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Formation of a Permeable Reactive Barrier of Apatite For Radionuclide Immobilization

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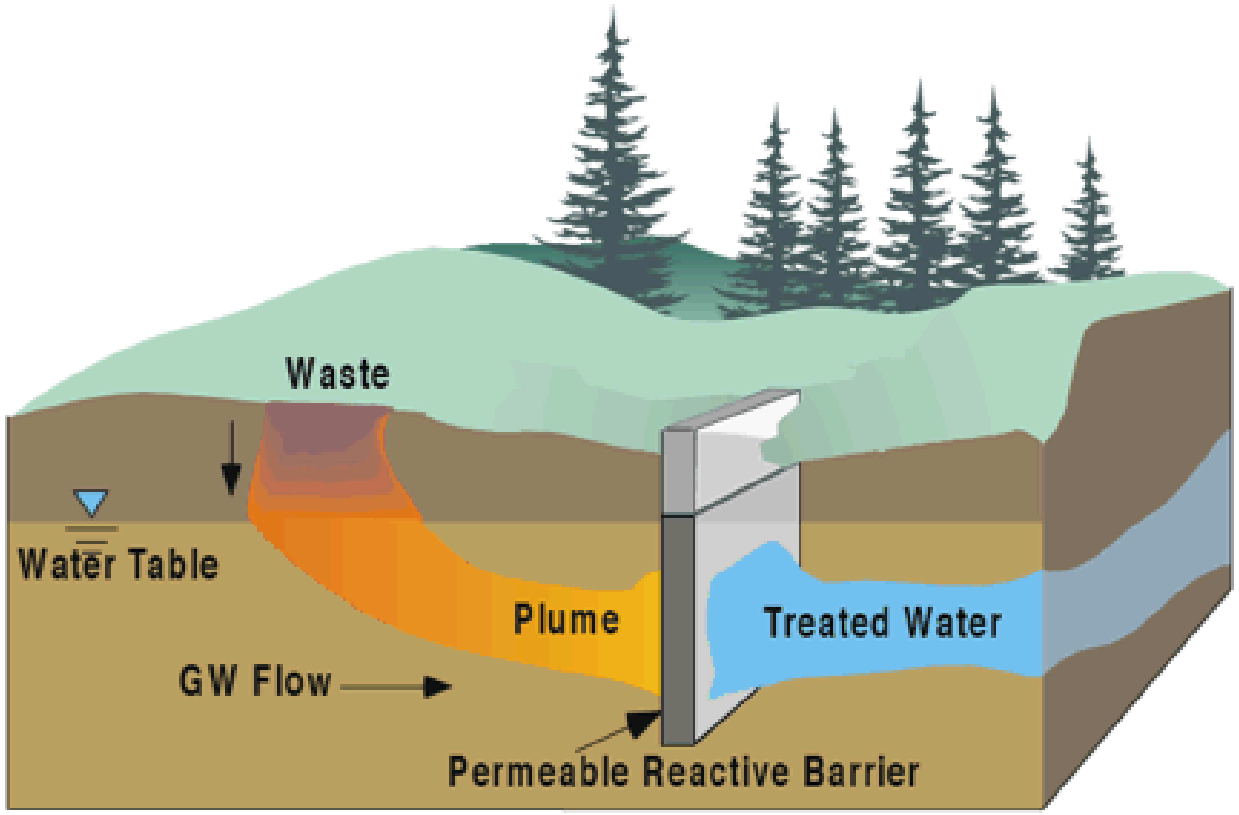
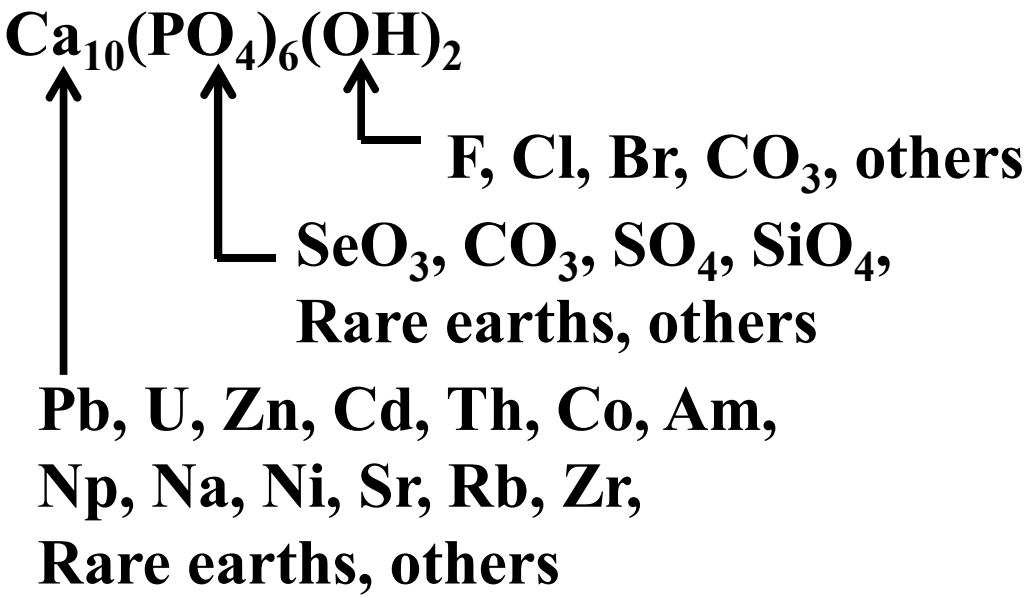
Permeable Reactive Barriers



Contaminants are Immobilized or Converted to an Less Toxic Form Below Ground

Hydroxyapatite: Radionuclide Sorbent

- $Ca_{10}(PO_4)_6(OH)_2$
- A common calcium phosphate mineral found in bone, teeth and mined as phosphate ore.
- Very stable and highly insoluble in water.
- Many radionuclides and heavy metals will strongly sorb to the surface of hydroxyapatite or substitute into its structure including uranium, strontium, neptunium, plutonium, lead, selenium, technetium, etc.



Construction of Permeable Reactive Barriers

- **Trenching and Backfilling**

  Conventional construction methods include trench followed by backfilling with reactive media or high pressure injection of the media

- **Apatite Forming Solution**

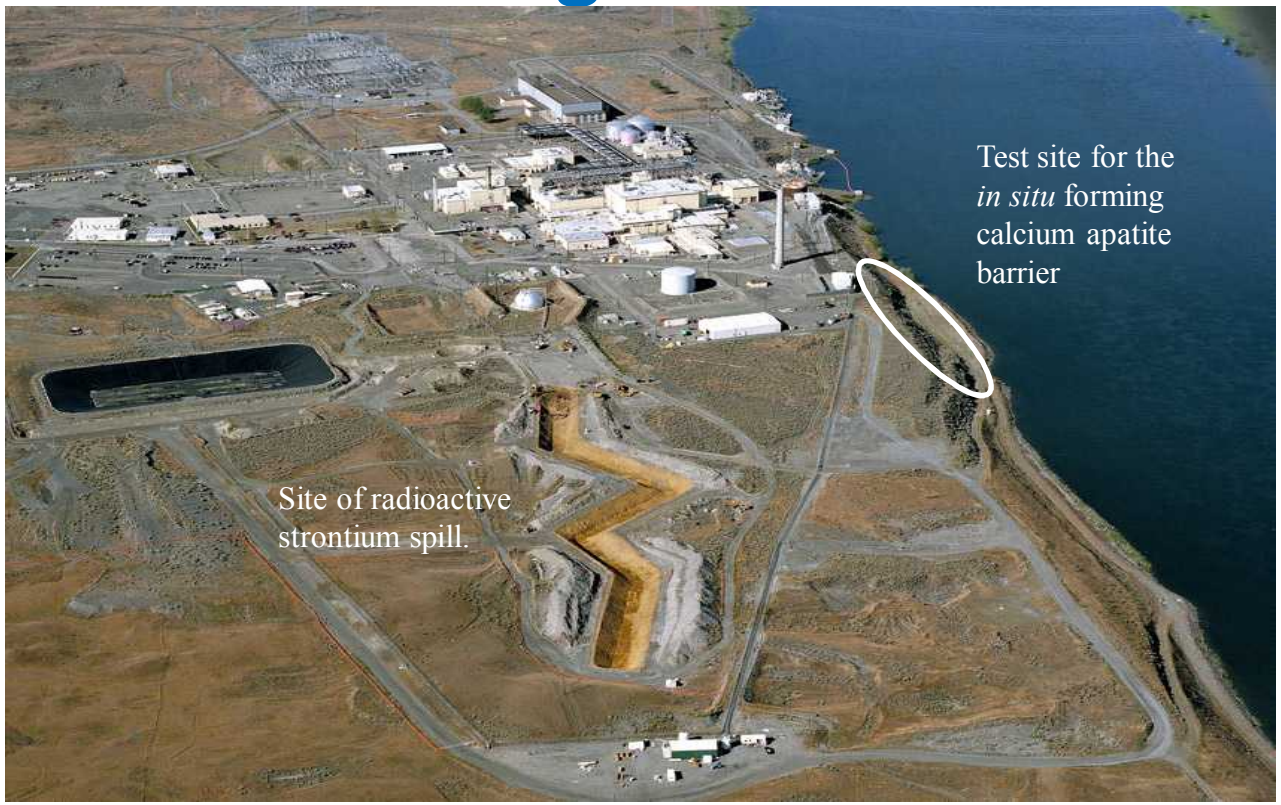
  An alternative is to use an aqueous solution of calcium- $(citrate)_2$ and sodium phosphate To make apatite *in situ* in the ground. When the solution is placed in soil, the soil microorganisms metabolize the citrate the calcium is released in a form that reacts with phosphate to form hydroxyapatite.

Conventional Trenching and Backfilling

Apatite Forming Solution Being Pumped into the Ground

$$\text{calcium–(citrate)}_2 + \text{sodium phosphate} \xrightarrow{\text{soil microorganisms}} \text{apatite}$$

In Situ Formed Permeable reactive Barrier. Department of Energy Hanford 100N Site, Washington State



Initial hydroxyapatite barrier was 100 meters long and is being expanded to 1000 meters. Injection well were placed every 10 m.
The barrier is 95 to 99.9% effective at removing radioactive strontium from the groundwater.

Future Uses

- **Prevent the Spread of Radioactive Material After an Accidental Release**
  - Apatite barrier can be placed in strategic locations to immobilize radionuclides and minimizing their migration in the environment after an accidental release
- **Prevent Releases from Waste Tanks or Storage Facilities**
  - Solid apatite or stannous treated apatite can be used in the annular space between double shell waste tanks or around and underneath storage sites to prevent releases of radioactive material.