The Precarious Global Geopolitics of Phosphorus

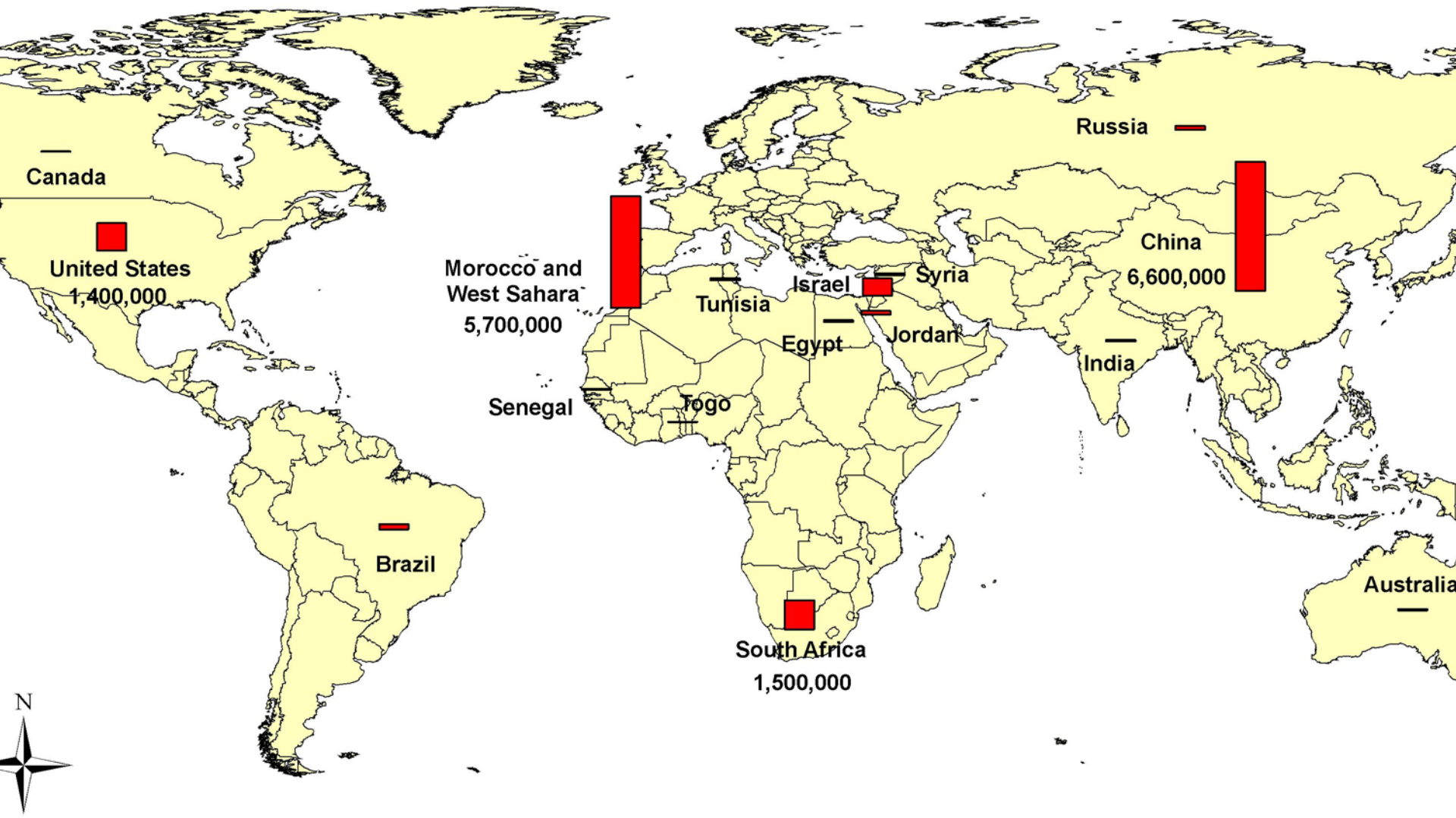
Arno Rosemarin & Ian Caldwell
Stockholm Environment Institute

SEI STOCKHOLM ENVIRONMENT INSTITUTE

The Story Line

- Little is published on the risks and limitations of global supply and demand of phosphorus
- But after reviewing the available data there is cause for considerable concern
- The US will deplete its commercially-viable reserves within 25-30 years
- Most of the commercially-viable reserves are found in only two locations on the planet in Morocco/Western Sahara and in China
- India is dependent on foreign sources of phosphate mainly from Morocco
- The global economy could flip from oil- to phosphorus-based 15-20 years

Phosphate Rock - Worldwide Reserve Estimates (thousands of metric tons)

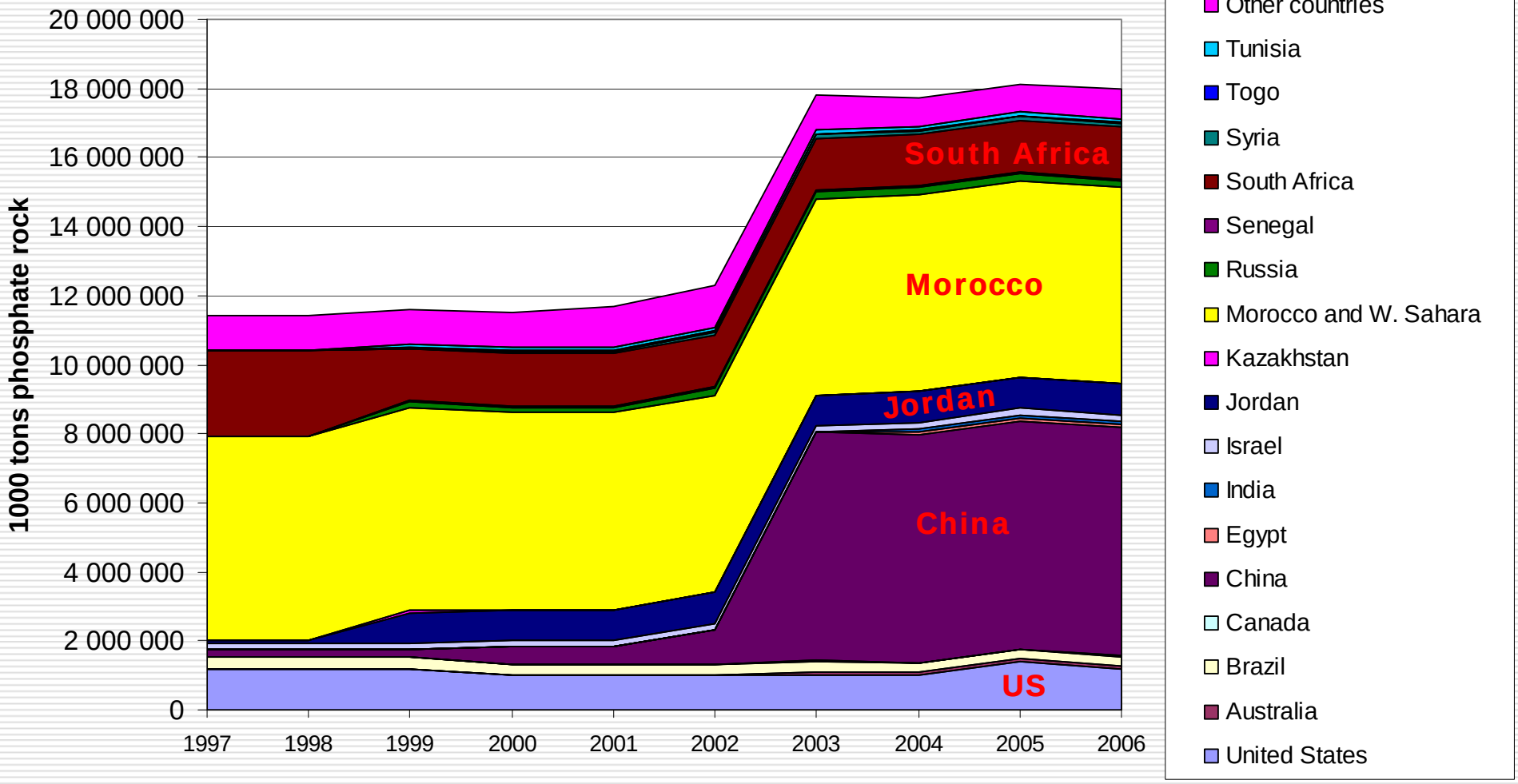


e: USGS and ESRI

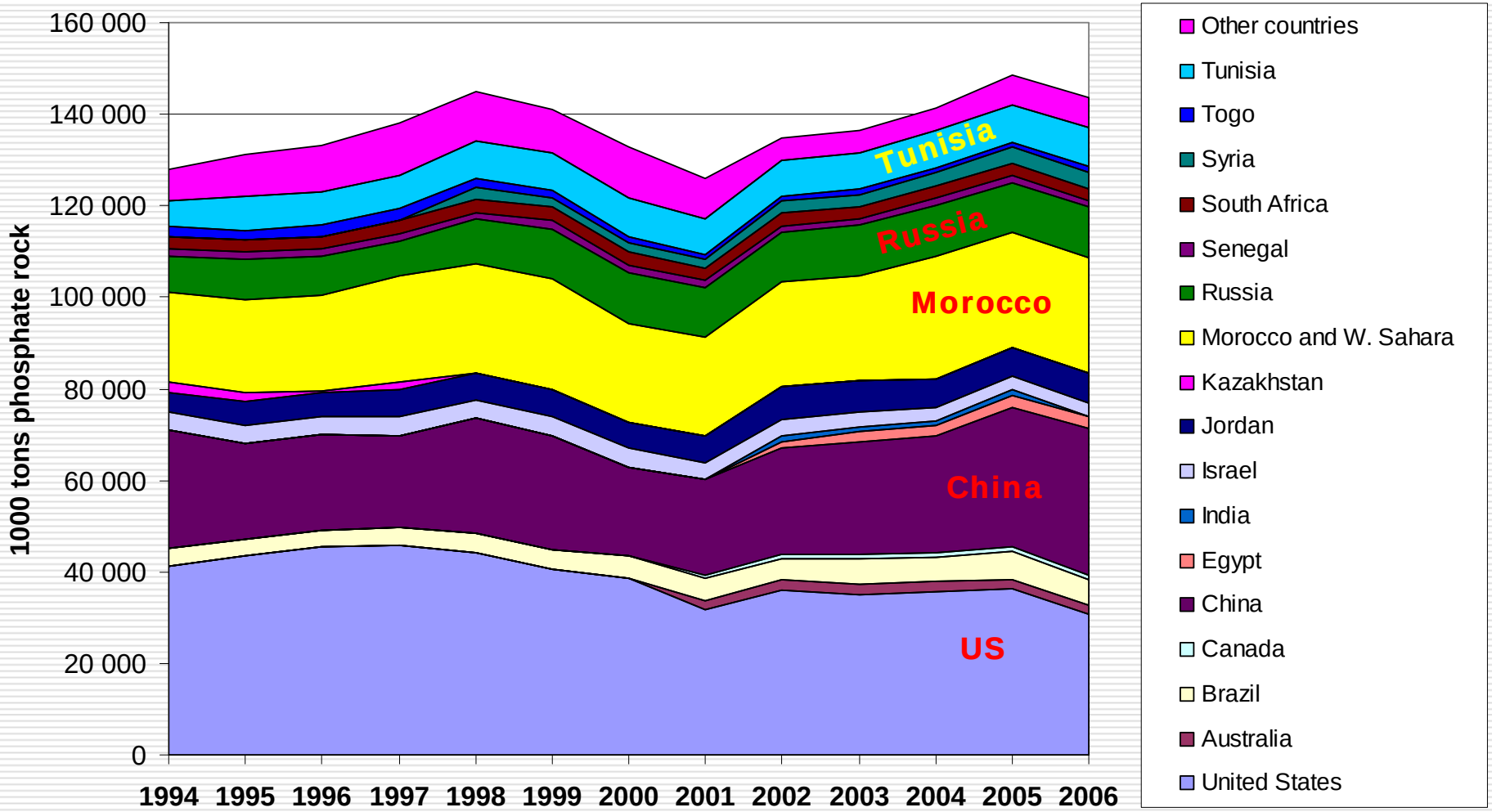
Phosphorus Use Since 1950

- Between 1950 and 2000, about 1 billion tons of P has been mined
- During this period, about 0.8 billion tons of fertilizer P were applied to the Earth's croplands
- This has increased the standing stock of P in the upper 10 centimetres of soil in the world's croplands to roughly 1.3 billion tons, an increase of 30%
- Close to a quarter of the mined P (0.25 billion tons) since 1950 has found its way into the aquatic environment (oceans and freshwater lakes) or buried in sanitary landfills or *sinks*

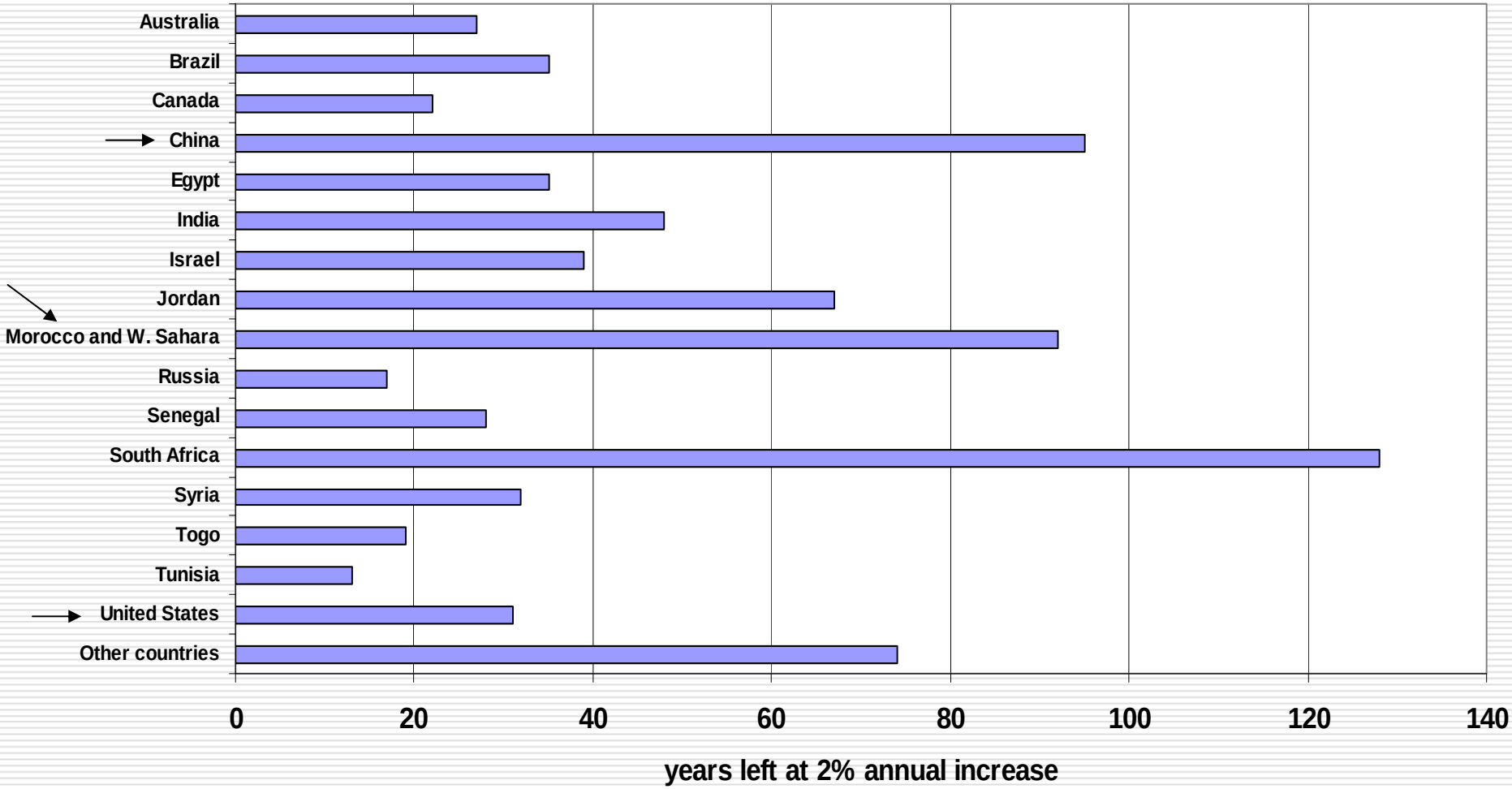
Phosphate Rock Reserves, 1997-2006 (from USGS summaries)



Mine Production of Phosphate Rock, 1994-2006 (from USGS)



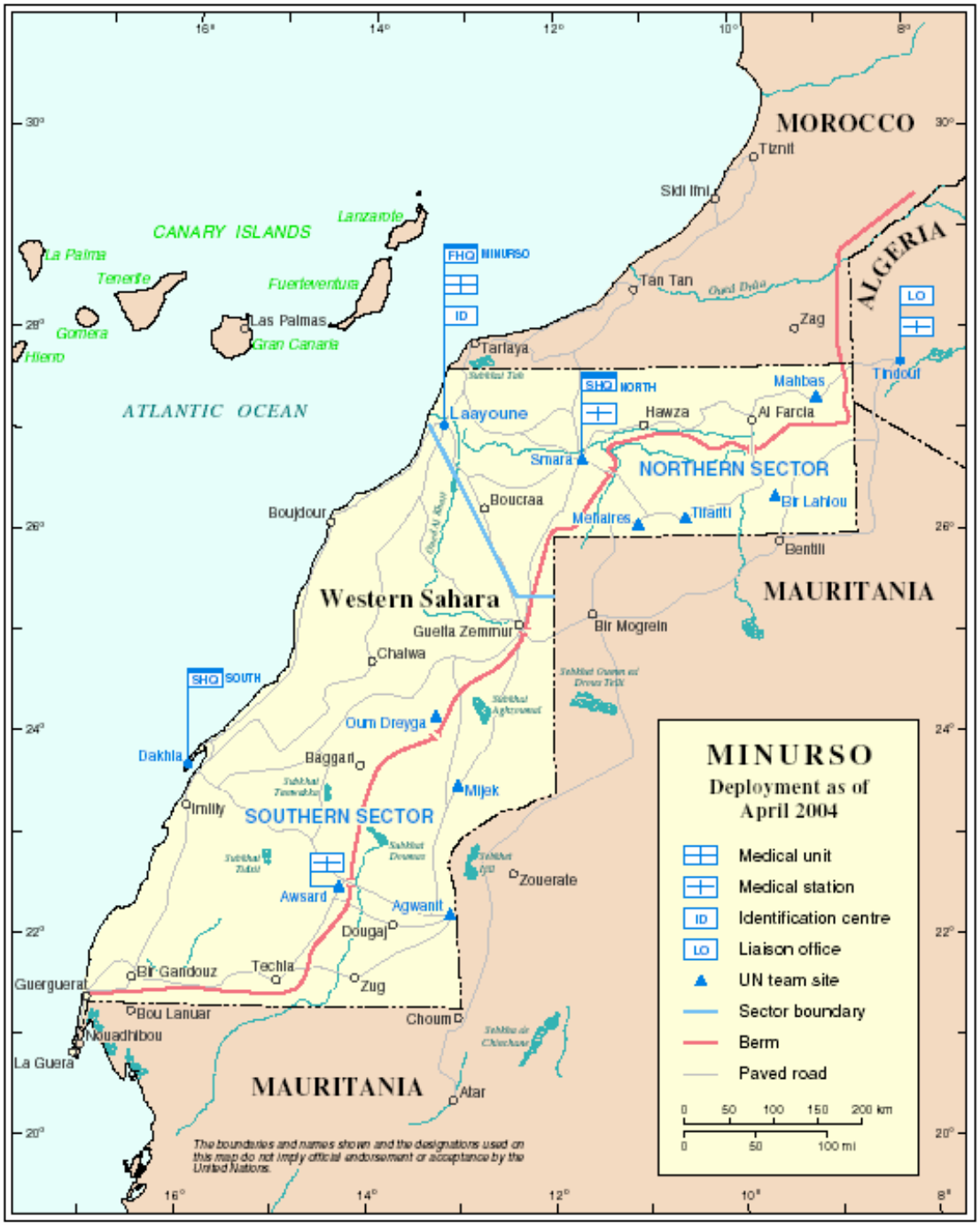
Phosphate Rock - Years of Extraction Remaining Based on Current Economic Reserves from 2006 (2% annual increase)



Source: USGS

The Battle for Phosphate in West Africa

- Western Sahara is the last African colonial state still to declare its independence. It was administered by Spain until 1976
- Following this it was invaded by Morocco and occupied until 1988
- An agreement was made between Morocco and POLISARIO to determine the peaceful future for Western Sahara
- The United Nations Mission for the Referendum in Western Sahara (MINURSO) was set up in 1991
- Since then plans for the referendum to determine the future of Western Sahara have been debated and postponed



Map No. 3691 Rev. 44 UNITED NATIONS
April 2004

Department of Peacekeeping Operations
Cartographic Section

Geopolitical Scene Today

- 25-30 yrs left of cheap reserves in the US
- 2006 was a 40-year low in US production and the reported economic reserves are now decreasing
- US signed free-trade agreement with Morocco in March 2004
- Since 2006, China extracts more phosphate rock than the US (and Morocco)
- India is the largest importer of phosphate and is dependent entirely on Morocco
- EU remains silent - ”watch and see what happens”

Phosphorus is lost to the soil

- Most of the phosphate we have applied as fertiliser is bound to the upper soil layer and not available for plant production
- The only practical method to free up phosphate from soils is slash and burn
- Biotechnology may be important in order to devise ways of extracting phosphorus – but this will cost
  - e.g. white lupin (*Lupinus albus*) is a grain legume used for nitrogen fixation which also excretes small amounts of organic acid from its rootlets
  - gene-modified soil bacteria and plants in order to achieve higher plant availability and recovery

Food Security

- Meat consumption in Asia is increasing and by 2030 it will have increased 5-fold from 2000, increasing the demand for fertiliser
- As P-reserves dwindle and geopolitical positioning intensifies, the price of phosphorus will increase
- Food security will become the central issue in countries that cannot afford to keep pace

Probable Scenarios by 2020

- Depletion of US cheap reserves in about 10-15 years time
- US offshore mining of phosphate begins
- Global price hikes in fertilisers and grains
- Morocco leads new OPEC for phosphorus
- China applies domestic sustainable development policy – self-sufficient in phosphorus and booming economy
- India's economy heavily stressed by global price of phosphorus
- Global economy flips from oil- to phosphorus-based
- Innovations for phosphorus recycling now a high priority

Probable Scenarios by 2020 (cont'd)

- Zero-waste source-separation and recycling in agro, solid waste and water/sanitation sectors (eg ecosan)
- Composting and urine diversion becomes global standard for urban agriculture
- Global convention on nutrient use and recycling
- Biotechnology developing root-nodule bacteria in legumes that extract phosphate from agrosoil – part of global convention on GMOs
- Vegetarian diet and aquaculture increases, meat production decreases
- Poor countries use widespread slash and burn to release soil phosphorus creating regional atmospheric pollution

Conclusion

- At current rates of extraction (144 megatons per year) with no annual increase the commercially viable reserves will last 125 years
- At 1-2% annual increase, this will be 100 years
- At 3% annual increase, this will be only 50 years
- Morocco/West Sahara and China hold >70% of the global reserve
- US cheap reserves will be depleted in 25-30 years
- By already 2020, rock phosphate may be the keystone resource of the world economy
- The geopolitics of phosphorus make this one of the most precarious global resource questions requiring immediate attention