

Inorganic Phosphorus and Potassium Production and Reserves

By T.L. Roberts and W.M. Stewart

The U.S. is the world's largest producer of phosphate rock, accounting for nearly 30 percent of the total world production, averaged over the past five years (**Table 1**). It is also the world's largest consumer and exporter of phosphate rock. More than 90 percent of phosphate ore mined in the U.S. is used to make chemical fertilizers and animal feed; the remainder goes to production of elemental P and industrial phosphates.

Domestic production of marketable phosphate rock steadily increased from 1970 until the early 1980s, where it peaked at about 60 million tons. Since then annual production has varied from 41 to 55 million tons with an average of about 45 million tons in the last five years. Trends in consumption have closely followed production.

Forecasting extent and life of exploitable deposits is not easy and estimates of world phosphate reserves vary greatly. The U.S. Bureau of Mines and U.S. Geological Survey define reserves as those deposits that can be economically extracted or produced at the time of determination. Resources are defined as reserves plus all other mineral deposits that may potentially be feasible at some time in the future. Reserve base is that part of an identified resource that meets specified minimum physical and chemical criteria related to current mining and production practices.

The U.S. has about 8 percent of world reserves and 8 percent of the global reserve base (**Table 1**). If future consumption

equaled the mine production averaged over the last five years, American phosphate reserves would last 25 years and the remainder of the reserve base another 73 years. This compares to a world reserve life of 88 years and reserve base life of 343 years.

The world's phosphorus (P) and potassium (K)-containing ore bodies are finite, and non-renewable resources. Estimates of reserve life are difficult to predict. However, at current production levels and costs, North America has sufficient P ore reserves to last about 25 years and almost 100 years if higher cost ore is included. There is sufficient K available for hundreds of years.

While exploitable P deposits have a finite life, it does not mean that the U.S. or other countries will run out of phosphate rock at some specific time in the future. Reserves and reserve base do not include resources, which are not presently economically recoverable. U.S. phosphate resources are immense. Onshore phosphate resources for the Atlantic Coastal Plain have been estimated at about 24 billion tons. Southeastern


offshore deposits are believed to extend from peninsular Florida to possibly as far north as the Grand Banks. As much as 200 billion tons of phosphate resources may occur in the Miocene sediments of the Continental Shelf offshore Georgia. In the western U.S., resources less than 325 yards below ground and that could be surface mined are estimated at 28 billion tons, with more than 500 billion tons at depths too deep for present mining technology.

The world mined 30.2 million short tons of potash in 2001. Canada was the largest producer at 10.1 million tons, or 35 percent of the world's total production. The U.S. was the sixth largest producer with 5 percent of the world's total.

Canada continues to be the world's

largest exporter of potash (43 percent of the world trade in 2000), and the U.S. remained the largest user with about 20 percent of the world's consumption. More than 90 percent of the potash used in the U.S. comes from Canada.

North American and world reserves and resources of potash are extensive. Canada and the U.S. have 5 billion tons of reserves, which represents 54 percent of world reserves, enough to last almost 600 years, at current consumption rates (Table 2). With just over 11 billion tons of potash in the North American reserve base, there is sufficient K to meet domestic and export needs for centuries.

Estimates of the world's potash resources vary widely, but by all accounts resources are huge, ranging from about 160 to 250 billion tons K₂O. Canada's potash resources are conservatively projected at 60 billion tons, while U.S. resources are estimated at 6 billion tons... enough to produce at current levels for several thousand years. 

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TABLE 1. World phosphate rock production, reserves, and reserve base.

| Country | Average production, 1997-2001, thousand tons | Reserves ¹ , million tons | Reserve life ² , years | Reserve base, million tons | Reserve base life ² , years |
|----------------------------|--|--------------------------------------|-----------------------------------|----------------------------|--|
| United States | 44,851 | 1,102 | 25 | 4,408 | 98 |
| Brazil | 4,875 | 364 | 75 | 408 | 84 |
| China | 24,134 | 1,102 | 46 | 11,020 | 457 |
| Israel | 4,487 | 198 | 44 | 882 | 196 |
| Jordan | 6,350 | 992 | 156 | 1,873 | 295 |
| Morocco/ Western Sahara | 25,346 | 6,281 | 248 | 23,142 | 913 |
| Russia | 11,020 | 220 | 20 | 1,102 | 100 |
| Senegal | 1,860 | 55 | 30 | 176 | 95 |
| South Africa | 3,152 | 1,653 | 524 | 2,755 | 874 |
| Syria | 1,955 | 110 | 56 | 882 | 451 |
| Togo | 1,917 | 33 | 17 | 66 | 34 |
| Tunisia | 8,697 | 110 | 13 | 661 | 76 |
| Other countries | 12,364 | 1,322 | 110 | 4,408 | 357 |
| Total (rounded) | 151,000 | 13,224 | 88 | 51,794 | 343 |

¹Reserve and reserve base cost less than \$36/ton and \$90/ton, respectively. Cost includes capital, operating taxes, royalties (if applicable), miscellaneous costs, and a 15 percent rate of return on investment, FOB mine (1992 costs).
²Life based on 1997-2001 five-year average mine production.
Source: U.S. Geological Survey.

TABLE 2. World potash production, reserves, and reserve life.

| Country | Average production, 1997-2001, thousand tons | Reserves, million tons | Reserve life ¹ , years | Reserve base, million tons | Reserve base life ¹ , years |
|------------------------|--|------------------------|-----------------------------------|----------------------------|--|
| Belarus | 3,780 | 827 | 219 | 1,102 | 292 |
| Brazil | 332 | 331 | 996 | 661 | 1,992 |
| Canada | 9,704 | 4,849 | 500 | 10,689 | 1,102 |
| Chile | 73 | 11 | 152 | 55 | 758 |
| China | 205 | 154 | 753 | 507 | 2,473 |
| France | 488 | 0.6 | 1 | | |
| Germany | 3,741 | 782 | 209 | 937 | 250 |
| Israel | 1,827 | 44 | 24 | 639 | 350 |
| Jordan | 1,130 | 44 | 39 | 639 | 565 |
| Russia | 4,232 | 1,984 | 469 | 2,424 | 573 |
| Spain | 645 | 22 | 34 | 39 | 60 |
| Ukraine | 57 | 28 | 481 | 33 | 576 |
| United Kingdom | 608 | 24 | 40 | 33 | 54 |
| United States | 1,411 | 99 | 70 | 331 | 234 |
| Other countries | | 55 | | 154 | |
| Total (rounded) | 28,500 | 9,257 | 325 | 18,734 | 658 |

¹Life based on 1997-2001 five-year average mine production.
Source: U.S. Geological Survey.