

Market Impact of Byproduct Uranium

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Byproduct Uranium: The Big Picture

- Byproduct in Copper/Multi-Metal Projects
 - Existing, likely to grow
- Byproduct with Multi-Mineral Mines
 - Could be significant in future
- Byproduct with Gold
 - Existing, modest output, large future resource
- Byproduct with Phosphates
 - Modest near-term output, gigantic future potential

Byproduct from Copper/Multi-Metal Mines

Byproduct from Copper/Multi-Metal Mines *Operating:*

Mine/deposit: *Olympic Dam (Australia)*

Owner: **BHP Billiton**

Primary metal: **Copper, plus silver and gold.**

Current uranium capacity: **3,800 tU per year (+/- 10 MM pounds)**

Proven and probable reserves: **Approx. 767 million pounds (295,000 tU)**

Grade: **0.05% (500 ppm)**

Comment:

Largest byproduct producer and likely to remain such for years to come.
Planned expansion could triple production, likely 2019 onward.

Byproduct from Copper/Multi-Metal Mines *Planned:*

Mine/Deposit: **Carrapateena (Australia)**

Owner: **Oz Minerals**

Primary/other metals: **Copper/gold, silver, rare earths, iron**

Uranium Resource: **47,000-53,000 tU (124-138 million pounds)**

Estimated production: **N/A (3,000 tU possible)**

Startup expected: **No earlier than 2017**

Comment:

Very large resource, near Olympic Dam, but reported to be “deep and complex,” hence the more distant start-up date.

Byproduct from Copper/Multi-Metal Mines *Planned:*

Mine/Deposit: **Lumwana (Zambia)**

Owner: **Equinox Minerals**

Primary/other metals: **Copper**

Uranium Resource: **Approx. 27 million pounds**

Estimated production: N/A

Startup expected: N/A

Comment:

Uranium-bearing materials are being stockpiled; possibly awaiting investor willing to fund development of uranium extraction circuit. Production could follow two years after investment commitment made.

Byproduct from Copper/Multi-Metal Mines *Planned:*

Mine/Deposit: **Radomiro Tomic (Chile)**

Owner: **Codelco**

Primary/other metals: **Copper/molybdenum**

Uranium Resource: N/A

Estimated production: **220,000 pounds (85 tU/year)**

Startup expected: **2013**

Comment:

Start-up originally planned for 2010, but numerous delays. Relatively small-scale project, more related to cleaning up copper output than profiting from uranium

Byproduct from Multi-Mineral Mines *Planned:*

Mine/Deposit: ***Sotkamo (Finland)***

Owner: **Talvivaara Mining Co.**

Primary/other metals: **Nickel, Zinc, Copper, Cobalt**

Uranium resource: **68 million pounds (26,000 tU)**

Estimated production: **900,000 pounds/350 tU per year**

Could be doubled depending on Nickel production.

Start-up possible: **2013**

Expected mine life: **46 years**

Comment: Cameco signed 2 agreements in January, 2011

1. Funding of construction and render technical assistance
2. Off-take agreement through 2027

Byproduct from Multi-Mineral Mines *Planned:*

Mine/Deposit: **Nolans Bore (Australia)**

Owner: **Arafura**

Primary/other metals: **Rare Earth Elements/Phosphates**

Uranium Resource: **13 MM pound (5,000 tU)**

Estimated production: **390,000 pounds/150 tU/year**

Startup possible: **2013**

Comment:

Current boom in rare earth sector driving this project.

Byproduct from Multi-Mineral Mines *Exploration Stage:*

Mine/Deposit: **Falea (Mali)**

Owner: **Rockgate Capital**

Primary/other metals: **Copper/silver**

Uranium Resource: **26 million pounds (10,000 tU)**

Estimated production: N/A

Startup expected: N/A

Comment:

Other uranium plays on property found, "Athabasca-style" high-grade uranium deposits. Rockgate would like to vend project to operating mining company for further development

Byproduct from Multi-Mineral Mines

Exploration stage:

Mine/Deposit: **Kvanefjeld**

Owner: **Greenland Minerals**

Primary/other metals: **Rare earth elements, zinc**

Uranium Resource: **350 million pounds (135,000 tU) (indicated and inferred)**

Estimated production: **7.4 Million lbs U₃O₈**

Startup expected: **2015**

Comment:

Discovered by Neils Bohr in 1955. Carbonate leach extraction method developed early 1960s. Waiting for exploitation license from the government.

Byproduct from Gold

Byproduct from Gold *Operating:*

Mine/Deposit: **Vaal Reefs (Great Noligwa, Kopanang, Moab Kotsong) (S.A.)**

Owner: **Anglogold Ashanti**

Primary/other metals: **Gold**

Uranium Resource: Proven and Probable Reserves (all three mines):

Approx. **31 million pounds (12,000 tU)**

Production: **1.4 million pounds (500 tU/year)**

Comment:

Stripping uranium reportedly improves gold recoveries. Plans to increase uranium output repeatedly delayed. High gold prices support continued mining; high value of Rand problematic.

Byproduct from Gold Operating:

Mine/Deposit: **Ezulwini; Mine Waste Solutions (MWS) (S.A.)**

Owner: **First Uranium**

Primary/other metals: **Gold**

Uranium Resources

Ezulwini: Measured and Indicated, **7.1 million pounds (2,730 tU)**

Inferred: **189 mm pounds (72,000 tU)**

Projected production: **200,000 pounds (2012) ramping to 900,000**

MWS: Measured and Indicated, **48 million pounds (18,461 tU)**

Projected production **120,000 pounds (2012), ramping to 750,000**

Comment: One of the few succeeding in mining uranium from tails; ramp-up dates uncertain

Byproduct from Gold

Sample Planned Projects

Project: **Raptor and Harrier (S.A.)**

Owner: **West Wits Mining Co.**

Uranium resource: **22-32 million pounds**

Status: **Continuing feasibility studies**

Project: **Driefontein Tailings (S.A.)**

Owner: **Gold Fields**

Uranium resource: **77 million pounds**

Status: **Advanced feasibility study under way**

Project: **Cooke Tailings Dam**

Owner: **Rand Uranium**

Uranium Resource: **35 million pounds**

Status: **Engineering 60% completed, could start within two years
at 2 million pounds per year for 15 years**

Byproduct from Phosphates

Byproduct from Phosphates

Phosphate Facts:

- **Primary component of inorganic fertilizers—no substitute**
- **World reserves of phosphate rock: 65 billion tons (USGS definition)**
- **Uranium follows the P₂O₅/phosphoric acid**
- **Global P₂O₅ production in 2010: 33.6 million tonnes**
- **Theoretical limit on extraction of uranium from phosphate production:
Approx. 11,700 tU/year (+/- 30.5 million pounds U₃O₈ per year)**
- **Uranium resources in phosphate rock: At least 7 million MTU—literally billions of pounds U₃O₈. Direct extraction cost prohibitive now, perhaps not forever.**

Phosphate Producers with No Current or Uncertain Uranium Byproduct Plans

- China
 - World's largest producer of phosphate rock (65 MM tonnes in 2010), but no known plans to extract associated uranium
- Saudi Arabia
 - Increasing production of phosphoric acid, but indicated in 2007 that it had plans to extract uranium at that time
- Syria
 - Undertook lab-scale uranium extraction from phosphates under IAEA supervision during 1990s, but no current plans to ramp up
- Israel
 - No published plans to extract uranium
- Iran
 - No published plans to extract uranium
- Russia and South Africa, major phosphate producers, have access to less costly uranium resources

Byproduct from Phosphates: Planned and Prospective

Brazil

Project: **Santa Quiteria/Itataia**

Phosphate reserves (USGS): **340 million tonnes**

Uranium resources in phosphate: **140,000 tU in Santa Quiteria of which 80,000 tU in Itataia mine under development**

Grade: **13 -14 lbs U3O8/metric ton P2O5 (exceptionally high)**

Projected Annual Uranium Production: **Up to 1,000 t/U per year**

Time frame: **Officially planned to start in 2013; 2015 or beyond more likely**

Comment: INB (state nuclear agency) awarded contract to Galvani fertilizer company to develop this resource in 2008. INB will take uranium for domestic use. Plant and supportive infrastructure still in planning stage.

Byproduct from Phosphates: Planned and Prospective

Jordan

Phosphate reserves (USGS) : **1.5 billion tonnes**

Uranium resources in phosphate: **Up to 140,000 MTU**

Annual P₂O₅ production: **676,000 tonnes**

Potential Annual Uranium Production: **350,000 lbs U₃O₈/year (135 MTU/year)**

Comment:

SNC Lavelin turned in uranium-from-phosphate study in 2009, but in mid-2010, AREVA signed JV agreement to mine from conventional deposits. Unclear which goes first.

Byproduct from Phosphates: Planned and Prospective

Egypt

Phosphate reserves (USGS): **100 million tonnes**

Uranium resources in phosphate: **Up to 40,000 MTU**

Annual P₂O₅ production: **+/- 90,000 tonnes**

Potential Annual Uranium Production: **45,000 lbs U₃O₈ (17 MTU)**

Comment:

Domestic processing of 4.5 million tons of phosphate is planned, but status unclear. Pilot extraction of uranium was carried out at lab scale in mid-2000s, but results were mixed. If acid plant scaled up, Egypt may produce for domestic nuclear energy program in 2020 time frame.

Byproduct from Phosphates: Planned and Prospective

Tunisia

Phosphate resources (USGS): **100 million tonnes**

Uranium resources in phosphate: **50,000 tU**

Annual P₂O₅ production: **1,585,000 tonnes**

Potential Annual Uranium Production: **689,000 lbs U₃O₈ (265 MTU)**

Comment:

Pilot-scale uranium extraction carried on in the 1980s. Currently an active, government-supported research effort to define requirements for full-scale extraction program.

Byproduct from Phosphates: Planned and Prospective

Morocco

Phosphate resources (USGS): **50 billion tonnes (75% of world total)**

Uranium resources in phosphate: **6.9 million tonnes U**

Annual P₂O₅ production: **4.8 million tons (capacity)**

Potential Annual Uranium Production: **2.5 million pounds U₃O₈ (960 MTU)**

Comment:

Uranium was extracted from Moroccan phosphates by Belgian firm Prayon from 1980 to early 1990s at rate of about 50 tU/year. Low uranium prices led to plant closure. Agreement with AREVA in 2007 to study a restart of uranium extraction business. Current status unclear. Could be major future resource with improved technology.

Byproduct from Phosphates: Planned and Prospective

USA

Phosphate resources (USGS): 1.4 billion tonnes

Uranium resources in phosphate: 170,000 MTU

Annual P₂O₅ production: 9,616,000 tonnes

Potential Annual Uranium production: 6-7 million lbs U₃O₈ (2,300 – 2,680 MTU)

Comment:

8 operating U.S. plants used to produce up to 3.5 million pounds U₃O₈. All since shuttered, but serious plan to restart one at CF industries.

Plant City, Florida Uranium Recovery Facility Byproduct from Phosphates



CF Industries

- A leading manufacturer/distributor of nitrogen and phosphate fertilizer.
- CF operates:
 - Seven nitrogen fertilizer complexes.
 - Phosphate mining/production
 - Fertilizer distribution
 - KEYTRADE AG (50%interest)
- 2010 Sales \$4.0B with net earnings of \$349.2M



CF Industries

- Central Florida operations include a phosphate rock mine in Hardee County, a chemical plant in Plant City, and an ammonia terminal, warehouse, and dock at the Port of Tampa.



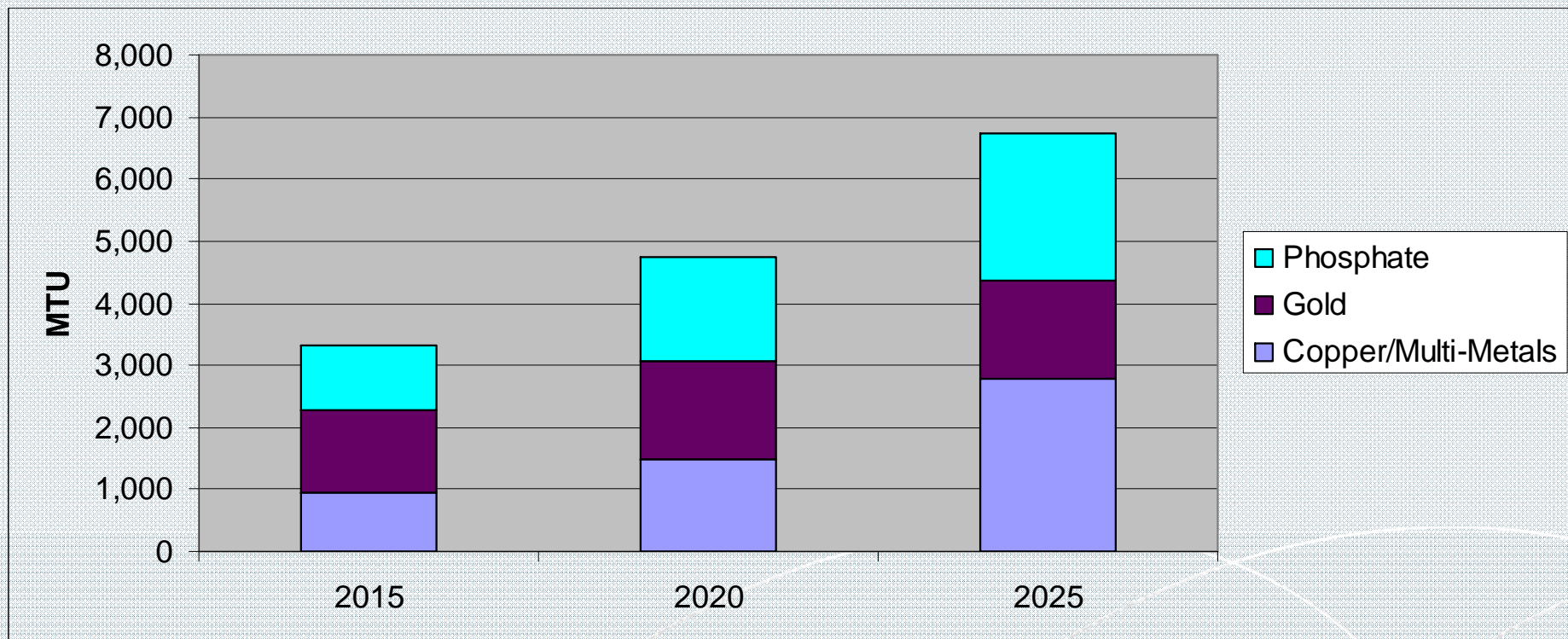
Plant View



Project Status

- Nukem, Inc. and CF Industries are proposing the development of a Uranium Recovery Facility at CF Industries' Plant City, Florida phosphoric acid facility.
- Pre-Feasibility Study completed in February 2007.
- Feasibility Study completed in August 2009.
- Front End Engineering and Design (FEED) Study to be completed during 3Q 2011
- Estimated annual U₃O₈ production 890,530 lbs U₃O₈ for 20+ years. Start-up +/- 2014.

Potential Byproduct Uranium Production



■ Excludes ODM and Vaal Reefs