

PHOSPHATE MINING – MINING PROCESS

Professor: Al Hine, Ph.D.

[MUSIC PLAYING] Good morning and welcome to Mosaic. We're actually at the South Pasture Mining Facility. It's one of our many mine facilities here in Central Florida. Right here the purpose of our organization is phosphate mining.

If you think about the bag of fertilizer in your garage for your garden, there are three letters that are very important. There's N, P, and K. N stands for nitrogen, P is the phosphate, and K is the potassium. So those three elements are the major components of fertilizer, which is very important to not only nurturing your garden, but crops to feed the world. So we're here talking about the middle part, P.

Millions of years ago, this part of Florida was underwater. And during that time underwater, phosphate was actually precipitated out of the seawater and settled on the sea floor, and that layer was also covered with sediment. So that layer is what we're targeting. So it can be anywhere from 5 to 30 feet below the surface.

And once you get there, it can be anywhere from 10 feet to 30 feet deep, so it depends on the deposit. And we actually have core samples we drill every 2 and 1/2 acres that tell us where the phosphate is and how to get it. So it kind of helps us map out our mine plan. And a lot of it is not only dependent on the phosphate being there, but minor elements that you encounter. If you have too much magnesium or too much iron, it sometimes affects the chemical processes.

OK. So if you look at this picture on your slide, you can tell that we really don't mine phosphate like that anymore. One of the older general managers, I like to joke that he was actually in that photo, but he was not because that was many, many years ago.

But mainly, the area that boomed really big in 1890 is Polk County. That area was a major area for mining, and it has continued down to the southern counties. Hardee County is where our facility's located now, and we also have mining in Manatee County and future mining in DeSoto County.

OK. So I'm going to go a little bit about the process overview just so you can kind of get your mind around it because it's all a cyclical process. So we have our field operations that actually take the dragline to harvest the phosphate rock after they uncover it. They ship that in what's known as matrix through a pipeline to our plant.

Behind me what you will see is our 1370 dragline mining some of our phosphate ore material. Currently what he's doing is taking the phosphate matrix, is what we call it, which contains the ore, the sand, and the clay and dumping it in the pit right behind us. And what you see in the spray right there is a high-powered water hose cannon that we use to slurry out the material, and it gets pumped in these pipes back to our plant where it's beneficiated.

Now, the plant is called a beneficiation plant. The first step is it stops at a washer. So that first part of the washer helps to wash off some of that clay from it initially. But the pebble size is what's yielded from the washer.

Then it goes on. The stuff that's too small for the screens goes through, and it goes to the sizing. And that's the medium size. So there's more screening at a smaller, finer screen. And the whole time the small, tiny phosphate and the sand that are the same size is falling out of those screens.

So the third process is flotation. Because once phosphate and sand are the same size, you can't mechanically separate it anymore. So what you do is you take the sand and the phosphate, and you find the chemicals that attach only to the phosphate. They're called reagents. There's fatty acids and fuel oils and different things that modify the pH in the cell, we call it.

It basically makes a soap that, once you introduce air bubbles, it attaches to the phosphate molecule and not to the sand. And then it comes to the top, and you have these skimmers on the top that skim the phosphate off the top. So the sand falls out the bottom. The phosphate floats to the top.

And in this entire time, once we get everything to the screening process, the water is constantly being recycled. We don't use the same water through the plant process, but it goes out into the system and comes back around eventually. So our entire process takes that water and reuses it. We like to say it kind of wears out the water because it just keeps using it over and over again.

Also, when we have high rain events, we have the occasion to be able to let water off the property. That water has to meet quality testing standards. And we're able to put that down into the surface waters and ship it out. So it's no different than if it rained on your property and drained to the natural.

Because once we have disturbed a place for mining, we cannot let that water go off the property. It's not because it has toxins, but it's because there's turbidity and particulates that could have been disturbed. So we don't want that going downstream unless we're testing and regulating it.

90% of our water, or over 90%, is reused and recycled through our process. And we get water from sometimes deep-well pumping and other times from rain. We have large dam areas that are part of the reclamation process that helps us to capture that water.

Once we get out to the dragline, where we actually-- visiting our 1370 dragline, called a Bucyrus-Erie, that's the brand, and it weighs over 7 million pounds. It can actually walk, and it's powered by electricity. So it's not diesel powered. It's got a massive power cable, and it's a 7,200-volt power cable. So it's got AC-DC converters inside and lots of motors that power the dragline.

So I told you about the core samples that are being taken. We have the overburden, which is that top layer. It has no phosphate value at all. The matrix is what we're targeting, those three, sand,

phosphate, and clay. And then the hardrock, or the bedrock, where once you kind of find out where the phosphate ends, then you stop mining.

Where we're standing at now, the overburden, normally runs about 20 feet thick. The matrix can run from 20 to 50 feet. And then we also have an interburden layer. That's normally a clayey layer that contains a lot of impurities. It's not always overburden, matrix, bottom.

There's often, particularly in this ore body, there's overburden, minable upper matrix, a clayey, impurity-ridden interburden layer, and then a lower matrix zone, which is normally higher in concentrate and very little pebble and much more sandy, not as clayey. There can be clay in it, but it's often not as clayey.

Before we mine, we have to clear off all the surface area. We bring in our dragline. And the dragline's job is not only to get the matrix, it is to strip off that top layer. And we stack in strategic areas for mining reclamation practices afterward. So if we're going to be building a dam along a certain area, we'll cast some of that overburden so that you don't have to move it so far to get that dam all built.

Once we stack our overburden, we expose the matrix. These cuts, you can kind of see the layers here. This top layer is the overburden layer. That middle is the matrix. And then when they stop mining, that hardrock bottom, they can't mine anymore. So there it looks to be about 10 feet deep, but it does vary with the deposits.

OK. So this is an area of one of our boundaries, or an example of one of our boundaries. Either it's the end of the property or it's right by a preservation area. Now, when we get our permits to mine, we cannot mine every single thing.

We have different regulators that look at the property and we say, OK, well, this area is pristine. We can't put it back exactly like this, so we're going to preserve this area. But other areas have been impacted, and we're able to mine those and reclaim them back better to than what they're functioning currently.

So this is an example of a B and P ditch, or a recharge ditch. That maintains the water level on our side so that it maintains the water level off the property. So this is a boundary that is between our property and a preservation area or a neighbor's property. This ditch is constructed because of our surficial aquifer, which is, in Florida, very close to the surface.

So it's important that we maintain the water levels in this ditch to levels our neighbors need to maintain for their water level because we don't want to dry them out. So we have several different monitoring stations, different piezometers that are testing that water level continuously so that you can find out if there's been any impact and correct that. So those recharge ditches are very important.

So the mining process-- if you can see our dragline sitting here. You can actually see where it's mined down, come around, and come back this way. And it's actually walking backwards the whole time. There's one operator for the dragline and one oiler. So that oiler helps to control ground situations.

And that's not in-a-day mining. Like that could be several months of mining depending on how deep the phosphate rock is. So it would actually sit in a certain spot anywhere from two to three days to two to three weeks depending on how deep the phosphate is.

The matrix, I was telling you how it was pumped to the beneficiation plant. We actually stack it in an area called a well. The water is introduced at 280 psi, I then it's sucked up in a suction pump back to the plant.

Inside the pit car, is what we call it, there's an operator in there who has two joysticks, and what they're doing is they're controlling the two hoses. They keep one hose kind of pointing down right before it enters the pipe, and the second one is that spraying that we're seeing right here.

The reason they do that is the one that's spraying breaks up the heavier material, and it gets down closer to where the one that's pointing down is. And that really adds the water to slurry it up so it flows much easier.

And that matrix can be pumped for miles, like anywhere from 2 to 3 miles to 10 to 15 miles, because the dragline and the plant, you just can't build those all the time. So the draglines can walk a lot faster and further than you can build plants.

So the pumping system is very important. Every mile, there requires to have a pump to kind of boost that material because that material is 40% solid. So you're pumping not only the water, but the rock, and you don't want it to slow down and choke your pipe. So you've got a pumping system every mile, and that's one of our major expenses, besides running the plant, is the electricity running those pumps.

Beneficiation plant-- I was telling you about the washer and the sizer and the flotation plant. It's all part of separating out the different sizes of phosphate. So that's pebble coming from the washer. Now, this is IP, or Intermediate Pebble or Intermediate Product. And those are all different screening sizes that yield these two products. And then the last one is concentrate that is the same size as sand. So that's the flotation process where you introduce reagents to get those.

From the plant, once that clay is rinsed through the process, it dissolves in water very easily. So we have clay slurry coming from the plant, and it settles down at the beginning and it's traveling this way. So if you can kind of see the change in the gradient of this picture, you see more clay stacked this way. And as it travels downward, then you have clear water you actually can pick up from end of the system and put it back in your recirculation system.

We actually ship out our phosphate rock to our chemical facilities. Because this is the main product in making the fertilizer, but if you just put it on your plant right now, it doesn't have any value because it's not dissolvable in water.

So we have a chemical process in our chemical facilities that changes it by dissolving it in sulfuric acid to make phosphoric acid, then adding in ammonia to make MAP and DAP. And those stand for the different letters, N, P, and K. So if you'll notice, N, there's still some value, P is the major value, and there's no potassium. So it's all part of the process.

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