Title: Rock Phosphate: Raw Materials for P Fertilizer Production Phosphorus Fertilizers and Management
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Unit 2, Lesson 8 P Sources and Management

Rock Phosphate:
Raw Material for P fertilizer production

2006 World Phosphate mine production (%)

- United States: 23.4%
- Australia: 11.0%
- Brazil: 6.4%
- China: 24.4%
- Israel: 1.6%
- Jordan: 8.4%
- Morocco and Western: 2.3%
- Tunisia: 4.2%
- Russia: 4.9%
- Other countries: 19.3%
Phosphate Minerals

General Forms of Ca-P:

Apatite: \( \text{Ca}_{10}(X)_2(\text{PO}_4)_6 \)

where \( X = \text{F, Cl, OH, CO}_3^- \)

General Forms of Fe, Al-P:

Varascite: \( \text{AlPO}_4.2\text{H}_2\text{O} \)

Strengite: \( \text{FePO}_4.2\text{H}_2\text{O} \)
Phosphate Fertilizer

Phosphate Rock

14-27% $P_2O_5$

Beneficiation

Phosphate Rock Concentrate

31-33% $P_2O_5$
Phosphate Fertilizer

Phosphoric Acid

**Phosphate Rock** + **Sulfuric Acid** + **Water**

\[ \text{Gypsum}^+ + \text{Hydrofluoric Acid} + \text{Phosphoric Acid} \]
Phosphate Rock

Sulfuric Acid

Ordinary Superphosphate

Phosphate Rock

Phosphoric Acid

Triple Superphosphate

Ammonium Phosphate

Mixed Fertilizer or Direct Application
Summary of Acid-Treated Phosphates

- phosphoric acid: can be used as liquid fertilizer in alkaline soils, but mostly a raw material for fertilizer production.
Acid treated phosphates (cont)

- calcium othophosphates
  - ordinary superphosphates 7-9.5% P; a mixture of monocalcium P and gypsum (8-10% CaSO4)
  - triple superphosphate 19-23% P; 95% soluble; <3% S.
• ammonium phosphates
  ◦ monoammonium phosphate (MAP) 11% N; 21-26% P
  ◦ diammonium phosphate 16-18% N; 20-21% P
• Bones, bonemeal
  ◦ Human (Mummies)
  ◦ Buffalo
  ◦ Cow
• Guano
• Manures
• Nightsoil and Biosolids (not certifiable)
“Organic” P source

- Rock Phosphate: usually apatite 11.5-15.5% P; 5-17% citrate soluble;
  - solubility is low in neutral to alkaline soils; immediate P availability may be limiting
  - increased sol. with decrease particle size.
- Heavy metals in western rock P??
- Is this organic fertilizer really chemically organic???
What are the advantages of refined P fertilizers vs. Rock P?
What P sources are used in your plant-soil system, and why?
Balancing crop production, resource use and environmental protection

Sharpley et al., 1999
Key concepts in P management

- Crop removal depletes soil P reserves
- P reserves must be replenished to sustain solution P levels for optimal crop production
Key concepts in P management related to crop production

- Phosphorus strongly binds to soil particles, requiring P additions higher than replacement amounts.
- P availability will decrease over time in high P fixing soils; placement is critical.
- Vertical movement of P in soils is minimal.
Phosphate Fertilizer Placement

- More critical than N placement: Why??
- Banding will reduce P fixation
- Coplacement with N increases P use efficiency, due to:
  - localized root proliferation
  - rhizosphere acidification with ammonium fertilization
  - increased P uptake efficiency
Dual N-P placement is often more effective than broadcasting P
Phosphorus Application
Band vs. Broadcast

- Less soil-P contact and less P fixation
- More highly concentrated in localized zone
- fine textured soils

- Greater, more even distribution throughout root zone
- coarse textured soils
Starter Fertilizer

- Place with or near the seed at planting
- Often contains N and P to boost early seedling growth
- Be careful not to overdo it!
  - Avoid salt and ammonium injury
Key concepts in P management related to environmental protection

- Organic and processed P fertilizers differ in soil reactions; organophosphates may have greater leaching potential.
- Organic P is mineralized during cultivation
- P buildup (inputs>crop removal) has lead to increased P runoff and surface water contamination