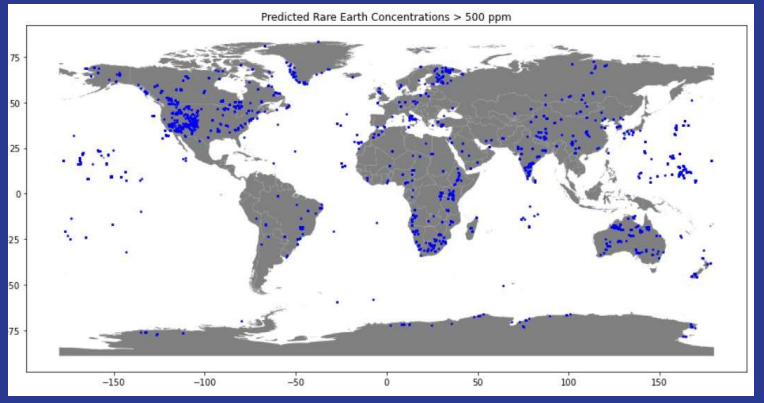
Rare Earth Metals Mining

Team Industrial

Janice Bolen
Stan Holko
Jamie Norman
Ying Zhu



Project Objective - Value Proposition

To develop a data science methodology that will enable faster, low cost, and reliable detection of potential coinage and rare earth metal deposits from previous assay analysis and aerial magnetic and radiometric scans.

Agenda

- Topic Selection
- Data Sources
- Data Questions
- Data Exploration
- Analysis

Topic Selection - Rare Earth Metals Mining

Key selection criteria:

- Industrial / Technical in nature
- Must have a geo-spatial element to it
- Environmental Impact

This topic aligns with the professional experience and interests of the group

Data Sources

Two Data Sources were chosen to be analysed as part of this project:

- Global Whole-Rock Geochemical Database Compilation by Gard, Matthew Geoffrey, Hasterok, Derrick, & Halpern, Jacqueline (2019).
  - 1.0M+ rows of sample data
  - 7 linked tables
  - Consists of temporal, spatial and physical property information
  - Coring sample information logged at locations around the world
- Geophysics of Colorado - National Uranium Resource Evaluation Magnetic and Radiometric Survey by Hill, Patricia L, Kucks, Robert P., & Ravat, Dhananjay (2009)
  - Arial scan of Colorado for magnetic and radiometric data, common practice for surveying for potential sources
  - 3,000 rows
  - Looking to find trends between the arial scan and the whole rock database

Both databases proved sufficient to carry out the project objective

Data Questions

Key questions that the team were attempting to answer through data analysis and machine learning:

- Identify the most commonly co-existing elements in samples rich with the target metals
- Identify if there are other factors that could contribute to the identification of samples rich with the target metals, for example:
  - Rock type
  - Rock age
  - Formation mechanism, etc
- Determine if local aerial magnetic and radiometric scans in the vicinity of the sample location can provide a means of potential identification of sites containing these elements

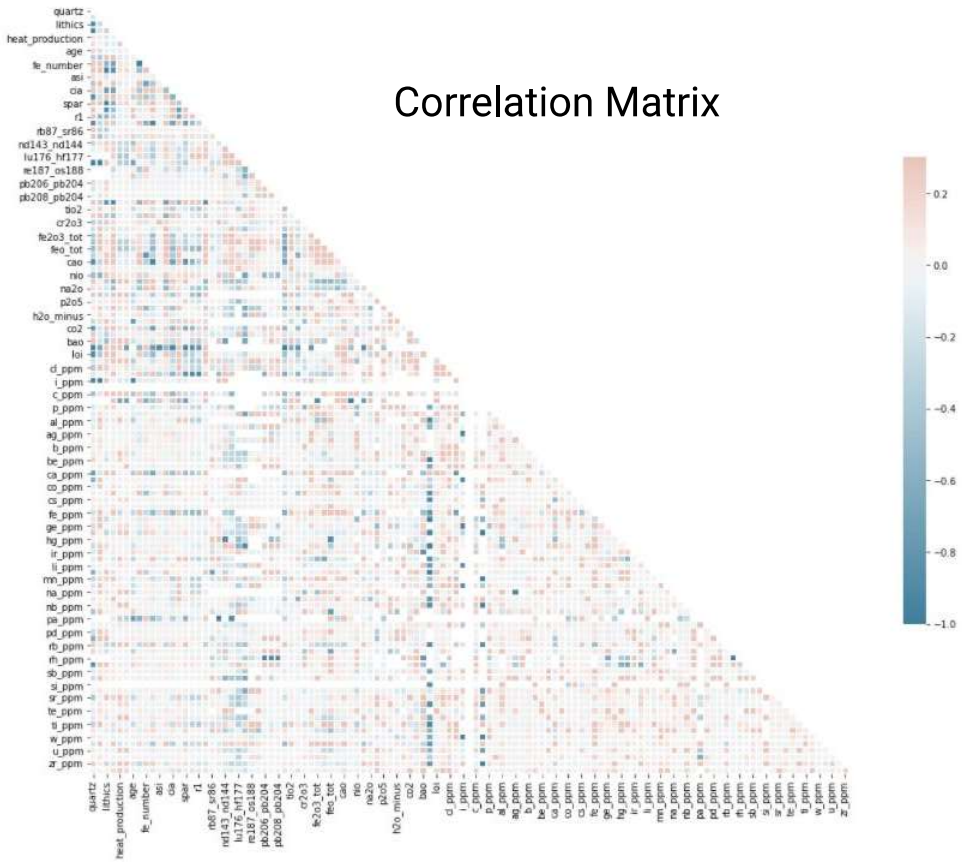
Focus on the identification of key features of the samples rich in rare earth metals

Data Exploration

Initial exploration was completed in python to test the viability of the dataset of core samples, key findings were:

- 100k of 1.2M samples contained rare earth metals
- There was an adequate amount of correlations between the rare earth elements and other elements found in the samples
- The dataset appears to be very sparse (many missing values), decision to proceed with a tree-based machine learning model

Correlation Matrix



Adequate correlations found between rare earth and other elements in samples

Analysis - Model Selection

Data analysis was performed using an XGBoost (Extreme Gradient Boosting) classification model for the following reasons:

1. Tree-based models are better able to handle sparse datasets
2. Tree-based models are good at developing understanding of the impact of individual features on the model
3. XGBoost is more adept at handling unbalanced datasets.

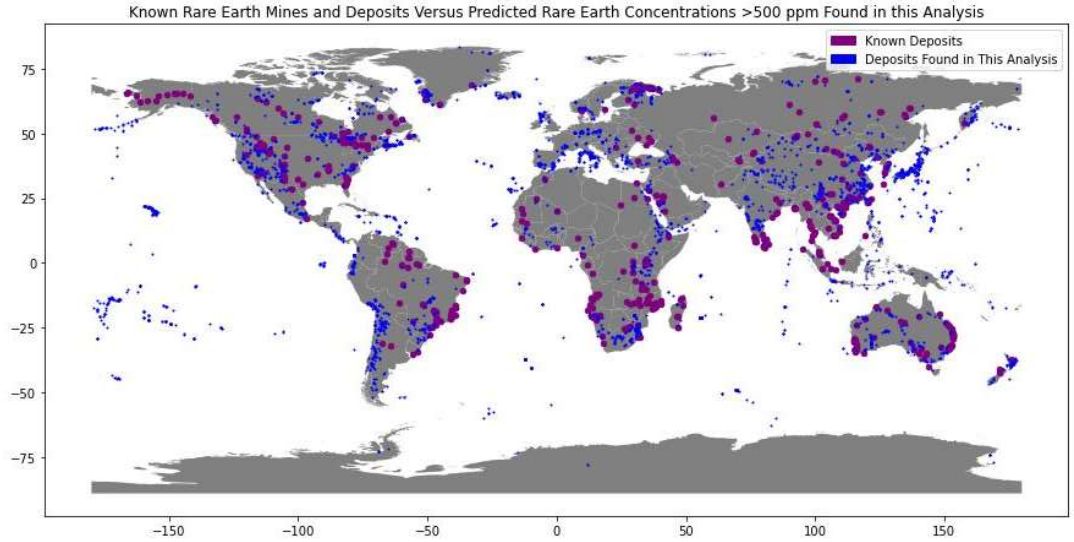
XGBoost was the model chosen to perform the analysis

98%

XGBoost Model Accuracy - Geochemical Model

Analysis - Geochemical Model

The model developed was able to leverage several key correlations to be able to predict other “potential” locations of areas that would be rich in the target metals.



Lots of potential new sources of Rare Earth Metals!

Analysis - Aerial / Combined Model

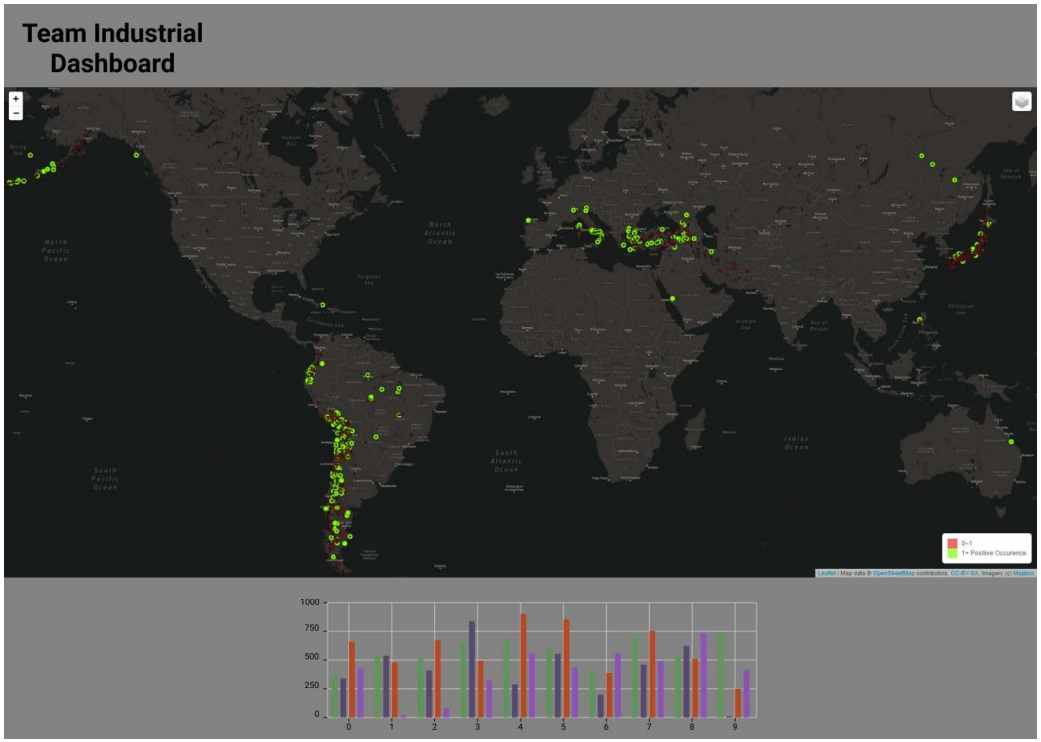
The Colorado Aerial Data Model did not show as strong correlations as the geochemical model.

Aerial Data was also merged with the Geochemical data with only marginal improvement to the accuracy of the first model

No definitive contribution from the aerial data

Output - Front End Development

The model data output was able to be converted into JSON data and output all of the sample points on an interactive map using Flask, D3 and JavaScript.



Sample graphic of the front end (in development)

Final point

The data analysis successfully discovered several key correlations in the assay samples in order to provide leads for other potential sources of coinage and rare earth minerals

Thanks!

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github.com/sholkojr/Rare_Earth_Metal_Mining