

The Mosaic Company –Rare Earth Element Opportunities

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Rare Earth Elements in Phosphate Matrix

- There are Rare Earth Elements in the phosphate matrix mined by Mosaic. The Rare Earths associated with phosphate matrix are primarily found in:
 - Clays
 - Mosaic produces a total of approximately 13.5 million tons of clays per year at the active mines in central Florida which contain approximately 4,813 tons of mixed rare earths.
 - The clays are stored in settling areas.
 - Tailings
 - Mosaic produces a total of approximately 37 million tons of tailings per year at the active mines in central Florida and contain approximately 2,288 tons of mixed Rare Earths.
 - Tailing used to backfill the mining cuts.
 - Phosphate Rock
 - Mosaic produces a total of approximately 14.8 million tons of phosphate rock with approximately 7,211 tons of mixed rare earths.
 - Phosphate rock is processed in to phosphoric acid, phosphate fertilizers, and Phosphogypsum.

Rare Earth Minerals in Phosphoric Acid Production

- The Rare Earths associated with phosphate rock are primarily found in two streams from the phosphoric acid production process:
 - Phosphoric Acid Solids
 - Mosaic produces a total of approximately 440,000 tons of phosphoric acid solids per year at the three active facilities in central Florida which contain approximately 660 tons of mixed rare earths.
 - The phosphoric acid is consumed in the production of granular fertilizer (MAP and DAP).
 - Phosphogypsum
 - Mosaic produces a total of approximately 19.7 million tons per year of Phosphogypsum at three active facilities in central Florida.
 - The Phosphogypsum is stored in stacks at each of the active facilities.
 - Mosaic estimates that approximately 6,900 tons per year of recoverable REE in the Phosphogypsum.

Recovery of REE in Phosphoric Acid Production

- There are several technologies for the recovery of REE from phosphogypsum and phosphoric acid solids; including solvent extraction and acid leach.
 - Recently Mosaic commissioned an engineering study for the recovery of certain REE using a resin in sulfuric acid leach process.
 - The Capital and operating cost requirements are high.

Challenges and Next Steps



- The results of the feasibility study indicate that the process is not economically feasible. This is due to low concentration of REE in phosphate industry's process streams and high capital and operating costs associated with the currently available technologies.
- Without significant government financial support, cooperative arrangement or other business incentives, the process is not economically viable.
- Other research has been conducted on various streams from the Phosphate production process by other research institutions but no significant economical data is available from that work. Additional research can be conducted on both lab scale and pilot scale given the appropriate partnerships and resource availability.

Rare Earth Elements in Phosphate Process Streams

Typical Rare Earth Elements in Phosphate Process Streams					
	Clay	Tailings	Phosphate Rock	Phosphogypsum	Phosphoric Acid Solids
Component	ppm	ppm	ppm	ppm	ppm
Lanthanum	54.6	2.70	89.2	59.3	317
Cerium	98.6	4.80	144	120	438
Praseodymium	13.7	0.70	20.8	17.1	50.37
Neodymium	54.00	3.00	83.5	80.1	236
Samarium	10.8	0.80	16.8	17.8	57.2
Europium	2.30	0.60	3.85	4.8	16.3
Gadolinium	11.4	0.60	18.5	25.1	96.7
Terbium	1.70	0.60	2.95	4.7	12.3
Dysprosium	10.0	1.0	18.0	33.5	66.2
Holmium	2.3	0.40	4.00	7.5	11.0
Erbium	6.5	0.80	12.15	23.1	23.4
Thulium	0.80	0.80	1.75	3.2	1.69
Ytterbium	6.30	0.40	11.25	18.0	6.36
Lutetium	1.00	0.60	1.70	2.6	0.97
Scandium	10.00	2.00	6.00	0.87	4.72
Yttrium	72.5	5.1	154	63.4	346
Total Mixed REE	357	25	589	481.4	1684