Phosphorus

Macronutrient

- essential element of ATP, RNA and DNA
- essential element of cell membranes
- yet still only 0.2% to 0.4% of leaves and approximately 2% of OM dry weight
- 1% to 4% of leaves and approximately 2% of OM dry weight

Reservoir	Total P \times 10 ¹² kg	
Land		
Soil	96-160	
Mineable rock	19	
Biota	2.6	
Fresh water (dis-		
solved)	0.090	
Ocean		
Sediments	840,000	
Dissolved (inorganic)	80	
Detritus (particulates)	0.65	
Biota	0.050-0.12	

Table 7.1 Aajor Reservoirs of P in the Earth"

^a From Richey.⁴





Pools and annual fluxes of P for the global P cycle. Reservoirs are expressed in 10⁹ kg and fluxes are in 10⁹ kg/year. (From J. E. Richey, The Phosphorus Cycle, in SCOPE 21, *The Major Biogeochemical Cycles and Their Interactions*, edited by B. Bolin and R. B. Cook, John Wiley and Sons, Ltd., 1983.)

P Sources and Sinks

Parent Material

- primarily apatite minerals, but other PM has...

range from 0.01% (100 µg/g) - 0.2% (2000 µg/g)

– native soil concentrations in 200 to 2000 μ g/g (avg 1000)

Fertilizer and Manure

- 10 to 15% of fertilizer

is taken up by plants



D Sources and Sinks	Reservoir	Total P \times 10 ¹² kg
P Sources and Sinks	Soil	96-160
	Mineable rock	19
	Biota	2.6
Soil	Fresh water (dis-	
	solved)	0.090

- amount of P available for biological activity is small (@ 0.01%)

 $0.96 - 1.60 \times 10^{12} \text{ kg}$

- bulk in 3 pools

Organic P, Ca-bound inorganic P and Fe/Al-bound inorganic P







Phosphorus content in the surface layer of U.S. soils. (Adapted from Sauchelli.⁵)



Once again the question should be what controls these fluxes and reactions...







P in soil solution range from 0.001 to 1 mg/L

Biological uptake is primarily in inorganic forms, though some organic P can be taken up...





The P cycle in soils, showing the partition of organic and inorganic forms of P into pools based on availability to plants. (From Stewart.¹ Reprinted by permission from Winter 1980–81 issue of *Better Crops with Plant Food*. Copyright 1981 by Potash & Phosphate Institute, Atlanta, Georgia 30329.)

Issues of Soil Fertility

Issues of Environmental Quality

Issues of Soil Fertility

- low native concentration levels
- mostly in unavailable form (insoluble)
- soluble forms can be quickly turned insoluble

Reminder: nutrients get to plants roots in the soil solution via concentration gradients



Issues of Environmental Quality

 due to ↓ P supply in humid and subhumid regions increased intensity of slap and burn agriculture additionally P deficiency inhibits microbial N-fixation
P is limiting nutrient in freshwater environments addition can lead to eutrophication











Potassium

Macronutrient

- cellular enzymatic activator
- remains as K⁺ ion in organism
- important regulator of cell osmotic potential
- 1% to 4% of leaf content



P Sources and Sinks

Primary Minerals

– micas and feldspars = 90 to 98%

Secondary Minerals

-2:1 phylosilicate clays = 1-10%

Soil Solution

-0.1-0.2% in K⁺ form only

Unlike previous nutrients, Potassium...

- is only present in soil solution in ionic form $\sim K^+$
- usually in excess amounts ~ not limiting
- flux controlled by CEC & chemical weathering ~ no organisms
- causes no toxic consequence ~ not a toxic pollutant

usually in excess amounts ~ not limiting



flux controlled by CEC & chemical weathering ~ no organisms



