Life without Phosphorus?

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Green Bug Lectures
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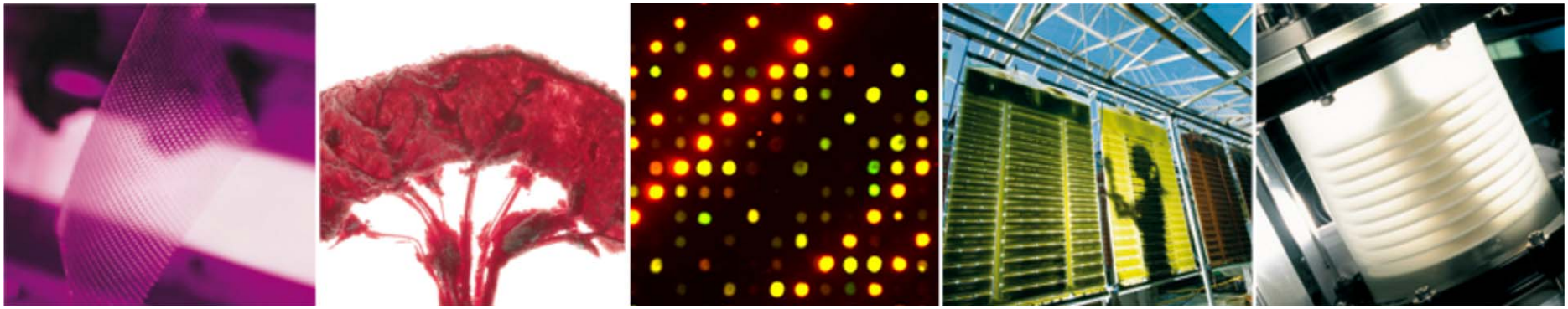

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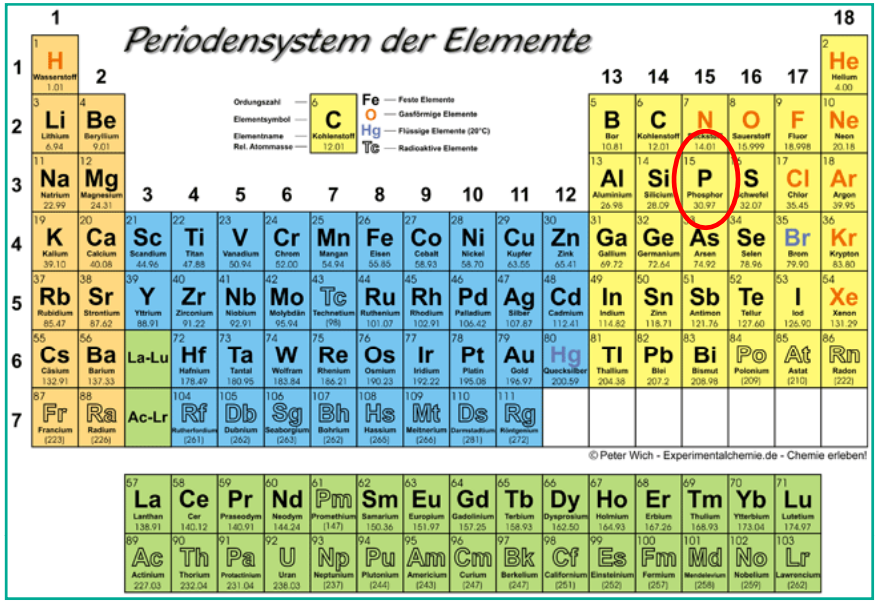
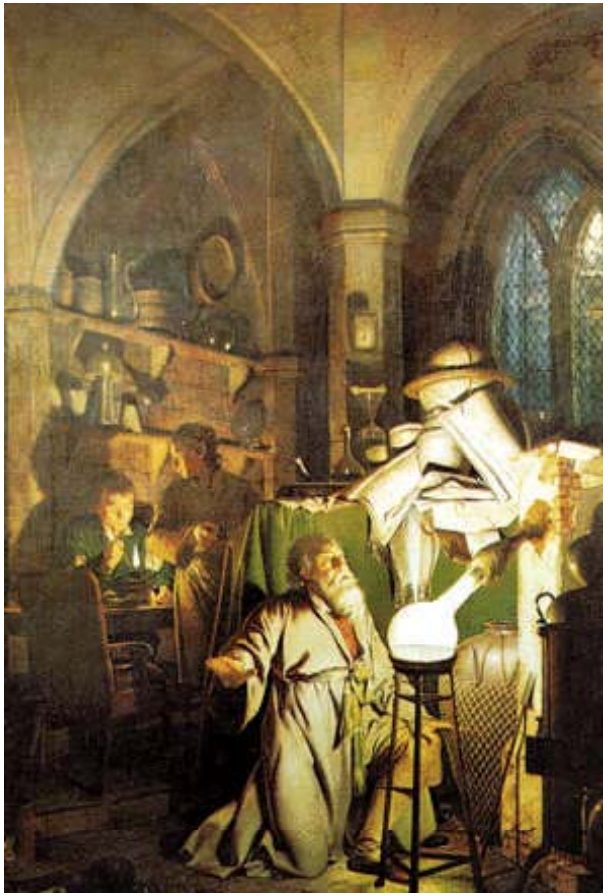
What is Phosphorus (P)?

- P is a chemical element
- P was discovered by Hennig Brand in 1669
- gr (*phosphoros)* "light-bringer"





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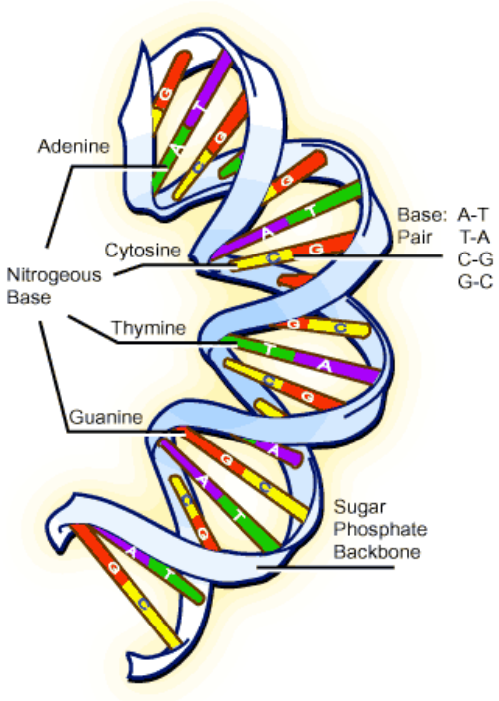
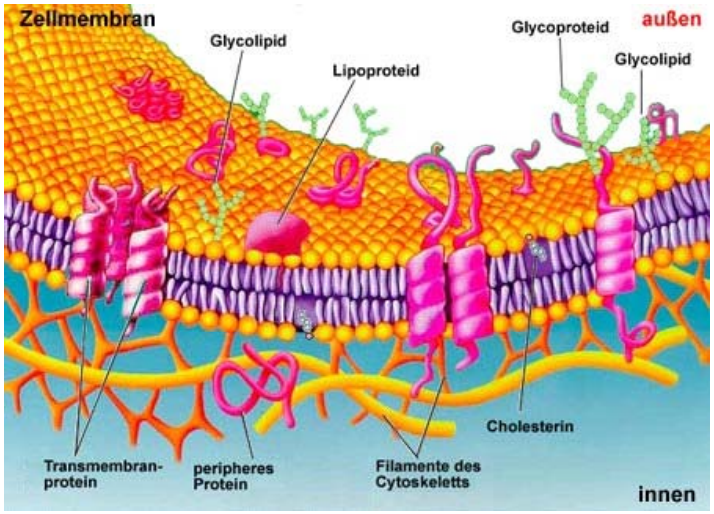
Why is P so important?

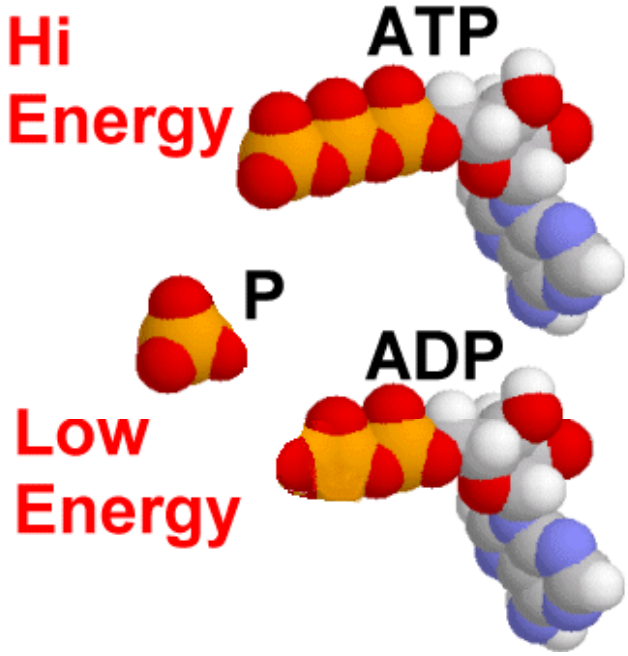
DNA



Cell membrane Phospholipides



Energy metabolism



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Uses of Phosphorus

10% explosives, plastics, detergents, pesticides

90% fertilizers

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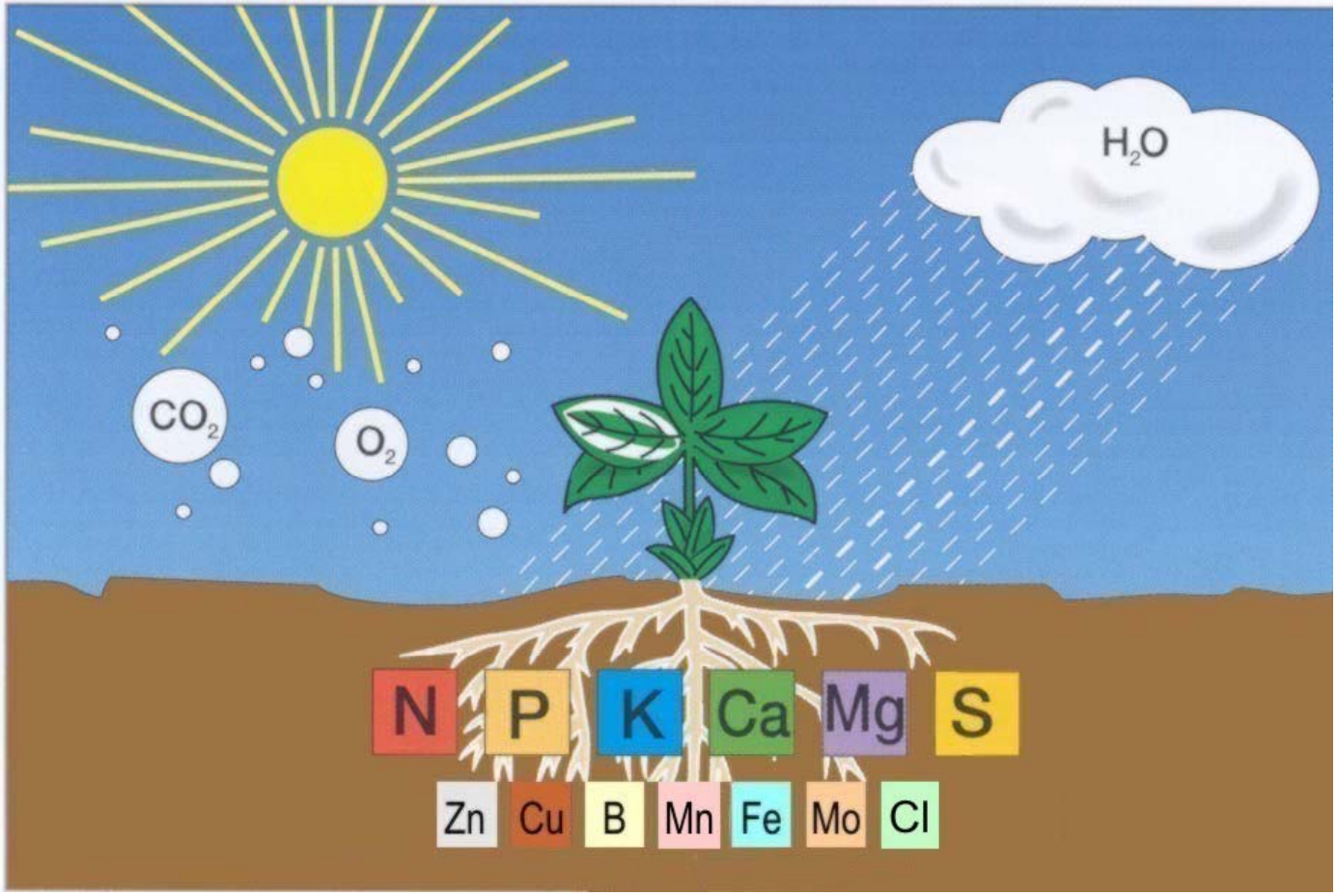
Minerals for plants



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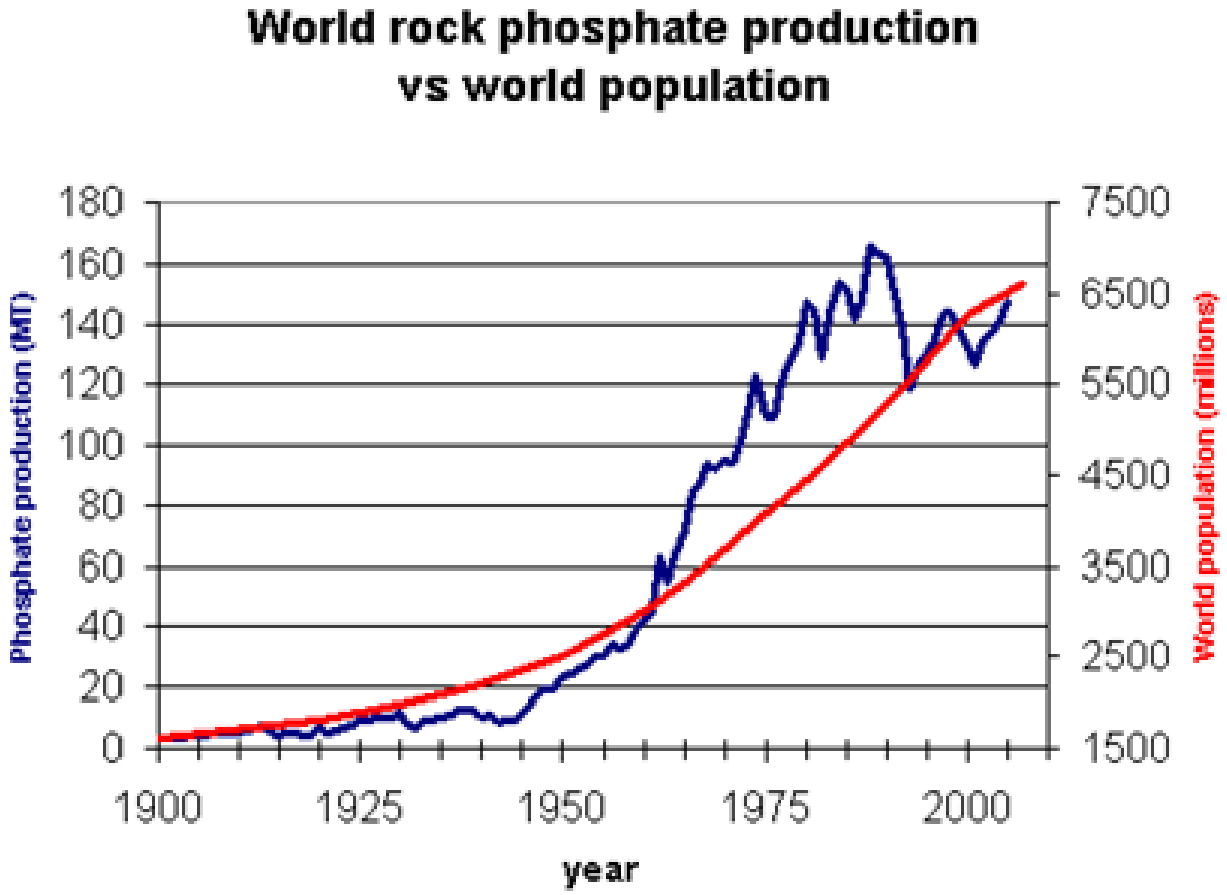
Phosphate production and world population



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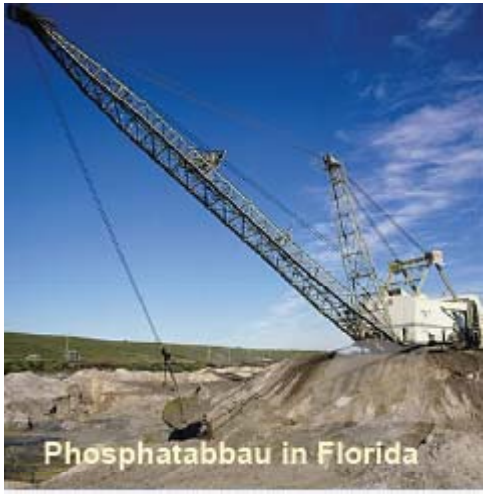
(Quelle: www.energybulletin.net/33164.html)

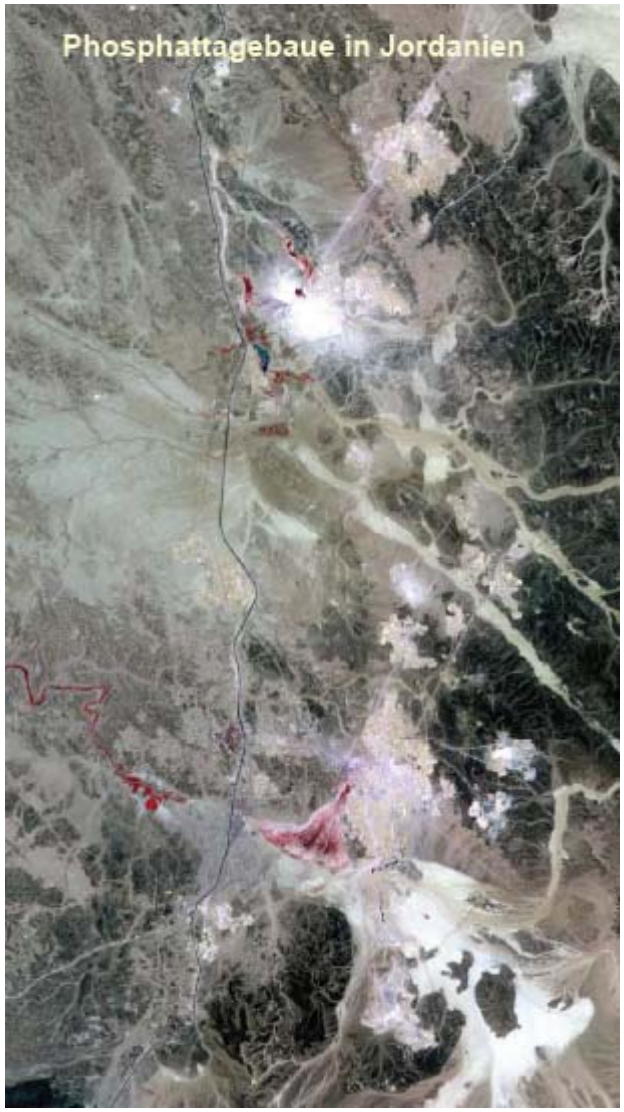
Where does P come from?

Guano -> bird excrements

Rock -> calcium phosphate (apatite)

- fossil marine sediments
- volcanic deposits





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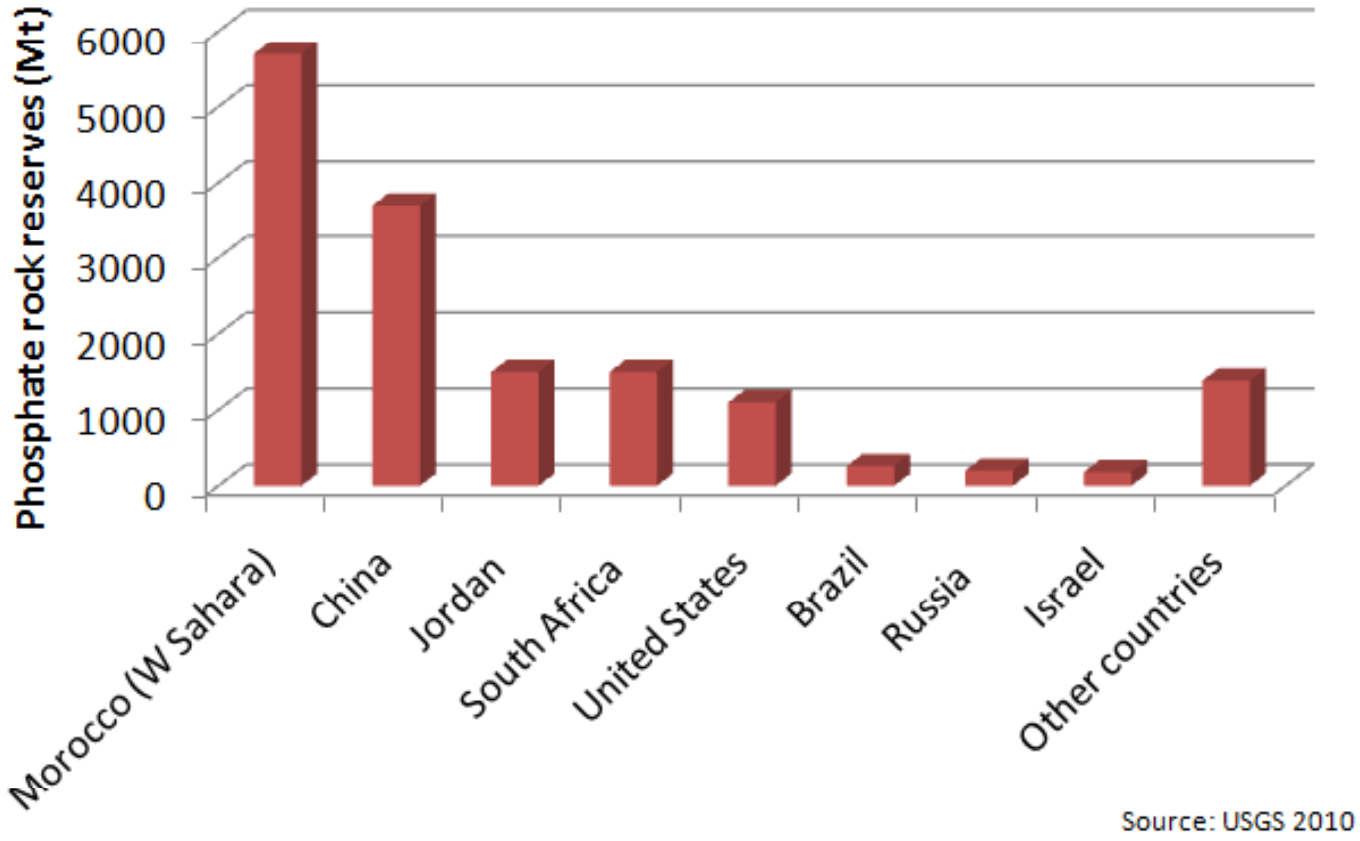
Where can P rock reserves be found?



Source: USGS 2010

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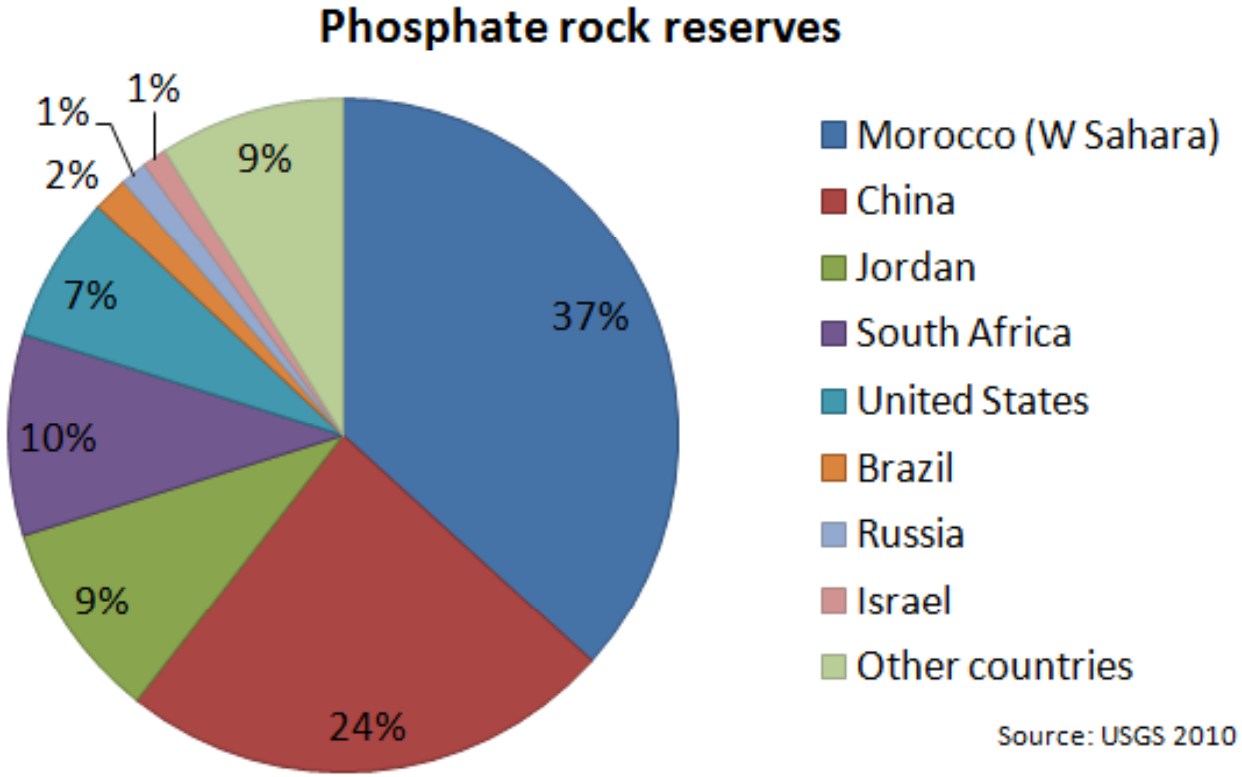

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Peak Phosphorus

- Phosphorus rock is a **non** renewable resource
- US will deplete its reserves within 30 years*
- Global reserves will run out within **75–100 years!****
- Peak phosphorus 2030

  demand will exceed supply

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*Rosemarin, A., Bruijne, G. d. & Caldwell, I. (2009)

**Cordell, D, Drangert, J-O & White, S (2009)

Same scenario as crude oil?

Crude oil can be replaced!!!

- Solar energy
- Wind energy
- Hydroelectric power
- Biogas

P cannot be replaced

P cannot be synthetically produced!

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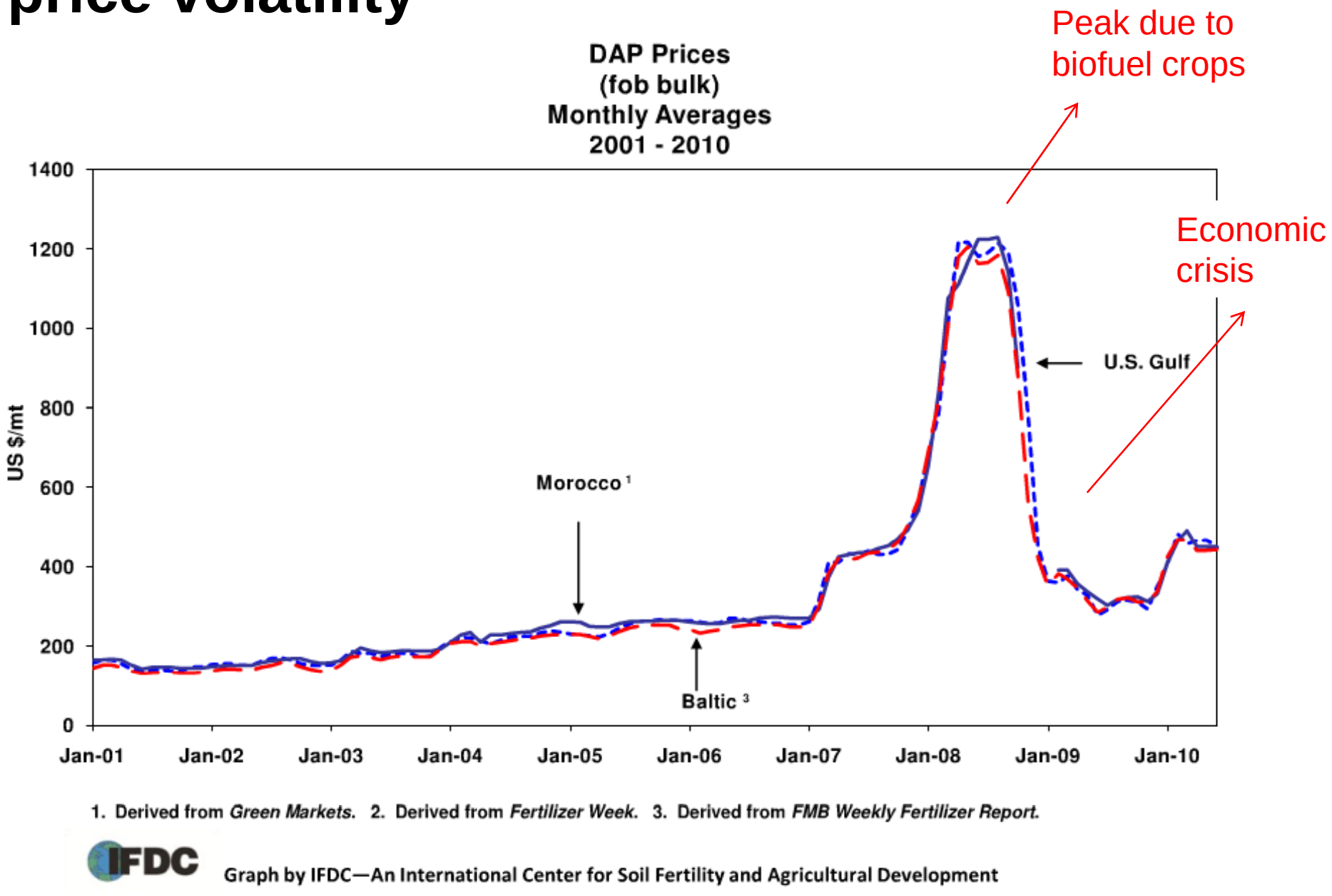
Consequences of P Scarcity

- farm output will decline
- higher fertilizer prices
  - higher food prices
  - food insecurity will increase
- global economic and social crisis
- Regional and global conflicts (wars?)

P price volatility

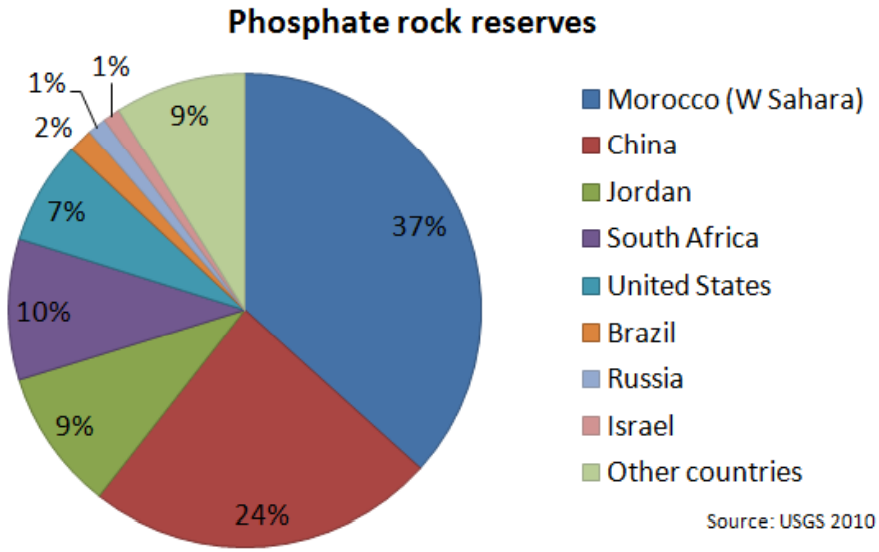


Consequences of P price volatility

- Price of food increased
- Conflicts in developing countries
- No changes in policy -> fertilizers nor agriculture
- UN -> Task Force on Global Food Security Crisis
  - Food security summits
    - Rome (2008)
    - Madrid (2009)

Geopolitical implications

- Five countries control 90% of the P reserves
- China 135% tariff on exports (2008)
- US extraction has now peaked -> dependent on imports
- Morocco next supplier



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Geopolitical implications

- Morocco’s P reserves -> W. Sahara
  - internationally recognized as a sovereign country
  - Since 1975 it’s been occupied by Morocco
- In 2004 US signed a bilateral free trade agreement with Morocco -> long access to P

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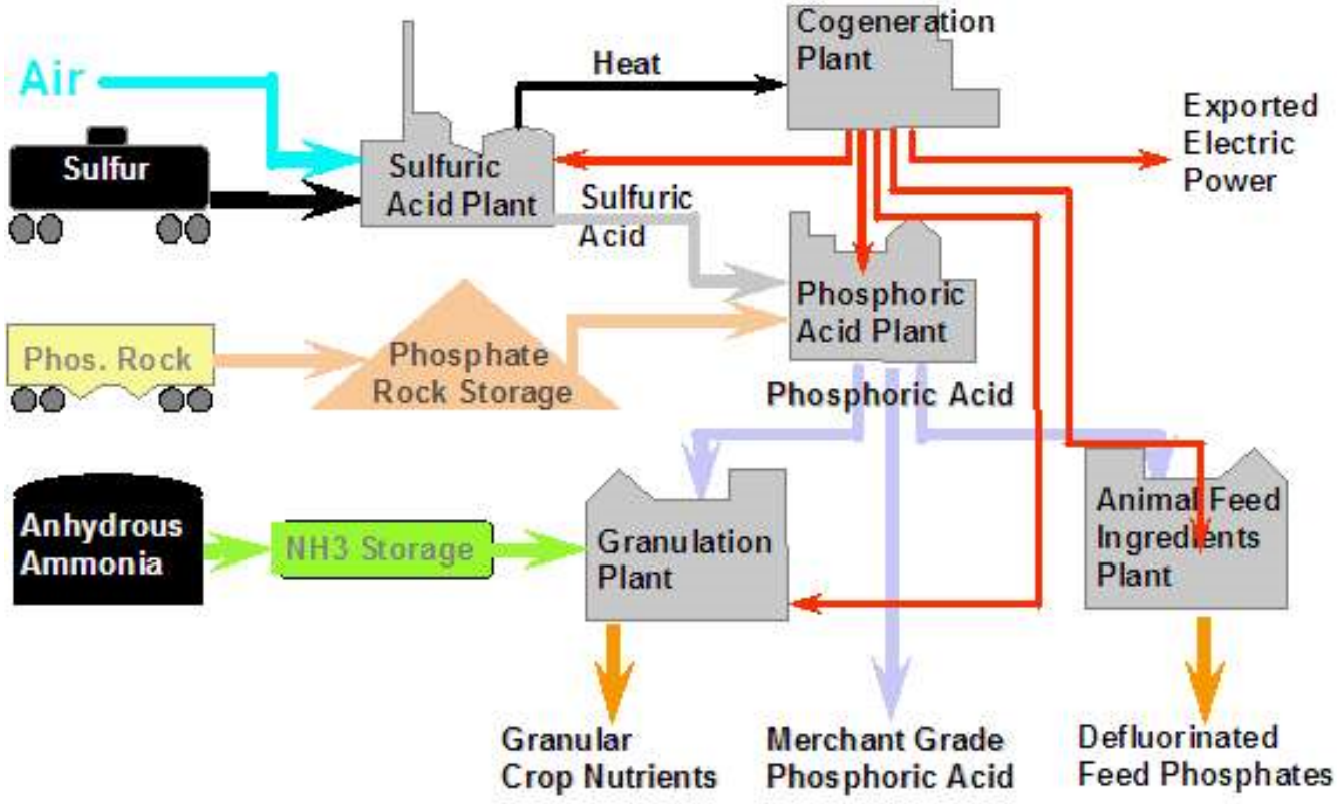
Geopolitical implications

Availability of sulfuric acid



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http://www.fipr.state.fl.us/index.html

Geopolitical implications

Sulfuric acid

developed countries

- Control of supply and price
- Price control of P

*Rosemarin, A., Bruijne, G. d. & Caldwell, I. (2009)

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Environmental implications

Phosphate rock contains naturally occurring radioactive materials

- Uranium (Radium) -> 20 to 300 ppm, or 7 to 100 pCi/g
- Thorium -> 1 to 5 ppm, or 0.1 to 0.6 pCi/g

By-product of phosphate fertilizer production

-> Calcium sulfate (phosphogypsum)

Only in Florida

- 1000 Mt of phosphogypsum (25 stacks)
- 30 new Mt are generated each year

What happened with P after fertilization?

Normally soils are over fertilized

- N-based nutrient management in most EU-countries (except the Netherlands and Sweden)

Eutrophication

- Over-fertilization of lakes with nutrients

-> Over-grow of water plants and algae

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What happened with P after fertilization?

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and after that?

Eutrophication

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Or to the wastewater treatment plant..

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State of Art in wastewater treatment plants

Chemical precipitation of phosphate

- Aluminium and iron salts are used
- They do not have a value as fertilzers
- They must be disposed in landfills

Potential P-Recycling in Germany

Demand in agriculture: 150 000 t P/a

Type of waste	t P/a
Sewage sludge	56700
Meat and bone meal	30277
Biowaste	15261
Paper	13500
Slaughterhouse	5460
Others	7499
Total (rounded)	130 000

What can be done?

There is no fast or a unique solution!

Sustainable P-Use

- Study phosphorus sustainability challenge
- Develop new technologies for P recycling
- More laws and regulations
  - Fertilizer production
  - Agriculture sustainability

New technologies for P-Recycling

- Wastewater and sewage sludge
  - Struvite precipitation (ammonium magnesium phosphate)
  - Calcium phosphate precipitation
- Ashes from sewage sludge incineration

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An unacknowledged problem in politics

- No response from governments, UN agencies or international NGOs
- USGS and IFA publish their own reports
- Little response from fertilizer companies

- Improve public awareness!

Summary

- P is a non renewable resource
- Geopolitical conflicts could occurred
- Policy makers do not recognize this as a problem
- No structures for the sustainable use of P

- More public awareness is needed!

What can we do?

More Information

- **Ecological sanitation**

  www.gtz.de/**ecosan**

- **Global Phosphorus Research Initiative**

  http://phosphorusfutures.net/

- **Global Phosphorus Forum**

  http://www.phosphate-forum.org/

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