Phosphates, Tungstates, Vanadates

• Phosphates are based on P$^{5+}$O$_4$
• Tungstates and Vanadates are based on W$^{6+}$O$_4$ and V$^{5+}$O$_4$ tetrahedra.

Apatite $\text{Ca}_5(\text{PO}_4)_3(\text{OH},\text{F,Cl})$

Occurrence: Accessory in Igneous and Metamorphic Rocks
Uses: Teeth, Bones

Apatite $\text{Ca}_5(\text{PO}_4)_3(\text{OH},\text{F,Cl})$

• Apatite is the most abundant phosphate mineral.
• It is a common accessory phase in igneous, sedimentary, and metamorphic rocks.
• The crystal structure has two large Ca sites that can incorporate U, Th, and REEs.
• The mineral can be used for fission-track dating to date the time a rock mass cooled below the healing temperature of tracks.
• Allows dating of uplift and erosion.

THE PHOSPHORUS CYCLE

Wind and rain erode phosphorus-rich rocks.

Plants use phosphorus from soil.

Wind and rain erode phosphorus-rich rocks.

Animals eat plants.

Plants use phosphorus from soil.

Decomposers return phosphorus to soil.

Phosphorus leaches from the soil into water.

Sediment accumulates to form phosphate-rich sedimentary rocks.

Runoff carries sediment to rivers, lakes, and oceans.

Runoff of phosphate-bearing compounds in fertilizers.

Phosphorus Cycle: (your teeth and bones)

• $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$ Apatite in rocks
• $\text{H}(\text{PO}_4)^-$ in soils
• Phosphorus is essential for plant growth.
• P is limiting nutrient in oceans
• P in runoff causes algal blooms and eutrophication (oxygen depletion in water)
Other Phosphates

Xenotime $\text{YPO}_4$

Monazite ($\text{Ce, La, Th}) \text{PO}_4$

Whitlockite $\text{Ca}_9(\text{MgFe})(\text{PO}_4)_6\text{PO}_3\text{OH}$

Vanadates

Vanadinite $\text{Pb}_5(\text{PO}_4)_3\text{Cl}$

(Apatite structure)

Scheelite $\text{CaWO}_4$

- Occurrence: High T Hydrothermal
- Density = 6 g/cm$^3$
- (It’s heavy)
- Uses: Major Ore of W

Wolframite $(\text{Fe, Mn})\text{WO}_4$

Ferberite $\text{FeWO}_4$

Huebnerite $\text{MnWO}_4$

- Occurrence: High T Hydrothermal
- Uses: Major Ore of W