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# A summary of phosphate-rock resources of the United States - an analysis of past estimates

by

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## INTRODUCTION

The United States produced in 1980 about 54 million tons of phosphate rock, which was 40 percent of the world production. About 62 percent of this production was exported, 28 percent as phosphate rock and 34 percent as manufactured fertilizers and chemicals. The remainder was used domestically, largely (88 percent) for fertilizer and animal feed supplement to produce agricultural products (U.S. Bureau of Mines, 1981). A significant portion of these agricultural products was exported, so the phosphate rock that went into that portion was exported indirectly. Thus, most phosphate production is exported directly or indirectly and contributes to the U.S. balance of international payments. Although the marketable value of the phosphate rock produced in 1980 was only about $1.2 billion, the total value of the agricultural and chemical products depending on phosphate rock input is many times that. The continued ability of the U.S. phosphate industry to supply low-cost phosphate rock for export and domestic consumption is clearly of major importance to the Nation.

During the last decade, people have questioned whether the national endowment of phosphate rock in the ground is sufficient to support the national phosphate industry very far into the next century. A report by the U.S. Government Accounting Office in 1979, using information largely from the U.S. Bureau of Mines, projected a significant decline in U.S. exports of

phosphate by the mid-1980's and forecast that the Nation would become a net phosphate importing country in the first quarter of the next century. This decline, the report said, would be caused by the exhaustion of high-grade, easily mined and beneficiated phosphate reserves in the northwestern phosphate province in Idaho and adjacent States of Montana, Wyoming, and Utah, and more importantly, in the southeastern phosphate province from Florida to North Carolina. These two provinces presently produce about 97 percent of the U.S. production and contain all but a minor portion of the Nation's phosphate resources.

A possible result of such a scenario would be the formation of an "Organization of Phosphate Exporting Countries," after the U.S. deposits were exhausted, by those countries which have large resources of phosphate rock that could be exploited at low cost. The purpose of "OPEC" would be to increase world prices of phosphate rock. The U.S. agricultural sector, forced to rely on imported high-priced fertilizer, would be weakened. In addition, some people fear that the very prospect of a greatly weakened national phosphate-resource position might result in export restrictions on phosphate rock and phosphate products in the near future. Furthermore, a deteriorating phosphate industry would be in a weakening position in regard to allocation for railroad rolling stock, environmental regulations, severance taxation policies and the like. The likelihood of such a scenario hinges on the future availability of low-cost phosphate rock, and an understanding of future availability is dependent on a careful assessment of the national phosphate-rock resource.

Many estimates of phosphate-rock resources exist, none of which are the same. Some view these different estimates as the result of a dispute between

"optimistic" and "pessimistic" resource geologists/engineers about the size of the resource. However, detailed analysis of various estimates of phosphate resources shows that the differences between estimates usually are due more to differences in what is being estimated than in how much is thought to exist. One resource scientist/engineer may give a large figure, including rock that is only potentially economically available along with rock currently economically available, whereas another scientist/engineer may limit his estimate to only the currently economically available rock. Differences in estimates, in general, may relate to differences in areas studied, differences in price assumptions or mining technology assumptions, differences in quality of phosphate rock due to differing requirements for ore processing or fertilizer manufacturing technology, differences in geologic assurance of existence or measurement, differences between the sets of data used in making the estimates, and finally differences in the methodology of assessing the resource. These real problems of producing compatible phosphate resource estimates have been hidden by an imprecise technical language, which is as confusing to the specialist as to the nonspecialist.

A system of classifying phosphate rock resources is being devised by a joint subcommittee of the U.S. Bureau of Mines (USBM) and the U.S. Geological Survey (USGS) to give a single language to this tower of resource babble and to permit <u>real</u> differences between scientific/engineering estimates to be identified and analyzed. This phosphate rock resource classification is based on the principles of classification devised by V. E. McKelvey (1972), modified somewhat and agreed upon by the joint committee of the U.S. Bureau of Mines and the U.S. Geological Survey, and published in U.S. Geological Survey Circular 831 (USBM and USGS, 1980). This system will allow future

resource estimates to be precisely stated. This classification system also allows a format in which previous estimates may be compared so that real differences in estimates may be identified. The comparison of past estimates of phosphate rock resources is now being carried out, and a preliminary summary of that study is presented below.

## UNITED STATES PHOSPHATE RESOURCES

Many estimates of phosphate resources of various parts of the United States have been made in recent years. These estimates have been made for different areas and different resource categories, under different economic and technologic assumptions; as a result, it has been difficult to obtain a clear picture of the United States phosphate-resource position. The U.S. Geological Survey has completed a study of these estimates in which a standard system of resource nomenclature and assumptions was used. If these estimates are reduced to a common level, they can be compared and integrated into a national phosphate-resource assessment. The "bottom line" of this integration is shown in table 1.

Table 1. Identified recoverable phosphate resources of the United States

(millions of metric tons)

| | Identified recoverable | | | Remarks |
|---|---|---|---|---|
| | Economic | Marginal | Subeconomic | |
| Florida | 3,700 | 1,470 | 430 | Recoverable |
| North Carolina | 1,000 | | | Mostly economic |
| Georgia | (1,000) | | | Unavailable due to environmental restrictions |
| Northwestern U.S. | 1,000 - | | 9,900 | Resources in ground. Recoverable is considered less. Excludes underground rock below entry level. |
| Total U.S. | 7,000 - | | 10,000 | Georgia resources not included. |

About 7 billion tons of phosphate concentrate that are economically or marginally economically feasible to mine and beneficiate by use of today's technology and prices are available for mining. Three quarters of this resource occurs in Florida, and the rest is split about evenly between North Carolina and Idaho. This resource is being depleted by mining and will be exhausted in the next century; of course, the exact time of exhaustion is dependent on the rate of extraction.

In addition to these available resources, there exist an additional 10 billion tons of subeconomic phosphate deposits, which are presently unavailable because mining and processing costs are too high relative to today's phosphate prices. Most of this subeconomic resource has been identified in

the northwestern phosphate district of Idaho and adjacent States, where it consists of rock that must be mined by underground methods rather than by strip mining. Not only is the cost of underground mining higher than that of strip mining, but the rock has a different quality from rock now being mined and will require a different processing technology. Such a technology has not yet been developed.

More than 16 billion tons of additional phosphate deposits probably exist but are unavailable because they have not yet been discovered. These undiscovered deposits have been hypothesized to exist in the southeastern Coastal Plain phosphate province, particularly in Florida, North Carolina, and the shallow, Atlantic offshore areas of the Blake Plateau, Onslow Bay, and the Savannah River. The portion of this resource that would be recoverable under today's technology and prices is unknown, but it probably is significant.

## FUTURE TRENDS AND PROBLEMS

The United States phosphate industry will have to undergo major changes early in the next century if it is to continue to supply phosphate to domestic and world markets to meet projected demand. The present available reserve will be depleted, and the industry will have to turn to resources that are presently unavailable. Several technologic opportunities exist that may make this possible. Valuable byproducts could be obtained, including uranium, vanadium, chromium, rare earths, and fluorine, and the value of these byproducts has been estimated to be as high as the value of the phosphate. The western underground phosphorites, in addition, contain significant quantities of organic matter, which constitutes an energy supply that could

be utilized in processing. Large amounts of ammonium-rich feldspar presently are being mined as waste in phosphate mining in Idaho, and this material might be utilized as a special nitrogen fertilizer. Bore-hole hydraulic mining and slurry extraction hold some promise for mining the deeper sub-economic phosphate rock in the southeastern Atlantic Coast province. Dredge mining of offshore phosphate deposits appears possible even at today's phosphate prices.

The phosphate resources that the Nation must turn to in the future are poorly known. In the southeastern Atlantic Coastal Plain districts, only about a third of the resource has been explored to the point that its quantity and quality can be measured. The undiscovered portion promises to be large, and its quality will probably be similar to that of the identified deposits, but much uncertainty still exists. Major surprises are probably in store for the Nation regarding this province. A similar situation exists for the Idaho and adjacent States. Although the deposits in the northwestern United States are much more regular in geologic occurrence so that their existence and quantity can be better estimated, their quality is only poorly known. The rock that will have to be mined if the province is to continue to contribute to the Nation's phosphate supply is deep under the ground, and samples cannot be obtained without drilling. Meaningful research on processing technology to produce both phosphate and byproducts cannot be undertaken until the quality of the rock is better known.

The important phosphate resources of the Nation occur in areas where the land is needed for such uses as citrus groves, suburban development, forestry, and recreation. Much phosphate land is presently unavailable for exploitation because of these alternate uses. In addition, the effect of

of phosphate mining and processing on water, air, and land quality is significant, and considerable effort, much of which has been successful, has been made to prevent mining. These problems for phosphate development will have to be resolved if the Nation's phosphate resources are to be used to their full potential.

## NEEDED STUDIES

Studies are needed in three general problem areas: resource assessment, mineral processing technology, and mining technology.

The resources to be mined in the future need to be understood better than they are at present. The existence of hypothesized, undiscovered phosphate rock in the Southeastern United States should be established, and its quantity and quality should be assessed by a reconnaissance drilling program. The quality of identified subsurface phosphate rock in the Northwestern United States should be assessed by a reconnaissance drilling program. Both these assessments should define not only the phosphate resources but also byproduct resources, so that meaningful processing research can be undertaken.

Studies on the beneficiation and treatment of phosphate rock should be undertaken to establish the opportunities of utilizing presently subeconomic deposits for phosphate and byproduct recovery. Not only should the technology for recovery be improved, but also the technology for protecting the environment from harm should be improved.

Studies on the technology of mining should be undertaken to allow presently subeconomic deposits to contribute to future supply. This should include studies of bore-hole hydraulic mining and offshore dredge mining.

## CONCLUSIONS

The future supply of phosphate rock in the Nation is very poorly known. This lack of knowledge means that decisions on the management of the Nation's resources by all sectors must be made in the face of more uncertainty than is necessary and desirable.

Whether or not the supply of U.S. low-cost phosphate rock continues depends on the Nation's ability to turn subeconomic and undiscovered resources into reserves at the prices of the future, and that depends on whether or not the necessary research and development are carried out before hand.

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