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New Technology and Exploration May Much Extend the Life of the Southeastern Phosphate Industry

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For many decades production from southwestern United States deposits has been the dominant source of phosphate for the United States and an important source for the world. Excluding some recent years when the market was depressed, the Florida and North Carolina deposits have been producing around 45 million tons of concentrate a year. Even though 32 other countries are also producing phosphate, these deposits yield about 36 percent of the world total and a similar percentage of the world's exports, helping to make the United States the world's largest producer and exporter (Krauss and others, 1984).

In recent years, however, many people began to doubt that these deposits could sustain their important role beyond the next decade or so. For example, in 1979 the U.S. General Accounting Office projected a significant decline in phosphate exports by the mid-1980's and predicted that the United States would become a net phosphate importer during the first quarter of the next century, largely because of the depletion of the easily mined southeastern deposits. In a similar vein, W. F. Stowasser said in the 1980 U.S. Mineral Facts and Problems "The mine production as currently planned by producing companies will cause the United States to discontinue being a net exporter of rock by the mid-1990's. As planned, the supply of phosphate will continue to permit export of fertilizers and chemicals beyond the mid-1990's, but unless phosphate rock is imported into the United States for conversion into fertilizers and chemicals or new sources of supply are developed, the quantity of fertilizers and chemicals for export will decline and probably by 2005 to 2015 the supply of phosphate will be in balance with consumption. After this period of supply demand balance, the United States may have to import phosphate rock, acid or finished phosphate fertilizer...".

Based as they were mainly on data supplied by phosphate producers, these forecasts were representative of rather widely held expectations. Nevertheless, it appears now--only a few years later--that a new technological development, combined with discoveries of extensions of known deposits not previously appreciated, may allow the southeastern phosphate industry to maintain its important role in United States and world production into the distant future.

The new development is borehole mining, that is, extracting the phosphate matrix as a slurry through a drill hole. First experimented with by several companies in North Carolina in the 1960's, but not pursued further then, tests on the method were undertaken by Flow Industries in 1980 under the sponsorship of the U.S. Bureau of Mines on a deposit in St. Johns County, northeastern Florida (Scott, 1982; Hrabik and Godesky, 1983; Savanick, 1985). Because the results appeared promising, the owner of the deposit, the Agrico Chemical Company, undertook further tests during the latter part of 1984 and the early part of 1985, again with highly encouraging results.

The mining is done through a borehole with a 0.4 meter inside-diameter casing by slurrying the phosphatic bed with a high speed water jet

surrounded by an air shroud to reduce the effect of water resistance on the cutting action. The cavity produced is about 13 meters in diameter. It is kept full of water to prevent roof collapse. The slurry is pumped out at the rate of about 35 tons of solids per hour. Michael Dibble, in charge of the operation, thinks 0.25 meter diameter casing will prove to be adequate, that the cavity diameter can be increased to about 18 meters, and that the pumping rate can be increased to about 80 tons of solids an hour.

The phosphate bed mined is in unweathered Hawthorn Formation of Miocene age. Its top is about 80 meters below the surface and it is about 5.5 meters thick. It is overlain by carbonate rock 2/3-1 meter thick and underlain by a tough clay--beds that form a good ceiling and floor to the cavity that develops.

The slurry is processed at the surface and the waste is pumped back into the cavity to prevent subsidence as well as leakage from a rather saline acquifer below the Hawthorn formation. Although Agrico is confident that borehole mining will prove to be economic, further development and testing will be undertaken before full scale mining is attempted.

The potential advantages of borehole mining are numerous and important. According to G. A. Savanick of the Bureau of Mines "This method requires an insignificant amount of prior development work and can achieve immediate production. In contrast, conventional methods require three to five years before production and return on investment can be realized...The environmental disturbance associated with borehole mining is minimal. No overburden is removed, ground water levels and composition are undisturbed, and subsidence can be avoided. Ore fragmented by the water jet is brought to the surface in slurry form and is thus ideally suited for pipeline transport...Slurries...are ideal for milling. Tailings from the milling operations could be pumped into the mined-out caverns to control subsidence and reduce waste disposal problems." Most important, thickness of overburden or depth to phosphate is not much of a factor in mining cost so that phosphate too deep to be mined by stripping could become available for production. Finally, borehole mining promises to be suitable for mining of buried deposits offshore. This has not yet been tested but with the enormous experience already gained in offshore petroleum production to start from it does not stretch the imagination to think that offshore borehole mining of phosphate may become feasible.

These several features of borehole mining lead me to believe that it has the potential for making available vast phosphate resources in the southeastern states that would not be feasible to mine by conventional methods. Cathcart and others (1984) estimated that phosphate resources in this region total about 22 billion tons of nearly the same quality as that being mined now. Only about 4.7 billion tons of this are considered to be minable economically now (and environmental restrictions may reduce the amount actually producible). Much if not most of the remainder is too deep to be mined by conventional methods but might be recoverable by borehole mining. Moreover the estimate does not include many large deposits that the authors thought to be too deeply buried to be ever considered for mining.

For example, they gave that reason for not including the phosphate resources in Dade County, Florida, where 100 meters of phosphate-bearing Hawthorn Formation are overlain by 100 meters of overburden. Inspection of their map (fig. 1) suggests that the area underlain by phosphate-bearing Hawthorn in South Florida but not included in their estimates because of thickness of overburden is several times larger than the area they did include. Also not included in their estimates are phosphate resources in phosphate-rich layers in the Hawthorn beneath previously mined deposits in the Central Florida district (S. R. Riggs, personal communication, 1985).

Nor does the 22 billion tons include offshore deposits. The Hawthorn Formation and its stratigraphic equivalents are known to extend offshore southeast, east, and northeast Florida, Georgia, South Carolina, and North Carolina. S. R. Riggs and his associates (1985) have estimated phosphate concentrates in near surface deposits offshore North Carolina to total at least 4.5 billion tons. Seismic surveys suggest that the deposits extend seaward beneath the surface over a much larger area. Specific estimates for other offshore areas are not available but J. B. Cathcart (personal communication, 1985) suggests that they might be equal to or larger than those onshore.

It would not be unreasonable, then, to suppose that offshore deposits and the deeply buried onshore deposits together much exceed the 22 billion tons already estimated. Rather than a supply dwindling in the near term, one can see the potential for continued production far into the future at the current rate. And because the southeastern deposits are essentially unconsolidated and nearly flat lying and are in a region where water is abundant they lend themselves to borehole mining better than do many of the world's other deposits. If borehole mining becomes economic, as seems likely, one can also see the potential for increased production from these deposits as they become cheaper to mine than many others.

It remains to be seen how competitive borehole mining may become with strip mining where it is now economic. Even if borehole mining does not prove to be as cheap, however, it is possible that it may be used instead of stripping in environmentally sensitive areas.

In concluding, let me emphasize that none of these things will happen without many more years of technological research and development and exploratory drilling. But the potential seems to be large enough and attractive enough to justify such efforts and we may expect them to be undertaken in time.

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