Data Analytics Boot Camp Final Project

Fort Knox Heap Leach Model Remake

August 5, 2021

KINROSS

Contents

KINROSS

What is an astronaut's favorite key on the keyboard?

The spacebar.

KINROSS

Background

- Founded in 1993, Kinross Gold is a senior gold mining company with a diverse portfolio of mines and projects in the United States, Brazil, Chile, Ghana, Mauritania, and Russia. Headquartered in Toronto, Canada, Kinross employs approximately 9,000 people worldwide.

- Fort Knox is an open-pit gold mine located near the city of Fairbanks, Alaska. It is mined by conventional open-pit methods, with ore processed at a mill and heap leach facility.

- Heap Leaching is a low-cost method that is most suitable for treatment of low-grade materials that do not justify the higher costs of grinding and agitation leaching. The ores are placed on a liner, cyanide solution is dripped on the pad and percolates through the ores. Dissolved gold in the solution is extracted through adsorption, desorption and regeneration (ADR) plant.

- The heap leach production acts similar to a "black box" function, where inputs are cyanide solution, gold ores, time, etc. and the output is pregnant solution (solution with gold dissolved). Understanding the heap leaching process can help the mining operation plan for the ore stacking and leaching cycle. On the financial side, a well established heap leach model can help the company foresee the upcoming challenges and opportunities.

Operations Map

Fort Knox, USA

Bald Mountain, USA

Toronto, Canada

Round Mountain, USA

Tasiast, Mauritania

Chirano, Ghana

Paracatu, Brazil

La Coipa, Chile

Dvoinoye, Russia

Kupol, Russia

- Operations
- Development Projects
- Head Office

KINROSS

5

I poured root beer in a square glass. What did I get?

Just beer.

Data Sources

- Mine technical services team – pad information

  - Ores information placed on the heap leach pad. Ores tonnage, contained gold ounces, time placed and location.

  - Leaching information. This describes the time when leaching at a certain area started and ended.

- Metallurgy team – solution information and metal production

  - Solution information. This records the cyanide solution strength and the gold grade in the barren and pregnant solutions. Solution information also includes the solution flowrate to the heap leach pad and the flowrate back to the ADR plant.

  - Metal production. This records the amount of gold produced by month.

KINROSS

Project Goals

- Explain the historical gold production coming out from the heap leach pad.

- Create a heap leach model that can help predict future gold production given pad loading sequence, material information, and operation options.

- Provide suggestions on operation options.

Data Exploration

- Leach pad information:
  - Cells polygons
  - Cells material information

- Geochemistry information:
  - Received data from exploration geologists.
  - Data includes multi-element assays, intersection range, drill hole depth.

KINROSS

Data analysis

- Heap leach model key functions:
  - Leach cell leach date conflicts check.

    The leaching end date of area that is on an lower elevation must be prior to the stacking finish date of area that is directly above it. The analysis uses shapely module to check if two areas overlap. If so, check the lower area's leach end date and the upper area's stacking finish date. Adjust the lower area's leach end date accordingly to avoid date conflict.

  - Break cells into blocks.

    Divide cells into multiple equal size blocks along latitude and longitude. Assume each block from the same cell has the same initial physical properties, including tonnage, ounces, leaching performance, etc. The only differences between blocks in the same cell are the coordinates.

  - Calculate blocks gold recovery over months.
    - Primary leach: the material in a block receives cyanide solution for the first time.
    - Secondary leach: block of material receives cyanide solution drained down from the block above this block.

KINROSS

This is an alternate divider slide

Sed elementum semper consequat. Donec a quam iaculis, gravida ipsum sed, euismod arcu. Phasellus tincidunt id metus at iaculis.

KINROSS