

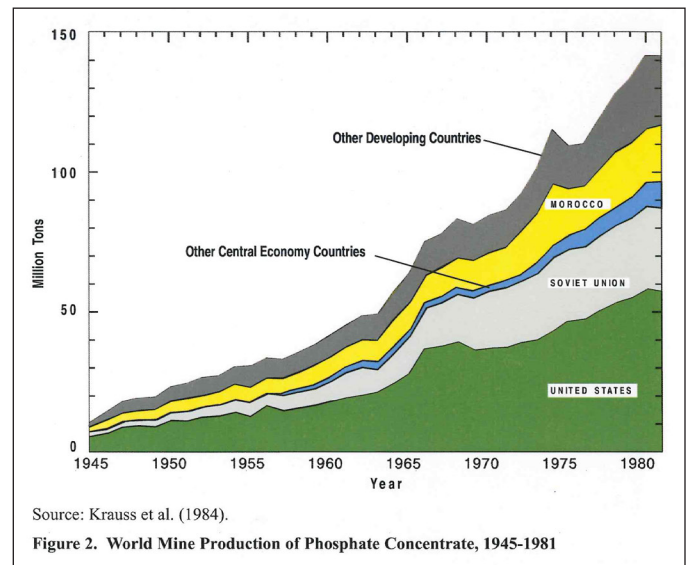


### REVITALIZING THE CENTRAL FLORIDA PHOSPHATE INDUSTRY: A Case Study of Potential Value Addition Enabled by New Technology

written by Joseph Megy

U.S. phosphate producing states, led by Florida, once held a dominant global position in the fertilizer industry. Phosphate fertilizers enabled the “green revolution” that increased crop yields per acre, improved global food security, and helped to keep the American farmer productive and profitable. The U.S. has ceded its phosphate production leadership position to Morocco and without technological change; Florida will cease to be a factor in this market within the next quarter century. Attendant to this loss of production capacity will be the reduction of tens of thousands of US jobs, the loss of substantial tax revenue and a less competitive American farm sector which will be forced to purchase fertilizer from overseas sources at higher cost. JDCPhosphate’s Improved Hard Process (IHP) holds the promise of revitalizing the Florida Phosphate Industry by delivering more of Florida’s substantial phosphate resources to the marketplace with less environmental impact, increasing the industry’s life and enabling low cost domestic fertilizer production to compete for the business of the American farmer.

#### Background



Source - IFDC Technical Report T-75

Prior to 1980 the US produced 40-50% of the world’s mined and beneficiated phosphate rock, with the massive Florida deposits accounting for 80% of that production. Keen competition in the US led by Florida kept fertilizer prices low and the American farmer productive and profitable. The US provided phosphate fertilizer to fuel the “green revolution”, enabling better nutrition and more food security in

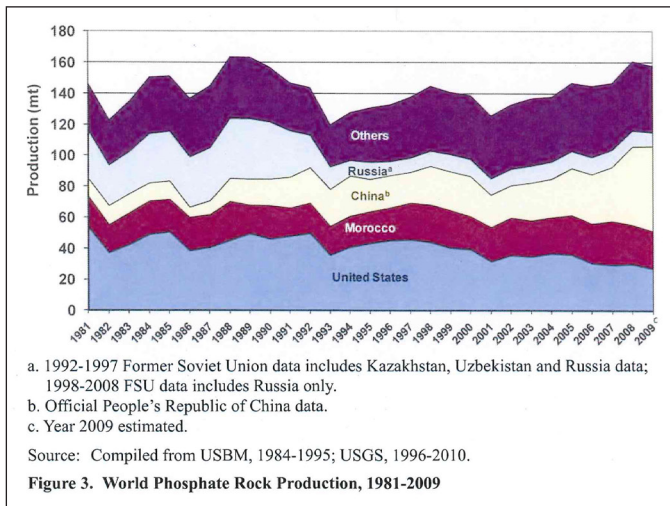
the third world and the “biofuel revolution”, to help achieve energy independence in the first world through ethanol production. Without mined phosphate to supplement the phosphorus in nature’s growth cycle both the food security of 40% of the world population and energy independence derived from biomass would be in peril.

## Phosphate Rock Reserves in Central Florida

The high grade phosphate deposits in Central Florida’s “Bone Valley” formation, after yielding over 2 billion tons of phosphate rock over the last hundred years are essentially mined out. There are 600 million tons of lower grade reserves remaining in an adjacent formation known as the “Southern Extension” of the Hawthorne formation<sup>1</sup>. There is additional phosphate rock in strata immediately underneath the “Southern Extension” reserve (lower zone), but it is too contaminated with magnesium to be processed using the wet acid process.

In 1994 an extensive study of the Southern Extension, was completed by the Florida Institute of Phosphate Research. They found that the lower zone contained 1.8 times the quantity of phosphate rock that existed in the upper zone, a staggering 1 billion tons of phosphate rock. They concluded, however that only phosphate rock extracted from the upper zone of the Hawthorne formation is suitable for the current Wet Acid Process.

Except for a few remaining pockets of the Bone Valley formation the “Proven (Measured) Reserve Balance” of phosphate ore reserves in Central Florida are nearly all in the Southern Extension. These reserves are estimated at about 600 million tons by the mining companies and, through analysis of USGS and other publicly available sources<sup>2</sup>, it is evident that they are comprised of substantially all upper zone phosphate rock and do not include material amounts of lower zone phosphate rock.



Source - IFDC Technical Report T-75

Florida phosphate rock has been shipped to world markets or processed in US chemical plants using the wet acid process to make fertilizers that have been consumed in the U.S. or exported. Since reaching a production high of over 50 million tons of phosphate rock per year in the 1980’s, U.S. production has declined to less than 30 million tons per year with state owned foreign production filling the gap. Currently the U.S. produces only 18% of the world’s phosphate rock and imports are required to fill the shortfall of domestic production. The high grade U.S. deposits are nearly mined out resulting in higher costs and proportionately higher fertilizer prices for the U.S. farmer.

1. Source: U.S. Geologic Survey (USGS)

2. In 2009 the USGS identified the proven US wet rock reserves as 1,100 million tons. Since a little over half of the reserves are in Central Florida, about 600 million tons are what the USGS considers to be the current “reserves” in Central Florida; again clearly indicating only the Upper Zone is being considered in the phosphate ore “reserves” balance.

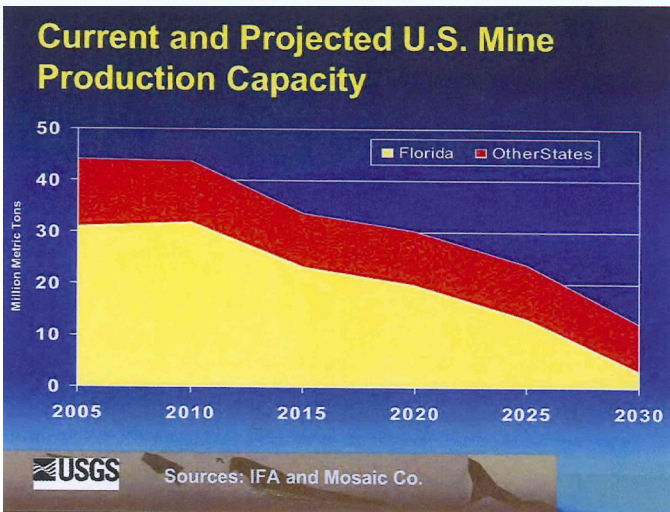


Figure 8. Current and Projected U.S. Mine Production Capacity (Jasinski, 2005)

Source - IFDC Technical Report T-75

Given recent permitting delays and the regulatory environment, one could be pessimistic about the future of phosphate production in Florida. Without new technology to be able to handle lower zone ores, the phosphate industry will decline more rapidly than need be as reserves are depleted. The effect on the American farmer is already being felt through higher fertilizer prices that will put the American farmer at a disadvantage in the years ahead unless domestic production, spurred by new technology can recover more of the available reserves and enable a vital domestic phosphate industry.

### The Improved Hard Process

Dr. Joseph Megy built on seminal discoveries by Dr. Robert Hard that resulted in a new dry thermal process for the production of phosphoric acid that is much more tolerant of common phosphate impurities. The Improved Hard Process (IHP) utilizes low grade phosphate in a rotary kiln to produce high grade super phosphoric acid (SPA) at lower cost than with the wet acid process. IHP has no solid waste products such as phosphogypsum. Instead an inert aggregate co-product is produced. Phosphate rock mined from the lower zone of the Southern Extension is amenable to IHP providing the phosphate industry the possibility to

more than double the amount of useful resource that is recoverable from the same acres that would currently planned to be mined.

Employing IHP to recover this resource would result in the production of high value phosphoric acid without phosphogypsum waste, decades of additional life for the phosphate industry, and substantial additional tax revenues to the State.

### Impact of the Successful Implementation of the IHP in Central Florida

In addition to being able to profitably process the lower zone material the IHP can also recycle waste materials from prior phosphate industry operations. Coarse-grained phosphate-rich material that is recoverable from “feed deltas” in clay settling areas could add an additional 120 million tons of phosphate rock equivalent to the reserves. In addition, phosphate containing sand and clay are also used in the raw material formulation for the IHP further stretching reserves in Central Florida. The feed material for the IHP generally does not require flotation which in turn reduces phosphate processing losses. A comparison of the reserve balance for Central Florida when augmented by IHP follows:

Item	WAP	IHP+WAP
Current Wet Rock Reserves	600	600
Lower Zone		1,000
Feed Delta		120
Reduced Flotation Losses		90
Clay and Sand Tailings Additions		30
<b>TOTAL</b>	<b>600</b>	<b>1,840</b>

Extraction and use of these additional reserves in IHP plants holds the promise of additional annual sales exceeding \$5 billion to Florida producers and

additional total severance tax of more than a billion dollars to the State.

### Production of a Valuable Co-Product

Florida imports aggregate today to supplement domestic consumption and fill its 100 million ton demand for this construction material that is used in residential, commercial, and infrastructure projects.

The IHP produces about 6 tons of co-product aggregate ton of phosphoric acid. This material does not emit meaningful amounts of radon gas (less emission than the average soil in Polk County) and does not leach heavy metals or other elements. It has promise as an aggregate substitute for soil stabilization, in concrete and in drainage applications. Adoption of IHP for the recovery of lower zone material could result in the production of 48 million tons/year of aggregate over time, which would have the effect of reducing imports of aggregate into Florida from other states and countries.

It is reasonable that IHP will grow over time processing lower zone phosphate ore while the existing WAP industry utilizes upper zone phosphate rock. Forty kilns would be needed to fully take advantage of this resource providing high paying jobs for 1600 people and adding meaningfully to the economic prosperity of Central Florida.

### Considerations When Mining the Lower Zone

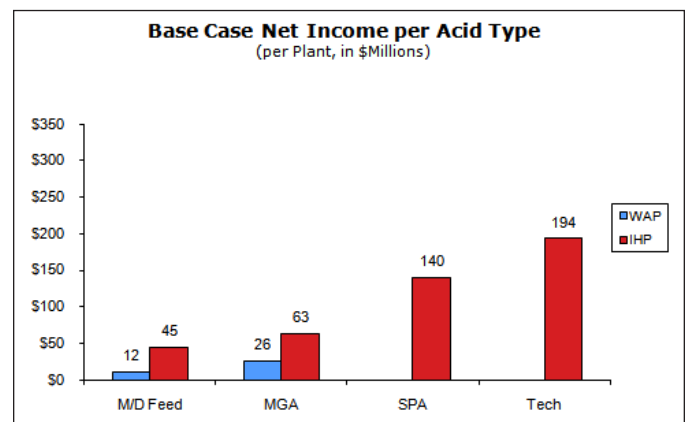
When using a combination of WAP on the upper zone material and IHP on lower zone material no additional mining investment in overburden removal or slurry pipelines needs to occur to more than double the amount of phosphoric acid from mine production. Increased digging depth and disproportionately more clay are considerations to be dealt with, but the

economic driving force to effectively deal with them is strong.

One major but subtle environmental consideration accrues as a result of the SPA product of the IHP plant. The SPA is of higher quality than WAP acid and therefore is preferentially used in fluid fertilizers that more efficiently transfer phosphate values to crops, reducing the excess that gives rise to surface and ground water pollution.

### Revitalization: The Projected Effect on Economics and Ability of Florida to Compete in the World Phosphate Market

JDC contracted outside experts to build a model to determine the projected financial performance of the Improved Hard Process compared to the existing Wet Acid Process for a wide range of operational and market conditions. The figure shows the relative net income of IHP verses WAP processing a high quality ore in Central Florida at a given sulfur price (\$143/st) and green petroleum coke price (\$90/st). Other variables were set to be those appropriate to Central Florida mining in December 2010.



The SPA and Technical Grade markets are not available to WAP for Central Florida ores because the magnesium level in the phosphate rock is too high to economically process. IHP is not limited by the

magnesium and can make SPA and Tech grades even with the quality of rock in the Southern Extension's lower zone. While both the SPA and Tech markets are small in comparison to the fertilizer market, the economic potential of them is high for the 5-7 IHP plant equivalent production volumes that could be served. IHP will be synergistic with existing phosphoric acid production for fertilizer by eliminating some evaporation costs and sweetening the acid so fewer expensive additives are required.

The projected profitability of adding IHP to Central Florida phosphate production capacity is sufficient to ensure a robust phosphate industry for many years to come with substantial benefits to public and private constituencies.