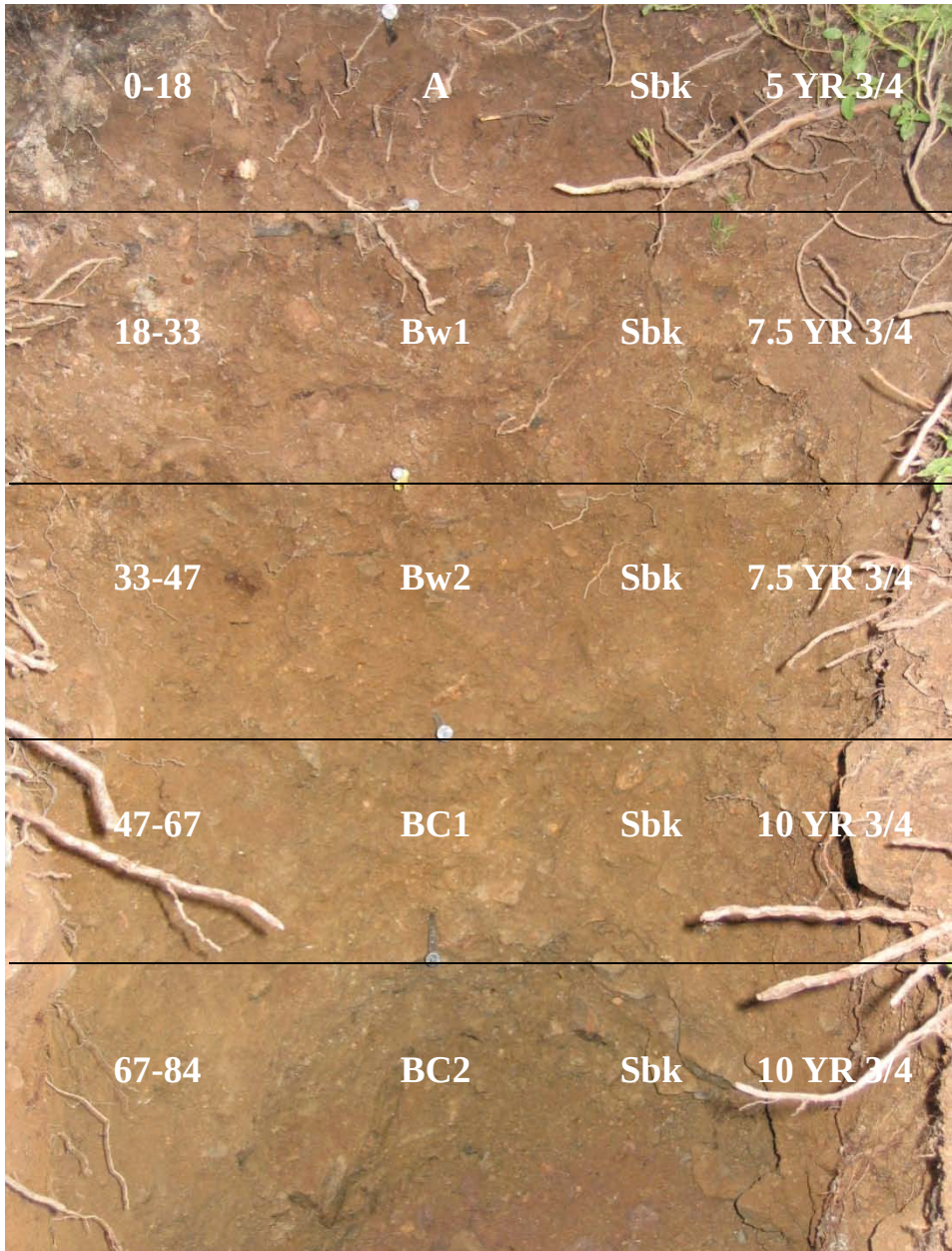
Field Pedon Description



Field Pedon Description

Depth (cm)	Horizon	Color (Moist)	Texture	Clay (%)	Gravel (%)	Structure	Effervescence	pH
6-4	Oi							
4-0	Oe							
0-18	A	5 YR 3/4	sl	13	>50	2 m sbk	eo	5.1
18-33	Bw1	7.5 YR 3/4	sl	12	>50	2 c sbk	eo	5.1
33-47	Bw2	7.5 YR 3/4	sl	8	>50	2 m gr	eo	5.4
47-67	BC1	10 YR 3/4	sl	8	>50	2 f-m sbk	eo	5.4
67-84	BC2	10 YR 3/4	sl	6	>50	2 f sbk	eo	5.5

Total Elemental Analyses

Sample Preparation

- Typical methods of sample preparation include extraction, dissolution, or acidification and should result in a solution free of particulates. Typical acid matrices include 10% HCl (1 volume of concentrated HCl in 10 volumes of solution), 25% HNO_3, and 1% HNO_3.
- Samples be at least 10ml in volume, but can generally get by with 5ml samples.

Analyses

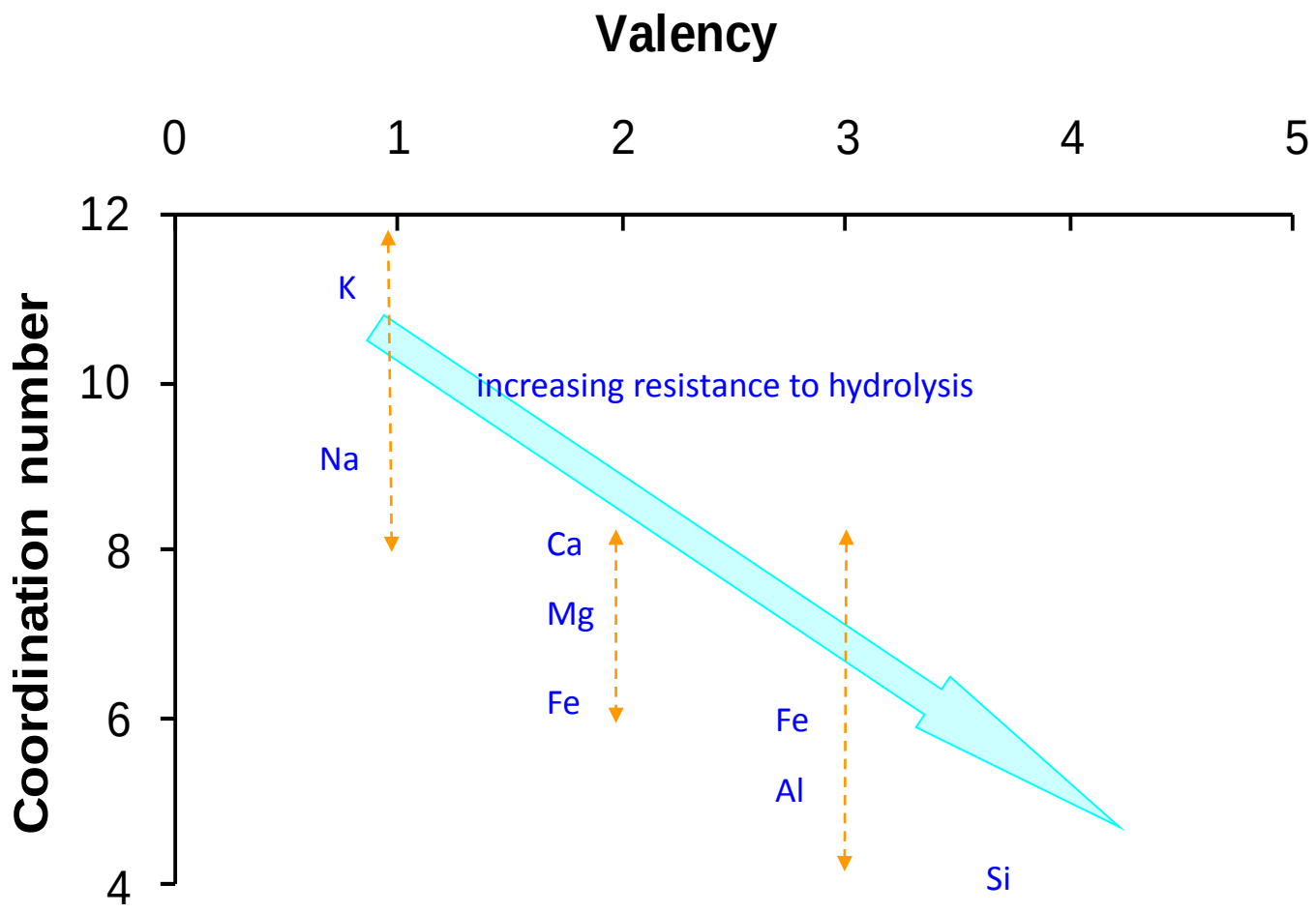
- ICP, Inductively Coupled Plasma
- ICAP-OES, Inductively Coupled Plasma Optical Emission Spectrometer
- Provides total elemental analysis of acidic solutions of soil extracts

Total Elemental Analyses

Interpreting Results

- Data values are expressed on an atomic weight basis (not as molecular species) and are reported in ppm
- To convert elemental values to other forms you need to factor in the atomic weight of the element as a fraction of the molecular weight of the species in question.

Elemental Weathering



Paton et al., 1995

Mass Balance

Goal

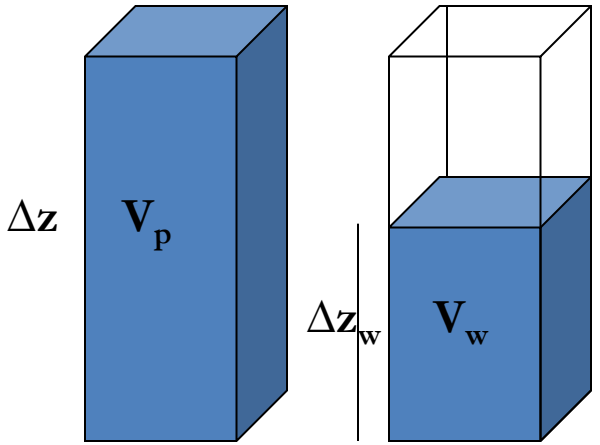
- To interpret the effects of weathering and pedogenesis quantitatively
- To merge pedologic and hydrochemical environments by assessing elemental and mineralogical gains and losses from the soil system

Mass Balance

What is mass balance?

- A physical and chemical model and mathematical tool used to quantify net gains and losses of material/mass in and out of soil horizons (mass transfers) during pedogenesis

- Comparison of bulk density, volume, and chemical composition between soil horizons and their respective parent material

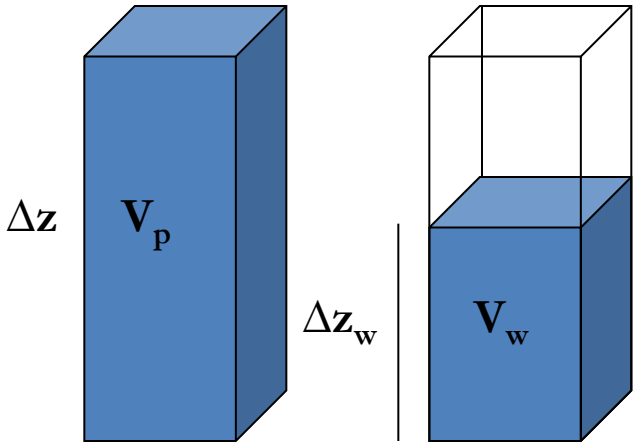


Chadwick O.A. et al. 1990

Mass Balance

What does mass balance do?

- Accounts for the fate of elements during weathering
- Accounts for mineral neoformation
- Accounts for leaching



Chadwick O.A. et al. 1990

Mass Balance

Conservation of Mass

$$\frac{V_p \rho_p C_{j,p}}{100} + m_{j,flux} = \frac{V_w \rho_w C_{j,w}}{100}$$

$$\frac{cm^3 * \frac{g}{cm^3} * \frac{g}{100g}}{100}$$

- The volume, density and concentration of the parent material (+) or (-) what has been added or removed contributes to the volume, density, and concentration of that element in the soil.

- The units combine to give the mass of element j in grams. So…the mass of the element in the soil is a product of the new volume (original volume (+) or (-) what has been removed), BD, and concentration.

Chadwick O.A. et al. 1990

Mass Balance

Strain

- To observe strain based on the volume change due to weathering:

$$\varepsilon_{i,w} = \frac{V_w - V_p}{V_p} = \frac{V_w}{V_p} - 1$$

- This is strain or volume change determined by use of an immobile element like Ti or Zr due to weathering

- Don't assume isovolumetric weathering (an initial volume may dilate or collapse during soil evolution)

  - So…the volume change relative to an immobile element determined by the density and concentration loss of a mobile element

$$\varepsilon_{i,w} = \frac{\rho_p C_{i,p}}{\rho_w C_{i,w}} - 1$$

Chadwick O.A. et al. 1990

Mass Balance

Strain

"a change in bulk density that is not compensated by an inversely proportional change in the concentration of the immobile element"

(Chadwick et al.,1990)

- Collapse- negative strain due to mineral dissolution and element mobility
- Dilation- positive strain due to elemental additions

Chadwick O.A. et al. 1990

Mass Balance

Mass Gains and Losses

- Open System Mass-Transport Function: Mass Fractions Relative to the mass of element in parent material

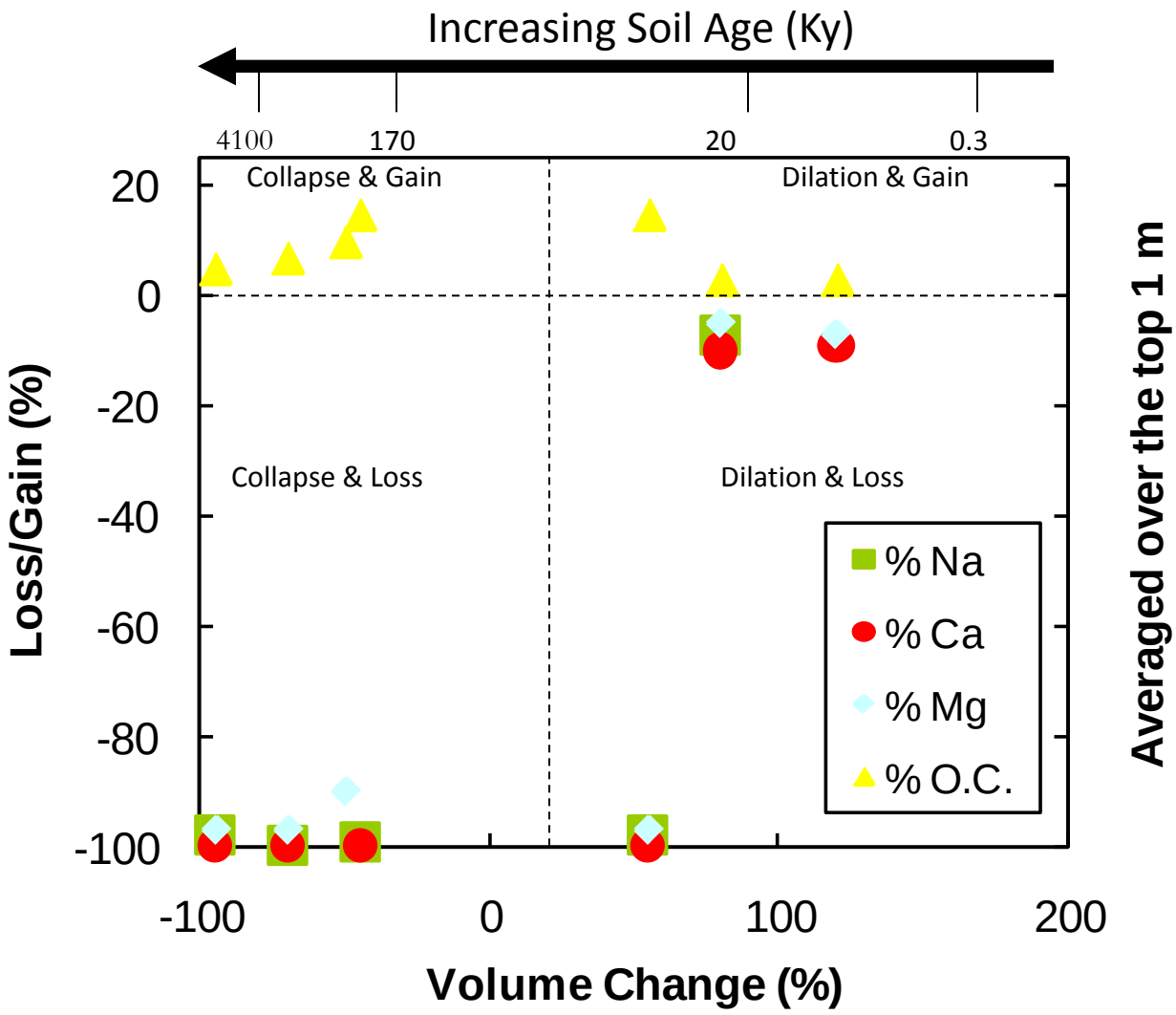
$$\tau_{j,w} = \frac{100 m_{j,flux}}{V_p C_{j,p} \rho_p} = \frac{\rho_w C_{j,w}}{\rho_p C_{j,p}} (\varepsilon_{i,w} + 1) - 1$$

- Density, concentration and volume change are considered

- -1.0 = 100% of mass of element originally in parent material was extracted during weathering.
- 0.00 = element has been immobile

Chadwick O.A. et al. 1990

Mass Balance Theory



Chadwick O.A. et al. 1990

Mass Balance

Limitations

1. External sources are often unidentifiable
2. Determining accurate parent material is critical
   - In soils derived from sedimentary parent materials, the least weathered soil horizon is considered the parent material
3. Bulk density is difficult to determine for some textures (ie. gravelly)

Chadwick O.A. et al. 1990