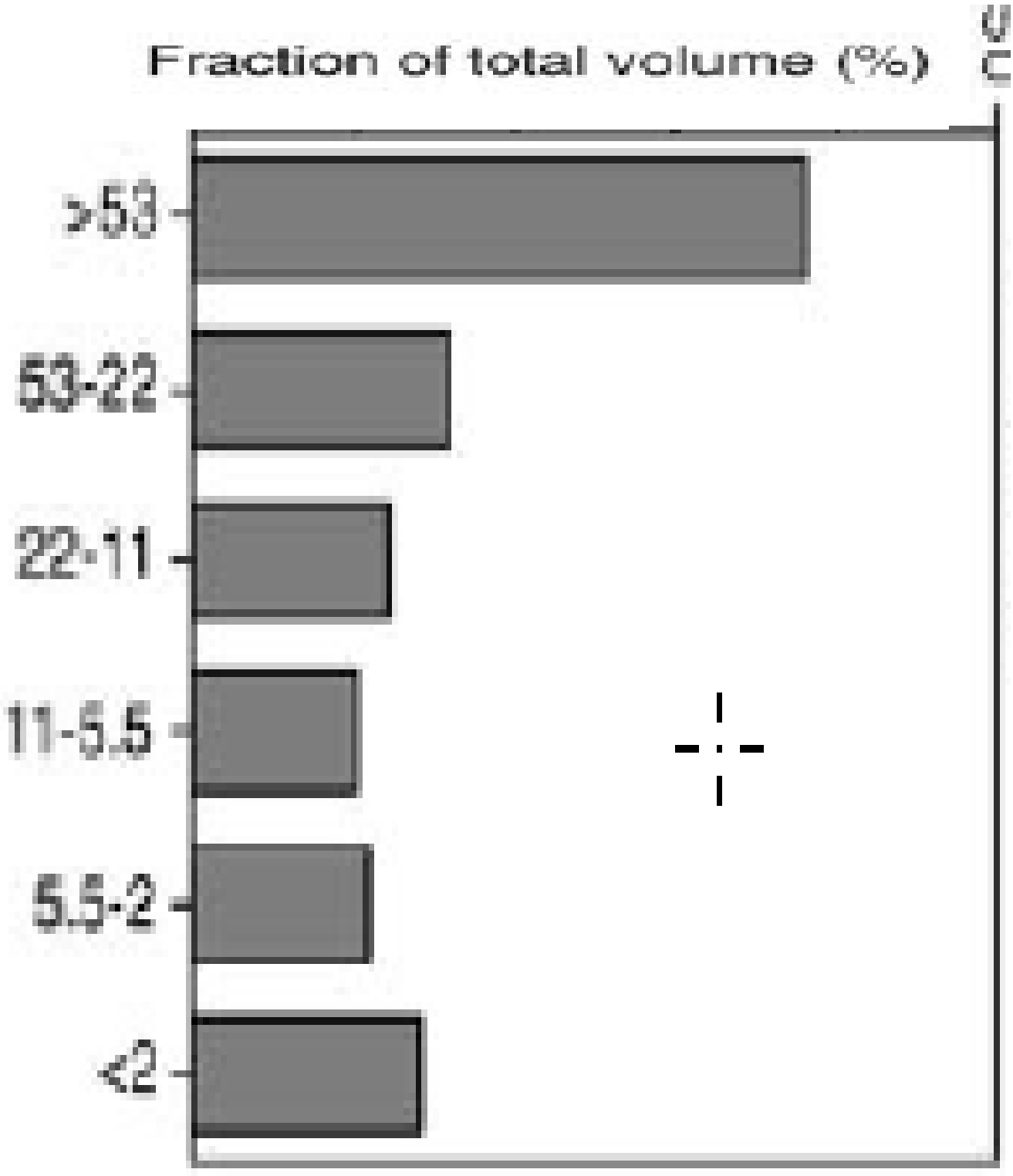
Sample number	Topographic position	Depth (cm)	Horizon	Percent sand	Percent silt	Percent clay	pH
CL11	crestslope	0–8	A1	33.0	33.7	33.3	4.3
CL12		8–18	A3	64.9	24.1	11.1	4.0
CL13		18–28	IIB2	67.6	20.2	12.2	3.9
CL15		38–48	IICox	73.1	16.8	10.1	4.4

Table 7.4 Oxide molar ratios of Caribou Lake cirque soils.

Sample number	Topographic position	Depth (cm)	Horizon	$\frac{SiO_2}{Al_2O_3}$	$\frac{K_2O + Na_2O}{Al_2O_3}$	$\frac{CaO + MgO}{Al_2O_3}$
CL11	crestslope	0–8	A1	7.33	0.39	0.51
CL12		8–18	A3	5.39	0.35	0.20
CL13		18–28	IIB2	5.10	0.35	0.22
CL15		38–48	IICox	5.29	0.36	0.20

Crest Slope





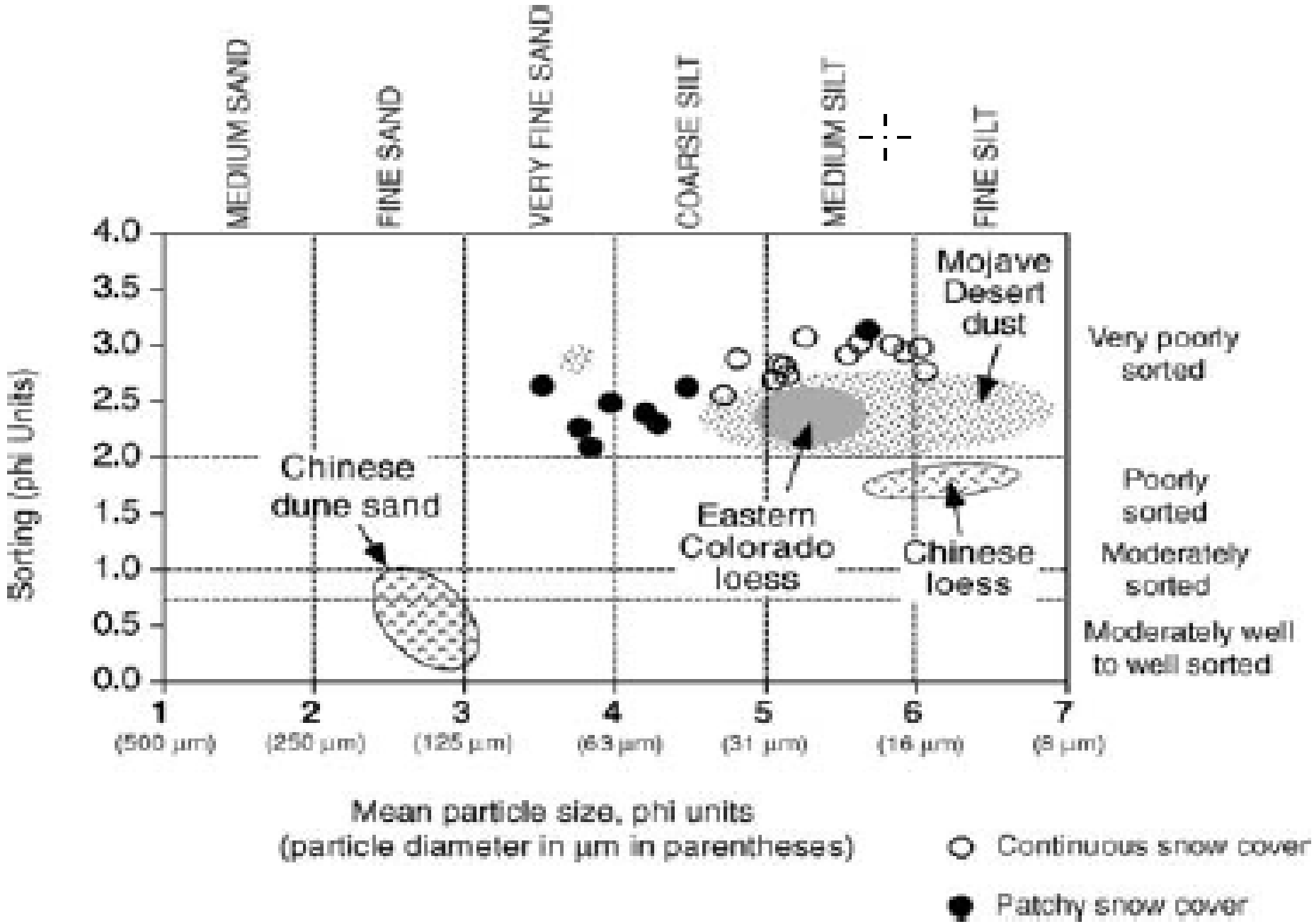
From Muhs and Benedict 2006

Dry Deposition Mineralogy

- Mineralogy
  - Biotite
  - Quartz
  - Feldspar
  - Calcite
  - Hornblende
  - Ilmenite
  - Magnetite
    - From: Thorn and Darmody 1980

Mineralogy cont.

- Clay Mineralogy
  - Kaolinite
  - Biotite
  - Quartz
  - Feldspar
  - Calcite
    - From: Thorn and Darmody 1980



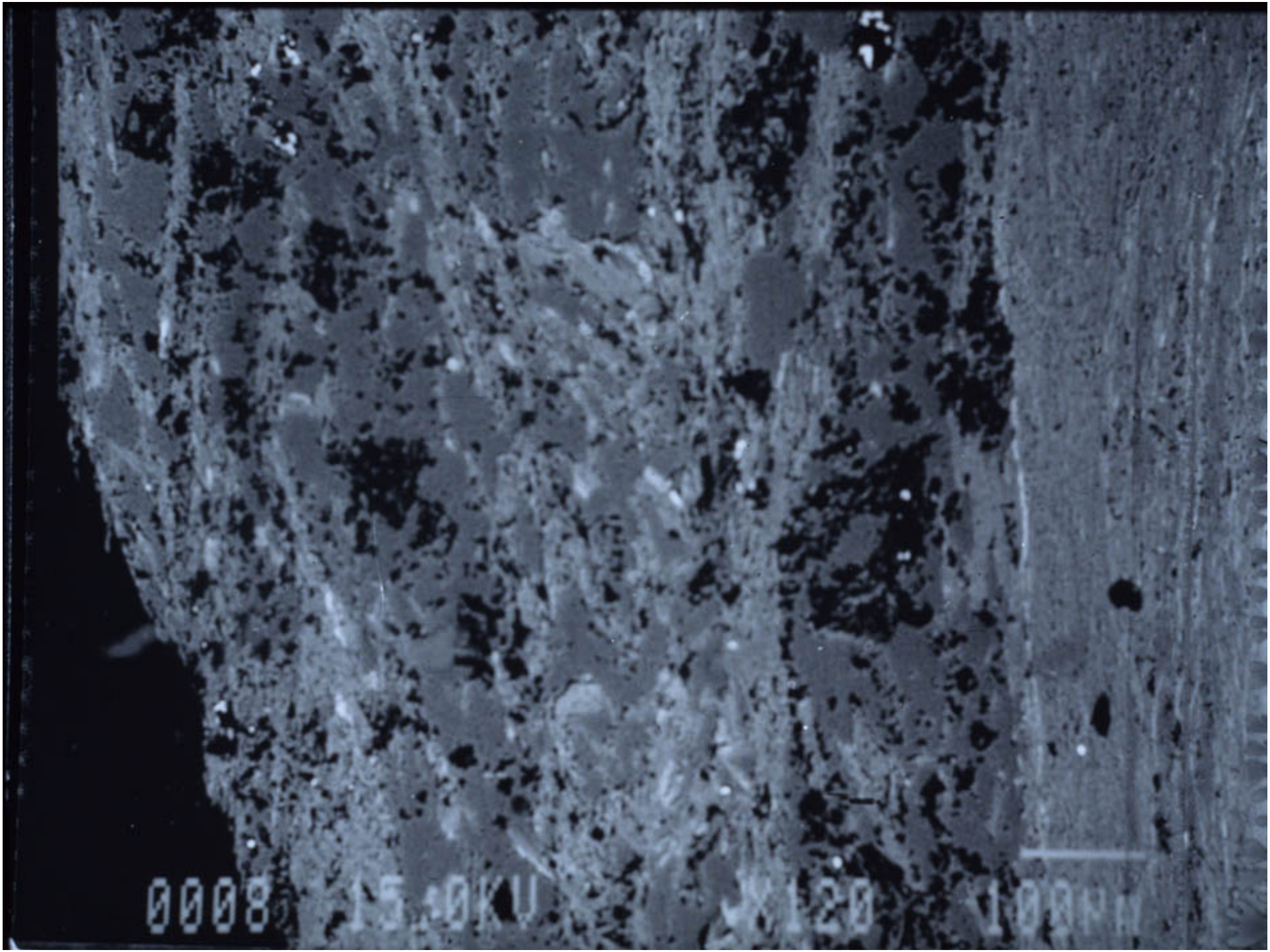
From Muhs and Benedict 2006

Chemical Weathering

- Dissolution
- Oxidation
- Hydrolysis

Mineral Dissolution

- Feldspars
- Quartz
- Ferromagnesian minerals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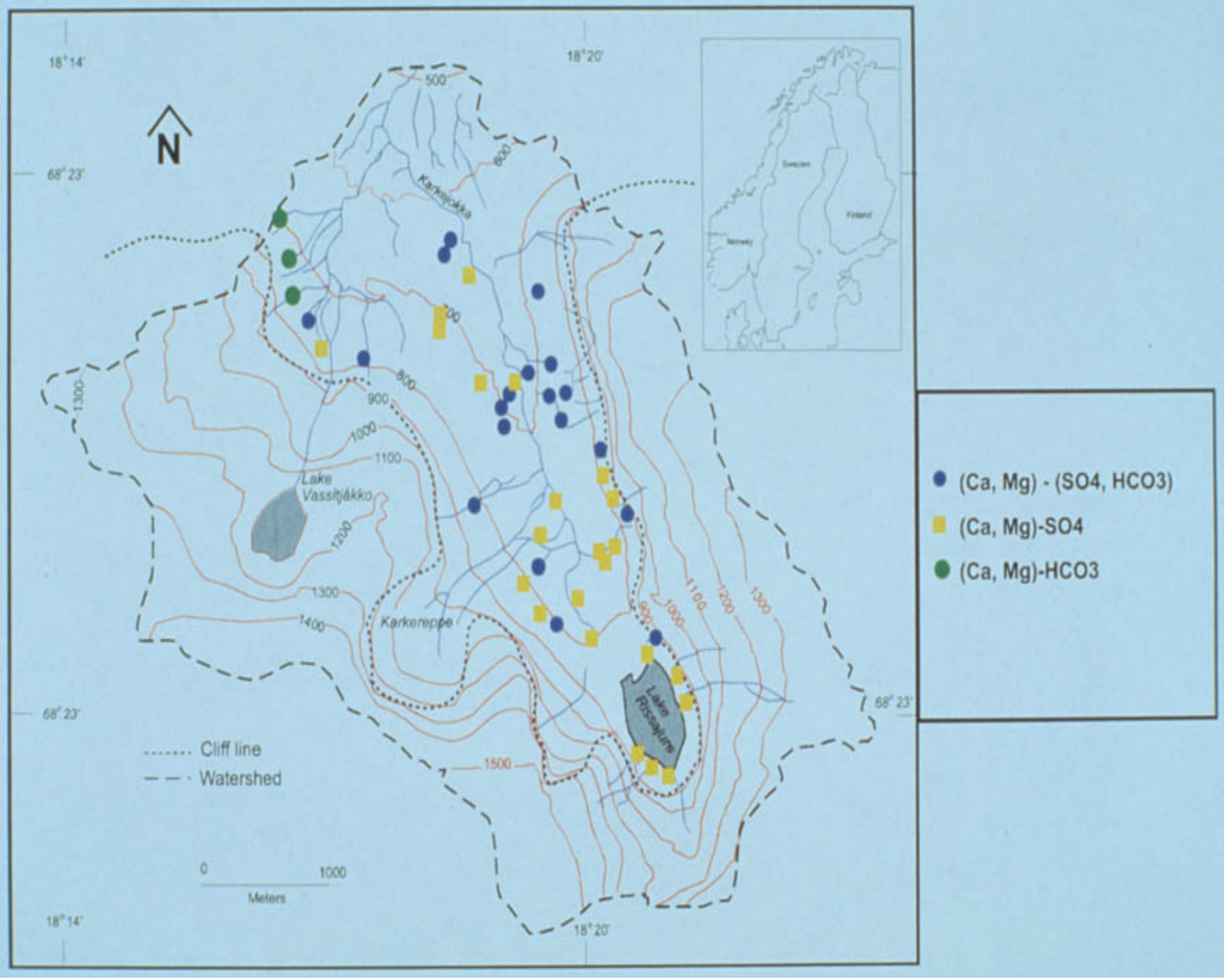
UNITED STATES OF AMERICA
ONE DIME

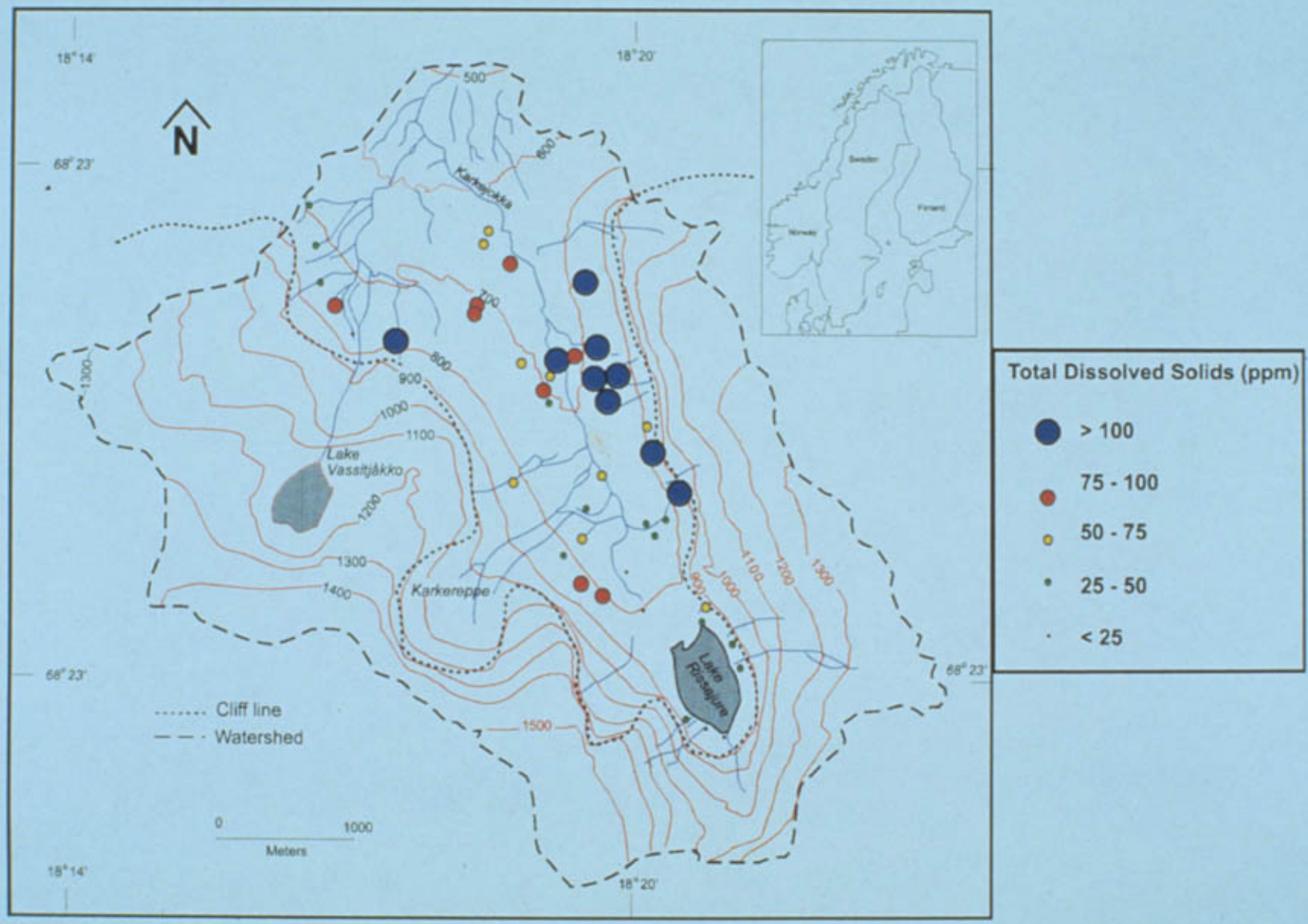
THROUGHPUTS

- Discharge controlled by sub-basin drainage area and snow/ice distribution
- Solute loads controlled by geology, discharge, and snow distribution
- Modulated by soils and groundwater

Spatial variability of Water Types

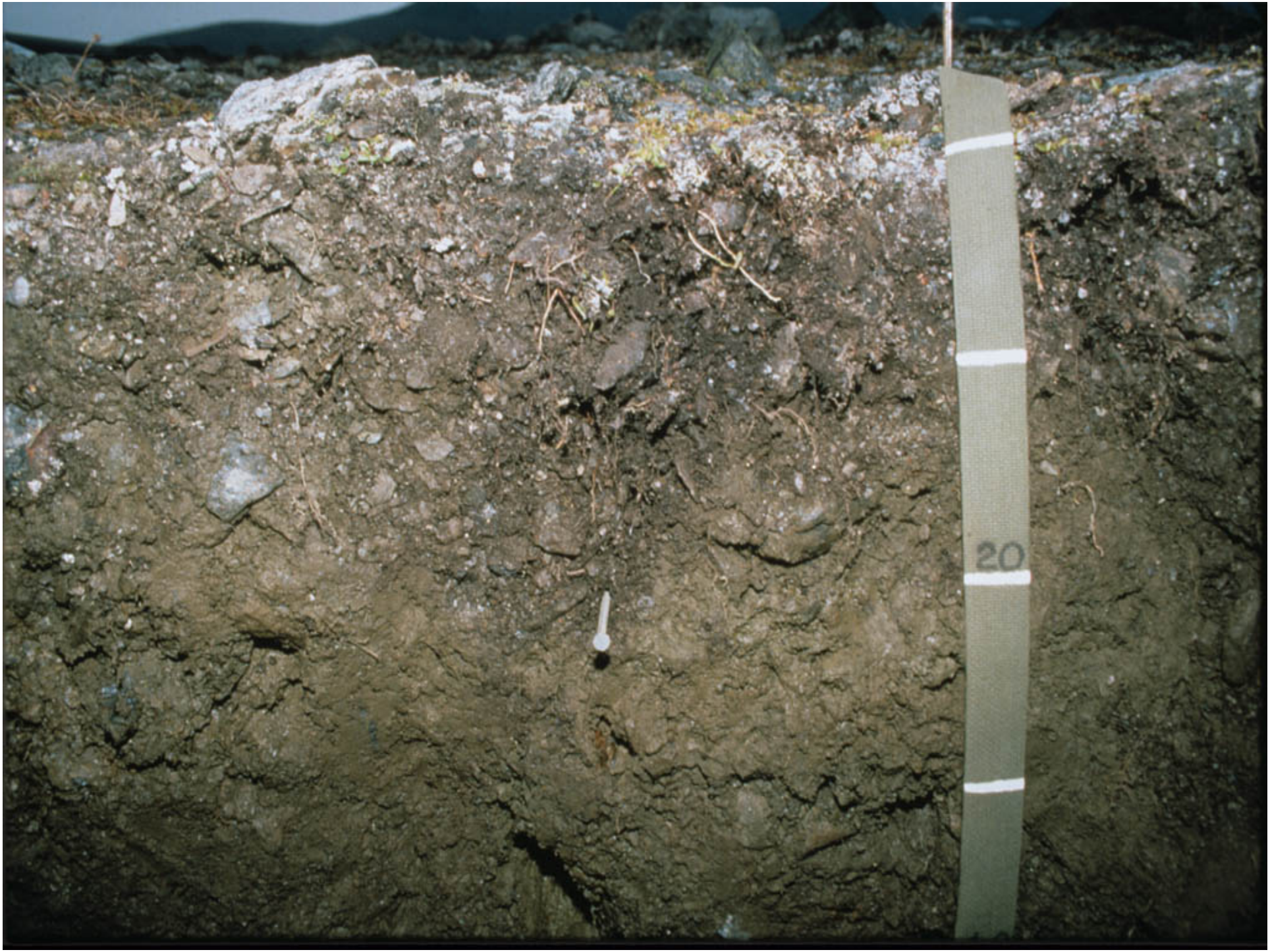


Spatial variability of Total Dissolved Load



STORAGES

- Soil Formation
- Rock Coatings
- Plant Uptake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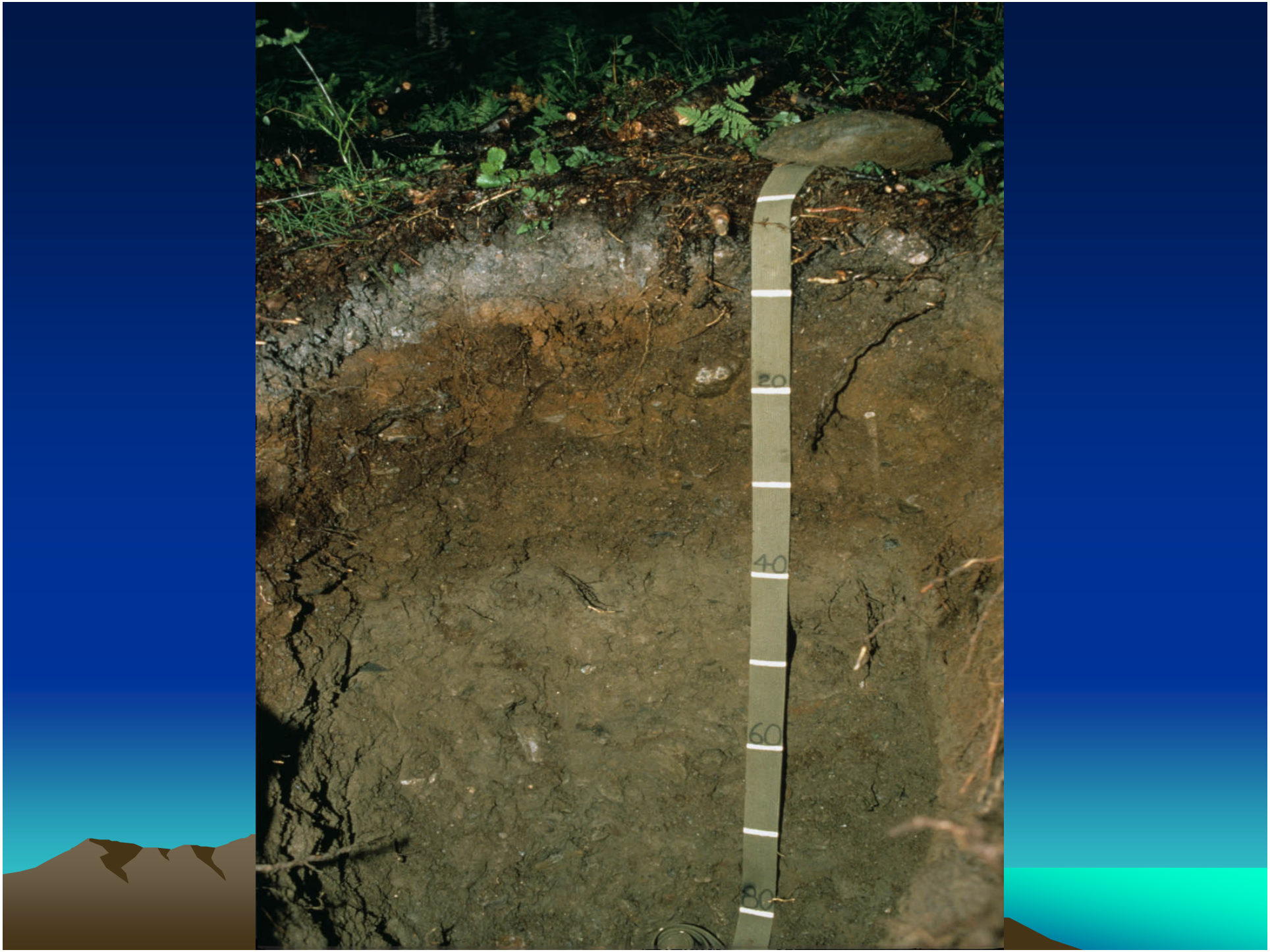
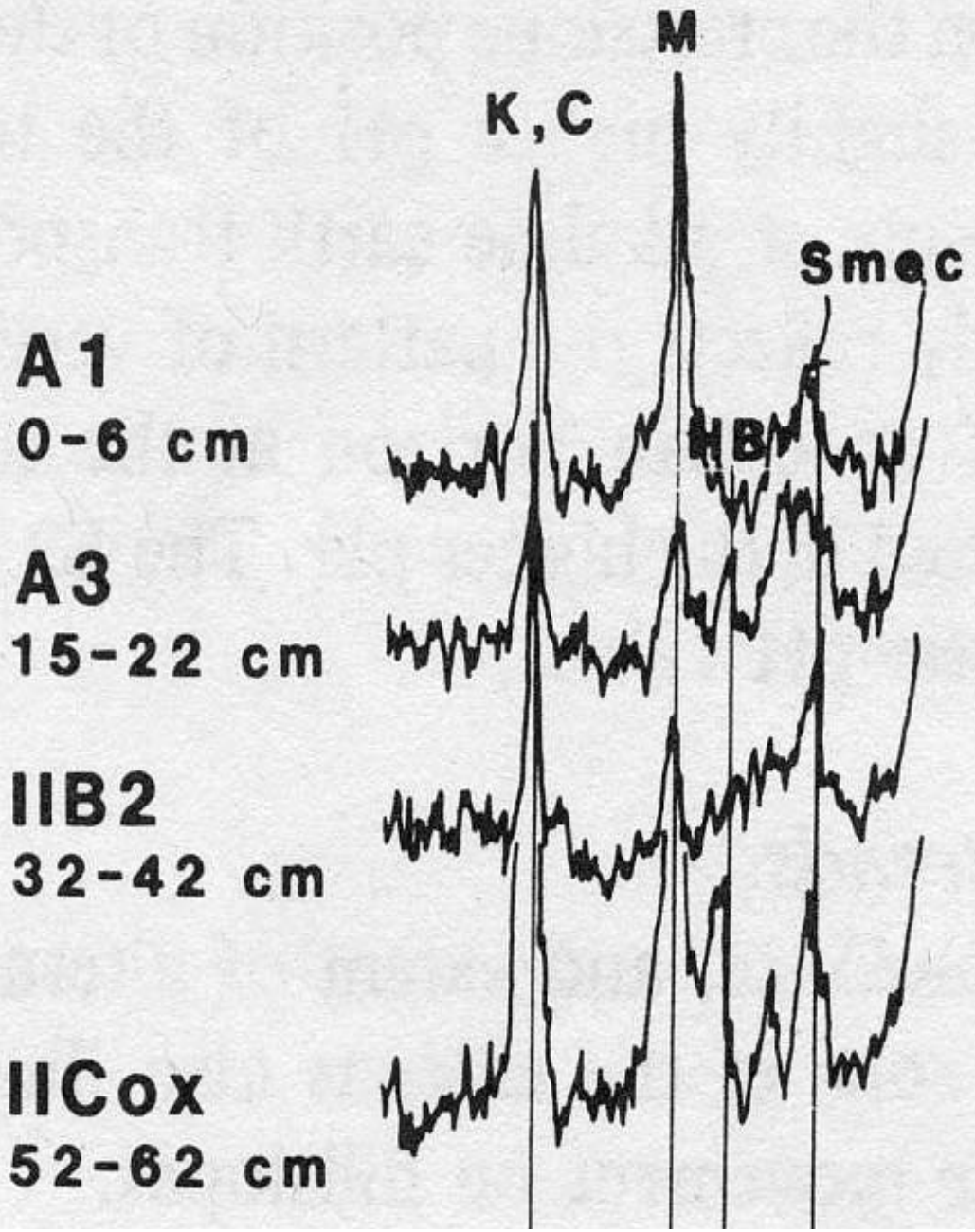
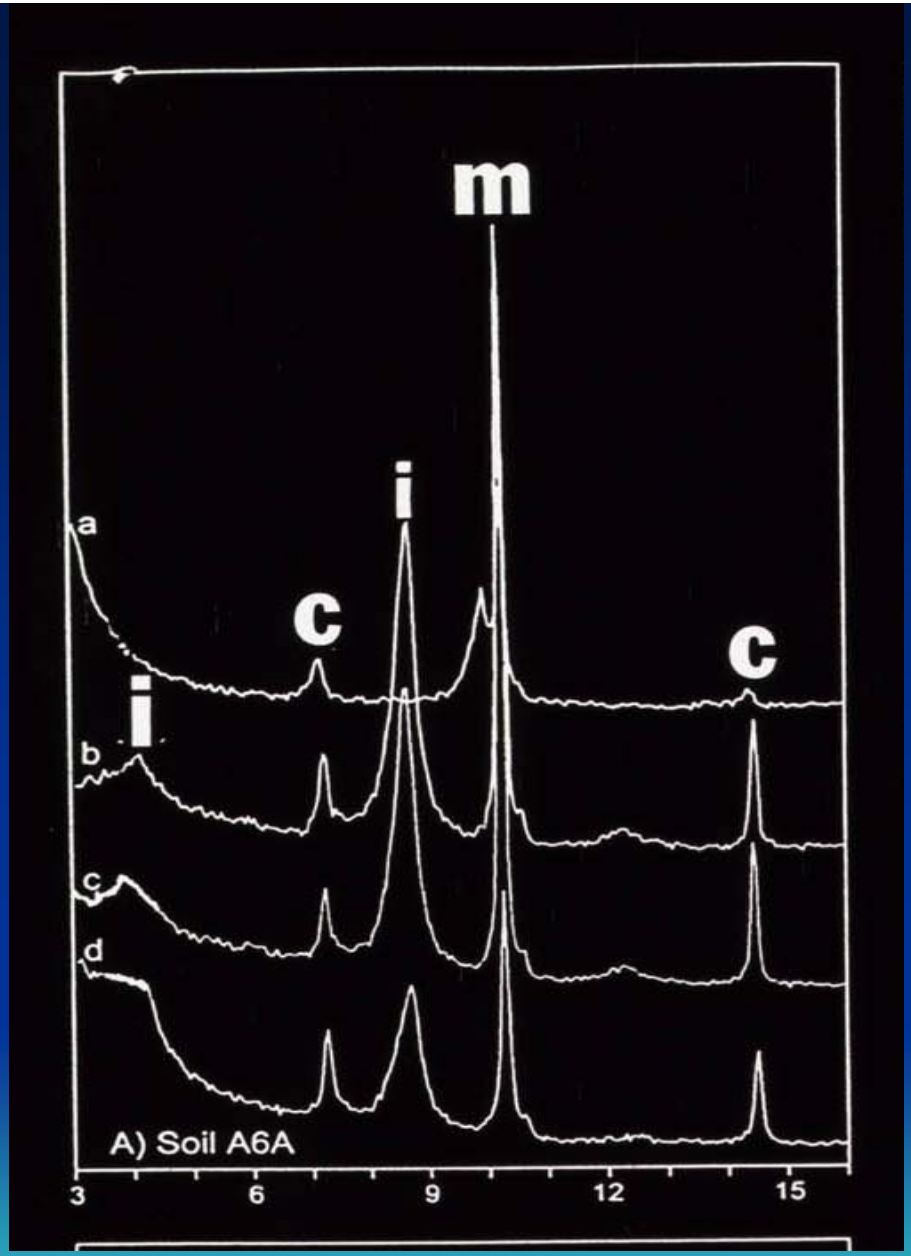

20
40
60
80

Dominant Soils

- Entiols
- Inceptisols
- Mollisols
- Spodosols
- Histosols
- Gelisols

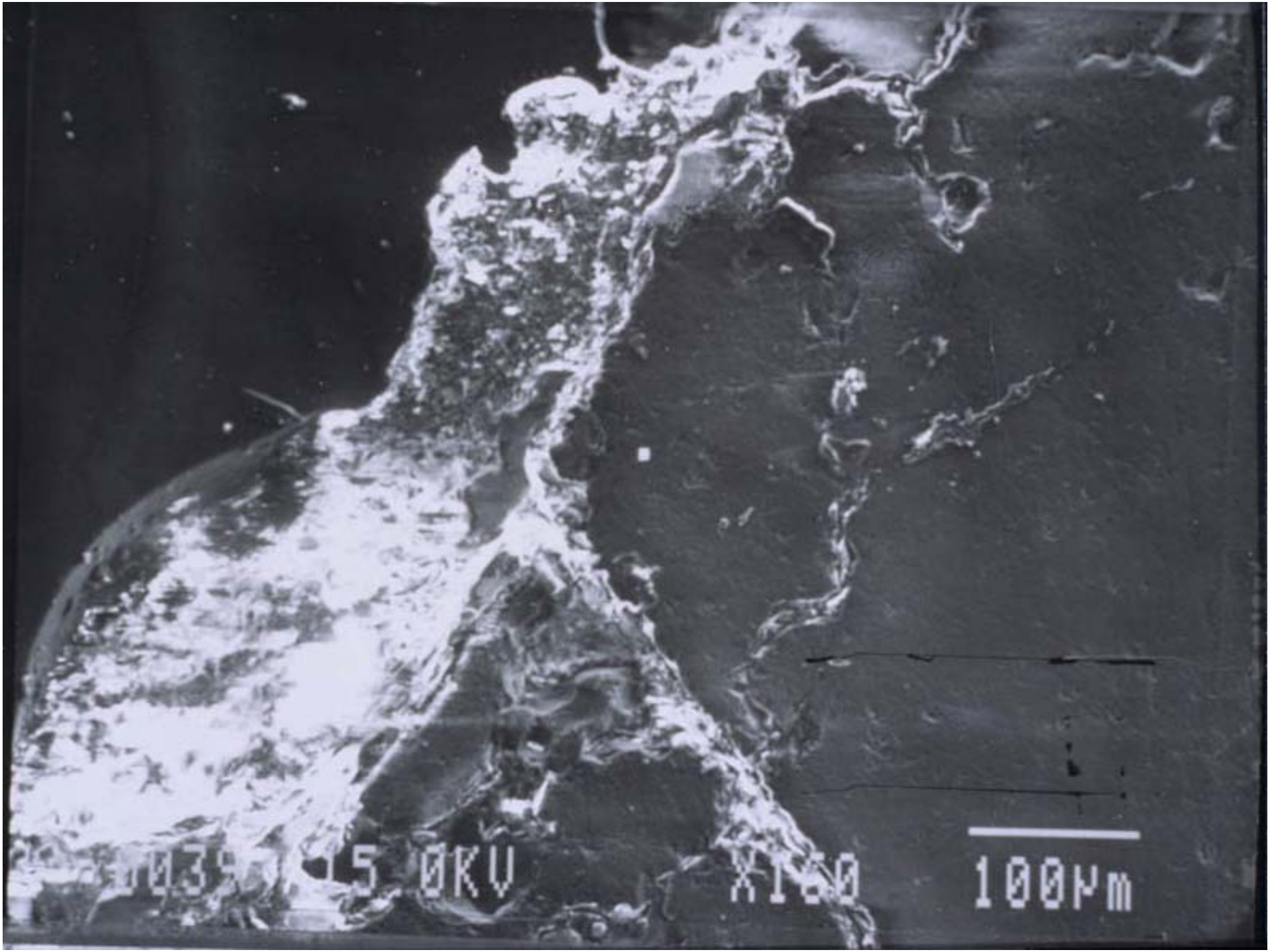
Crest Slope




m
i
c
c
i
a
b
c
d
A) Soil A6A
3
6
9
12
15

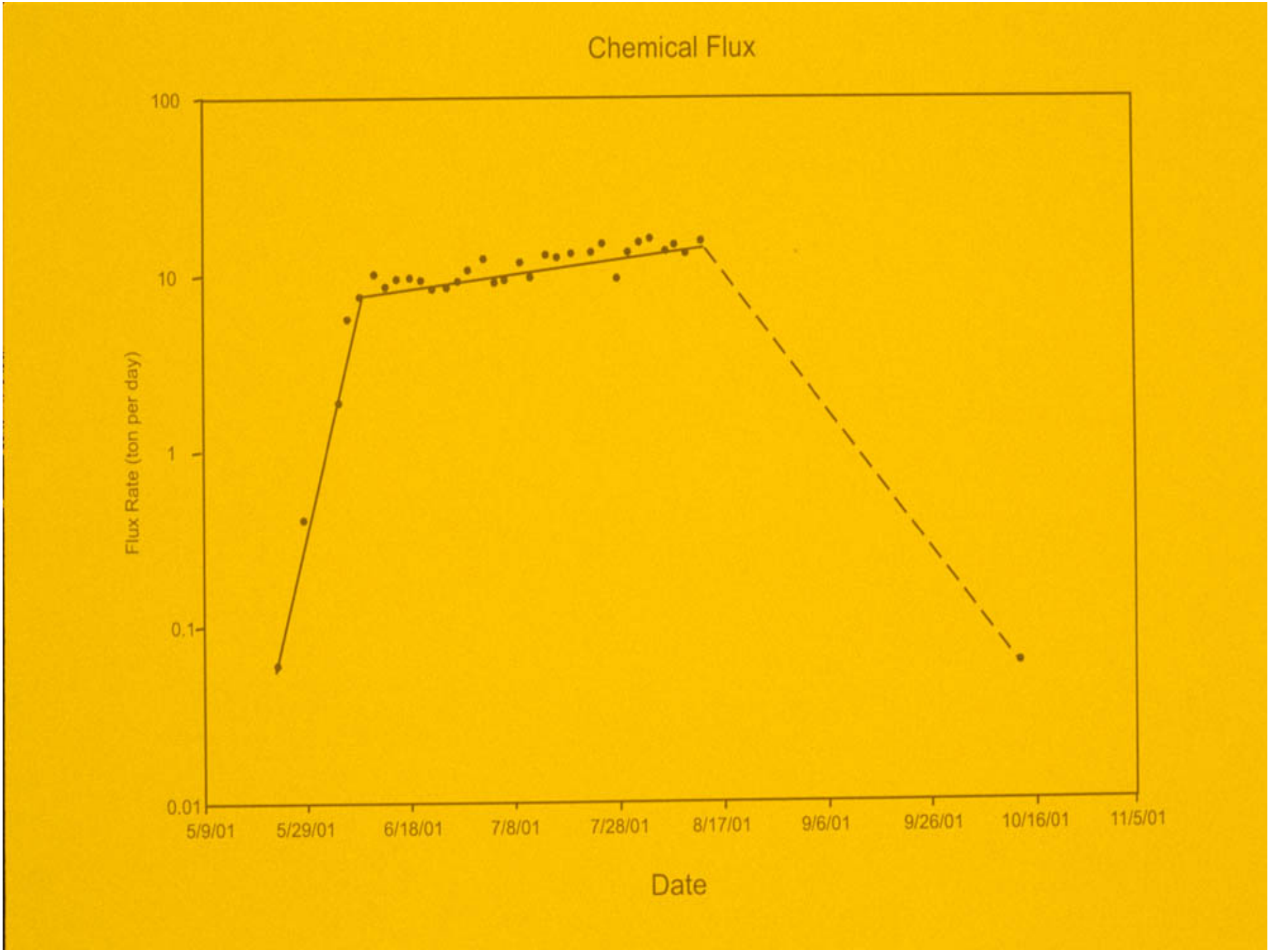
Rock Coatings

- Iron
- Aluminum
- Silicon
- Organo/metallic


5.0KV
100µm

OUTPUTS

- Dominated by seasonal patterns of snowmelt
- Early season increase followed by late season decrease


Chemical Flux
100
10
1
0.1
0.01
Flux Rate (ton per day)
5/9/01
5/29/01
6/18/01
7/8/01
7/28/01
8/17/01
9/6/01
9/26/01
10/16/01
11/5/01
Date

CONCLUSIONS

- Geochemical component of sediment budget multifaceted
- Rates of solute yields are highly variable
- Controls on solute yields include geology, pedology, precipitation, geomorphic activity, and patterns of snow/ice distribution