

# Geochemical Mapping of Dolerite Dykes: Challenges and Solutions in Automated Block Modelling

<sup>1</sup>Thompson, K., <sup>2</sup>Dangin, J., <sup>2</sup>Wilson, T.,  
Alcoa<sup>1</sup>, DeepLime<sup>2</sup>

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# Problem Statement

Identify problems, goals, solutions & impacts



- **Challenge:** Accurate identification and differentiation of Dolerite and Hardcap in geological domaining due to geochemical signature similarities.
- **Objectives:**
  1. **Identify Dolerite:** Develop methods to distinguish Dolerite from Hardcap for precise geological modelling through declustering of high Fe, Su, and low ST populations.
  2. **Characterize Hardcap:** Determine criteria for identifying Hardcap within Granite by removing Dolerite flagged drillholes.
  3. **Address Mischaracterization:** Mitigate issues arising from mischaracterization of Hardcap.
- **Implications:**
  1. **Density Differences:** Refine tonnage calculations and grade estimations due to weighted average grades.
  2. **Operational Value:** Better prediction of material hardness and grade.
  3. **Iron Characterization:** Improve refining processes through better identification of high Iron values.
  4. **Alumina Bias:** Improve known biases in current sampling processes (FTIR vs WET CHEM analysis) associated with differing rock types / layers
  5. **Grade Estimation:** Support improved geostatistical domaining
  6. **Boulder Intersections:** Better delineate large Doleritic boulders in pit & better predict likelihood of mining impacts
- **Goal:** Enhance regional geological understanding through accurate identification, modelling, and estimation of Dolerites, and better differentiation of high Iron, denser Hardcap at the top of Granitic holes.

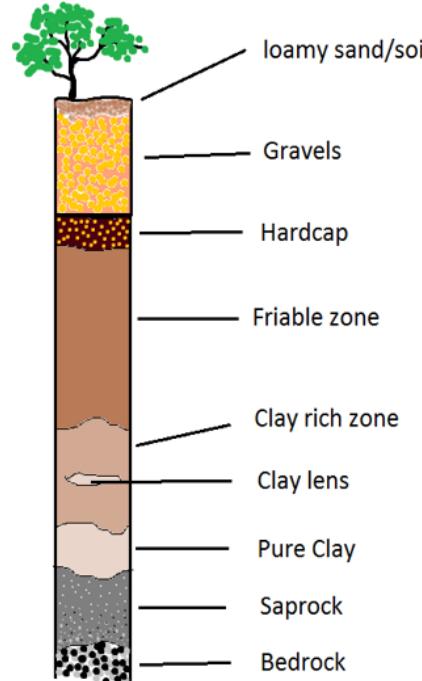
# Coding Flowchart Overview

Dolerite → Granite → Hardcap

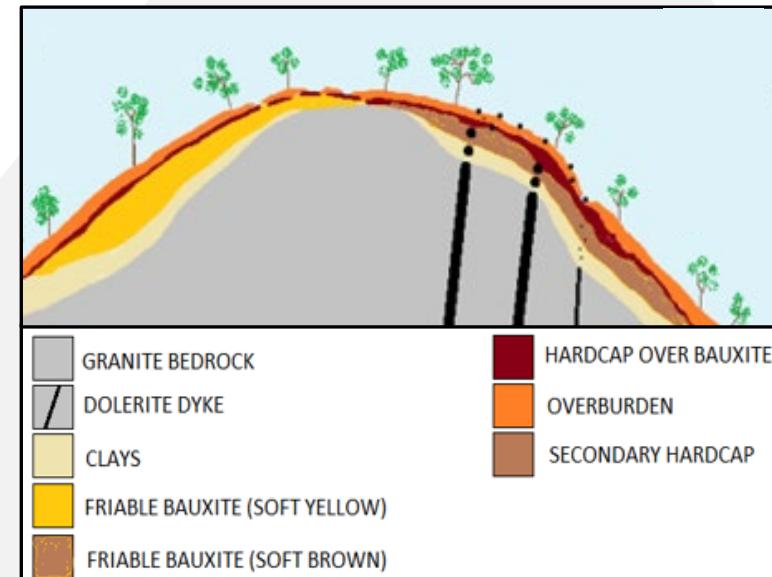


## 1. Dolerite Identification

- A. Combined Assay Population
- B. Decluster using FE,SU,ST normalised values
- C. Granitic & Doleritic Assays flagged
  - A. 1. 'is dyke' assay coding 0 , 1
- D. Drillhole % of Doleritic assays calculated
  - A. 2. 'Dyke Average'
- E. </>70% assays Doleritic samples
  - 3.0. <70% → Granite 'Dyke Final' = 0
  - 3.1. >70% → Dolerite 'Dyke Final' = 1



## THE GEOLOGY GUIDE FOR EXPLORATION FIELD STAFF



## 2. Hardcap Identification

- A. Granite 'Dyke Final' = 0 holes' samples declustered for hardcap and bauxitic samples
- B. Hardcap Population grade cut offs generated for coding
- C. Group together sequentially flagged hardcap samples at top of hole

# Dolerite Identification

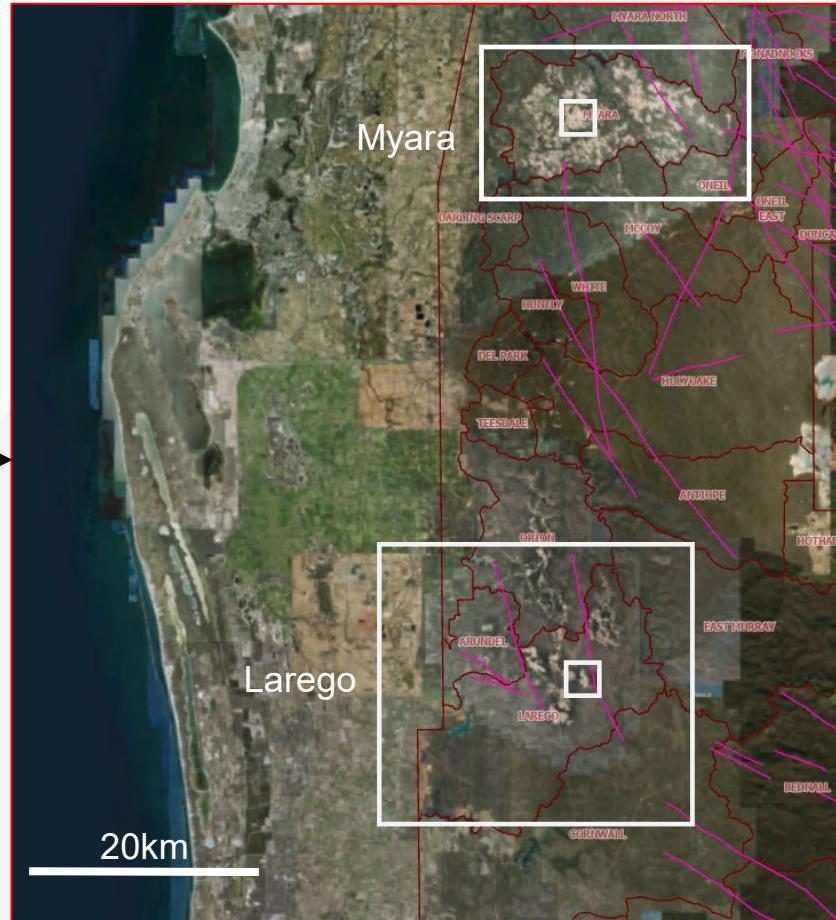
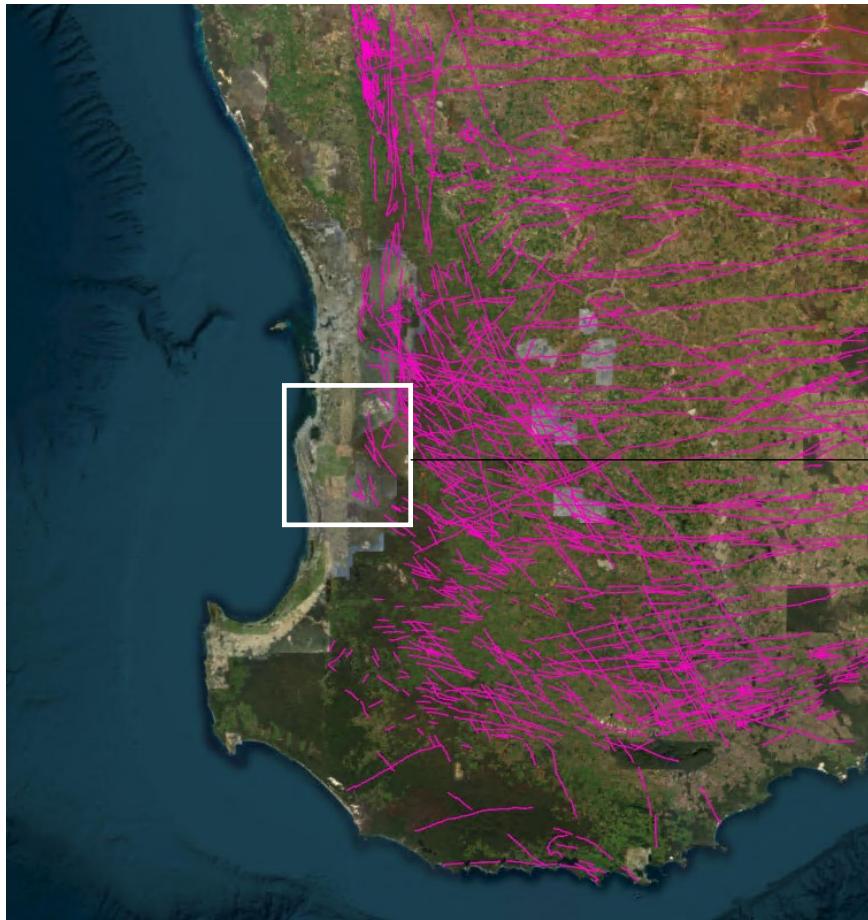
Declustering Drillholes into Granite & Dolerite



# WA DMIRS Dolerite

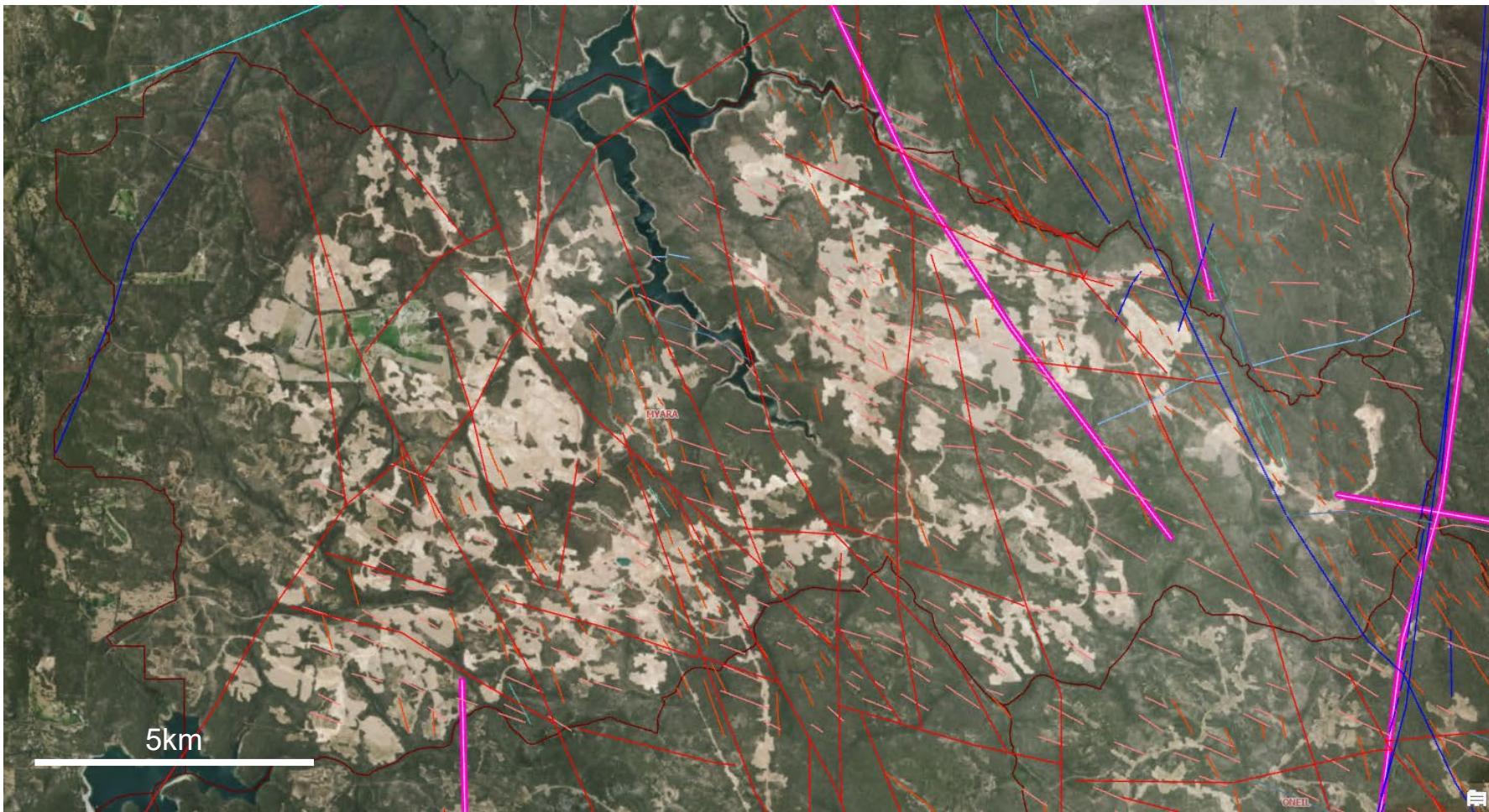
(Geology 1:2 500 000 Geological map of Western Australia - [GDA1994]) : DMIRS

<https://dasc.dmirs.wa.gov.au/Download/File/214>



# Myara compared to Regional Dyke Mapping

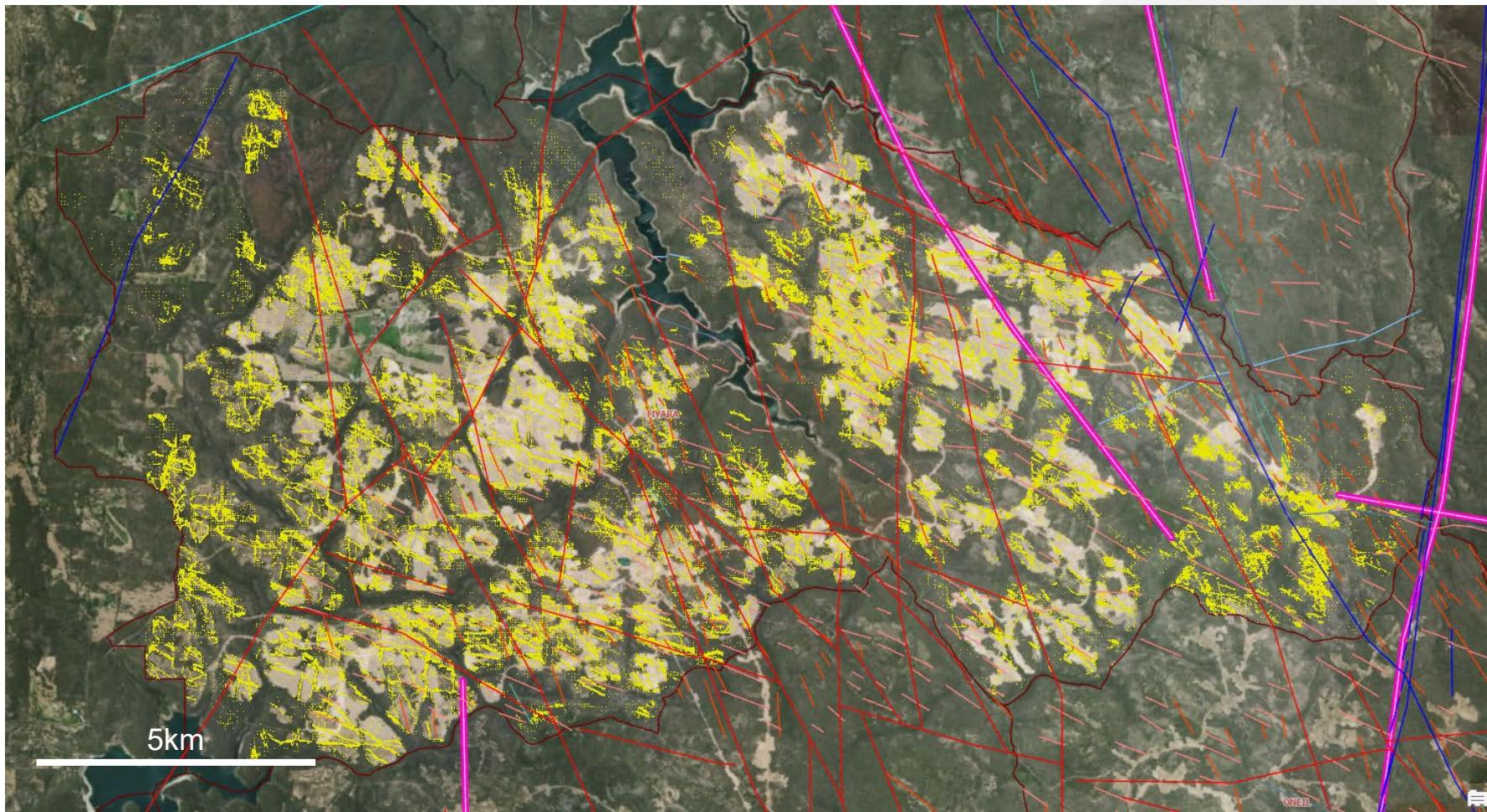
Aerial Geophysical Survey Program - Alcoa



# Myara compared to Regional Dyke Mapping



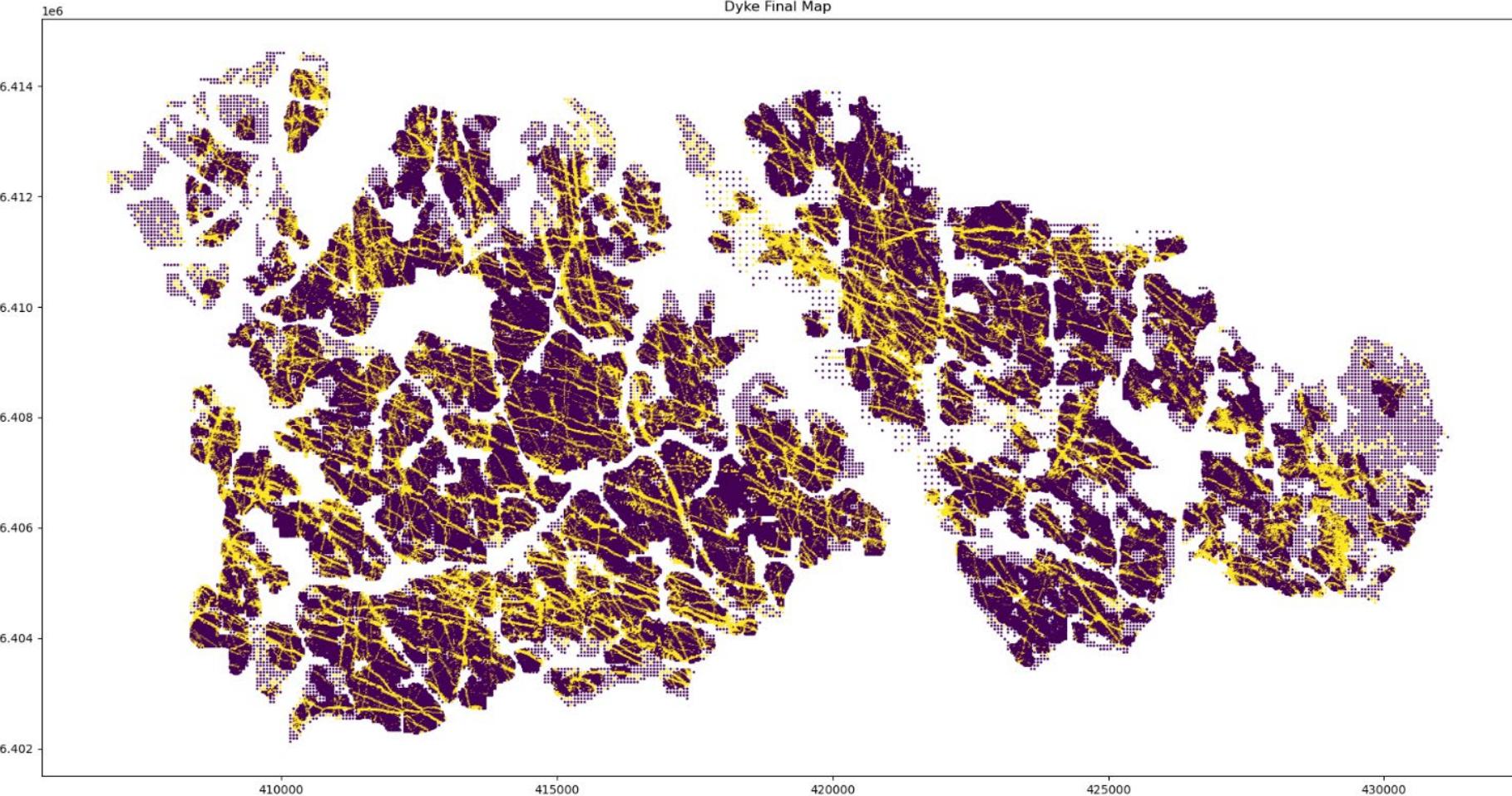
Geochemical Interpretation – Assay population declustering



# Myara Dyke Final Drillhole Map

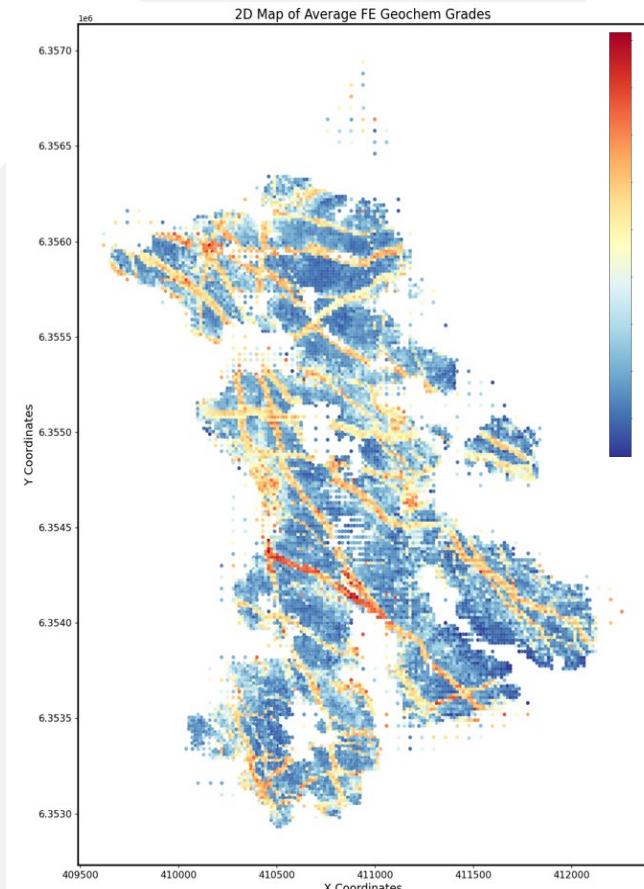
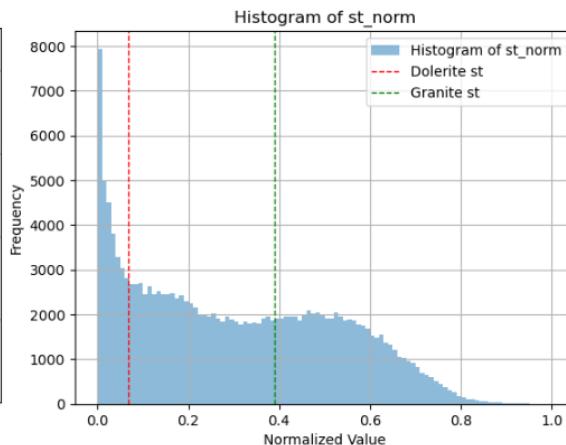
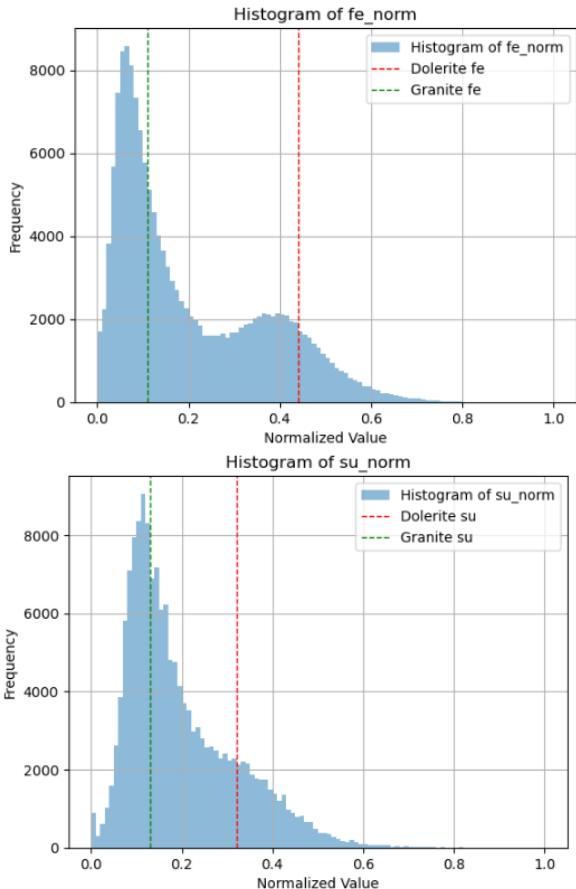


Dyke Final Map



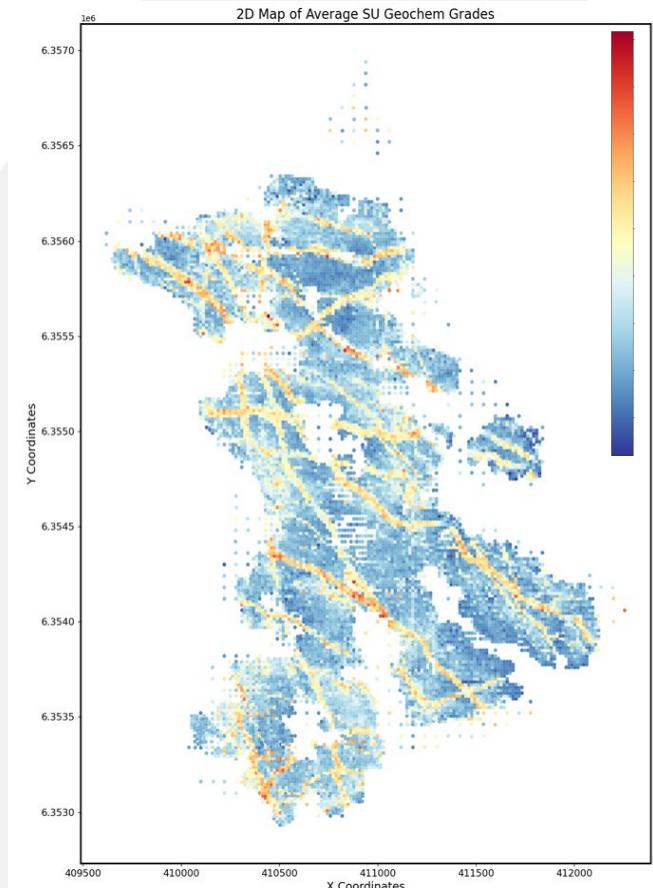
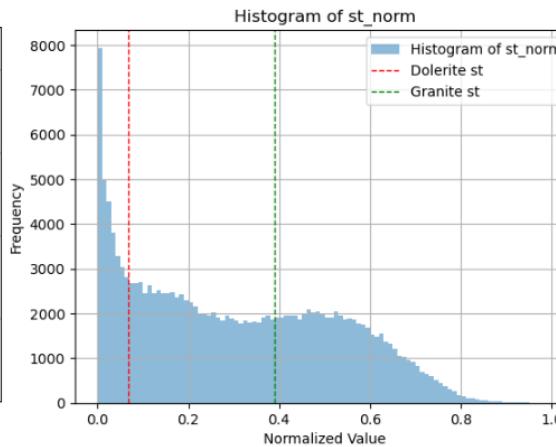
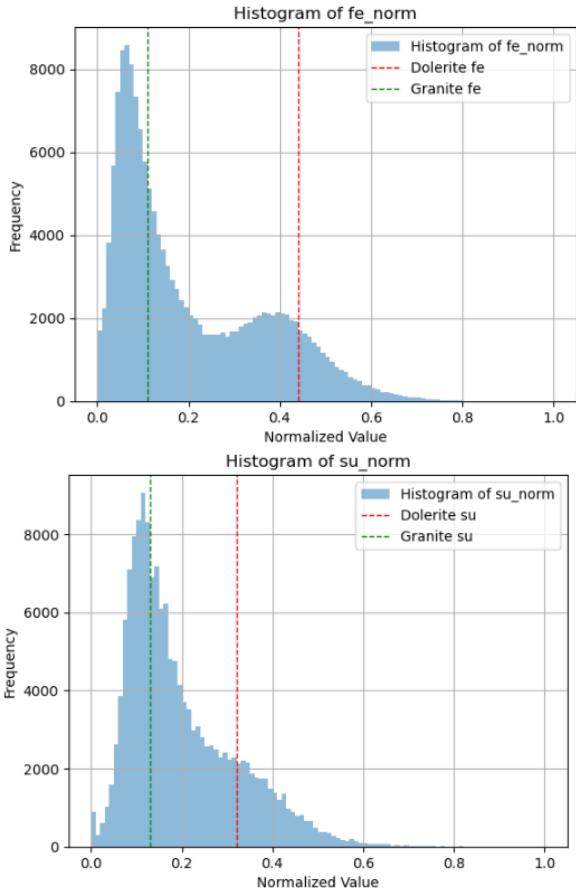
# K-Means Declustering & Downhole Average FE

## Grade Control Model Scale Example



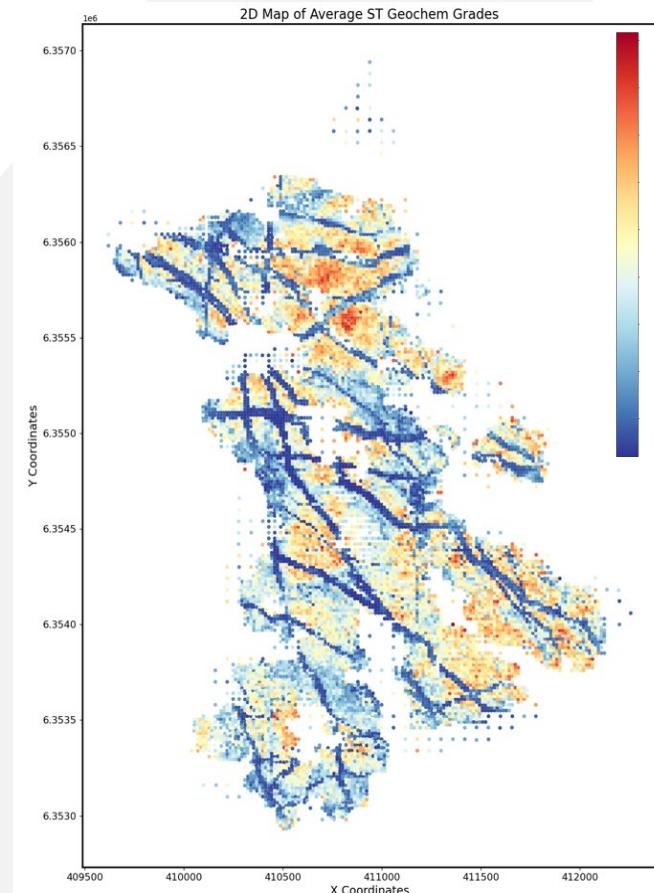
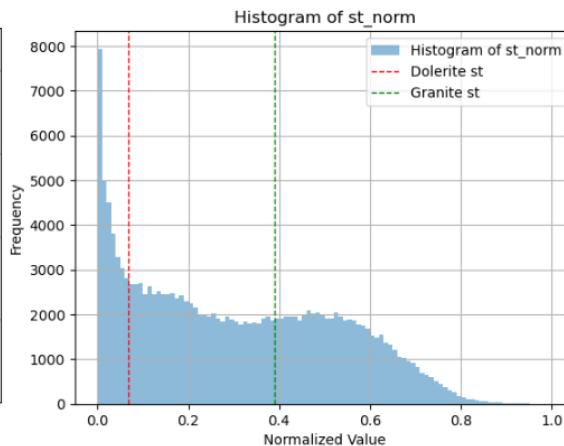
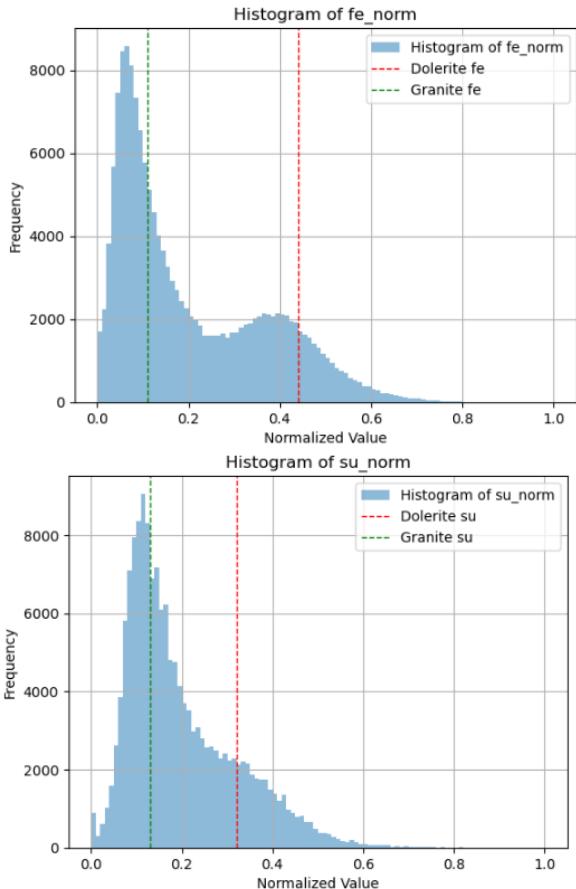
# K-Means Declustering & Downhole Average SU

## Grade Control Model Scale Example



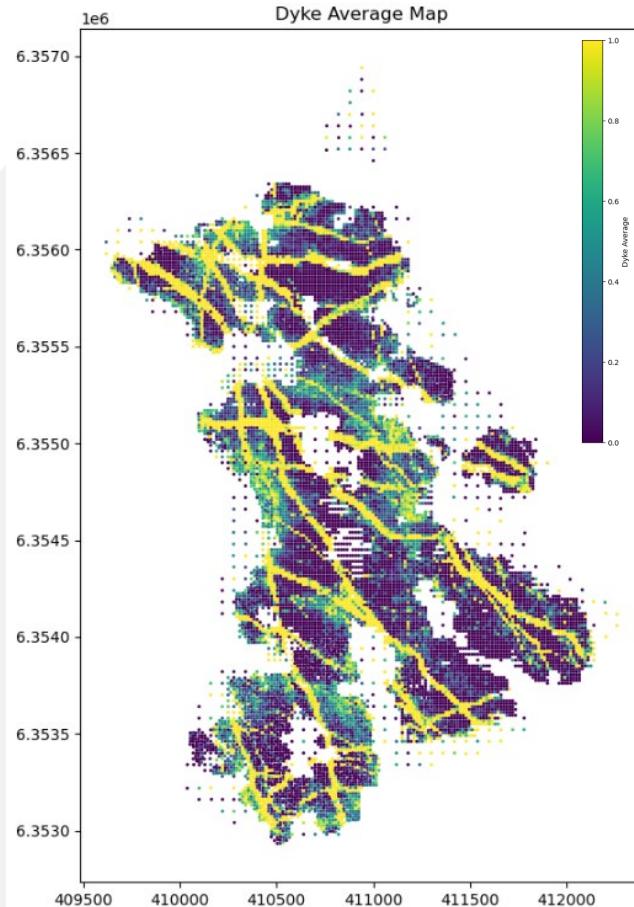
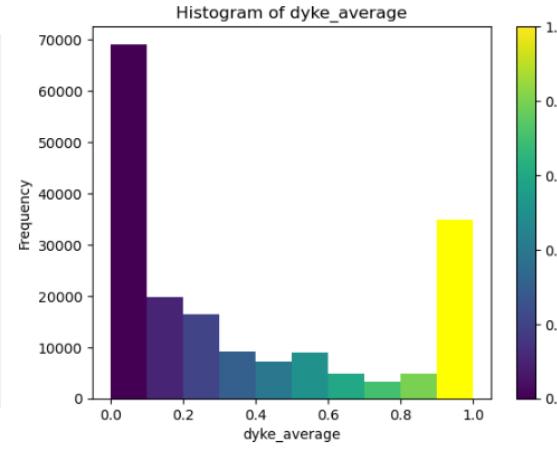
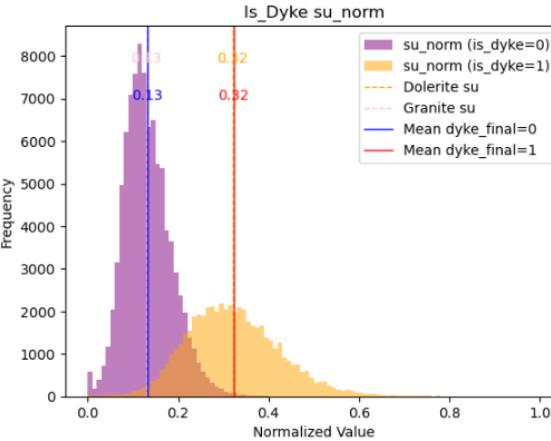
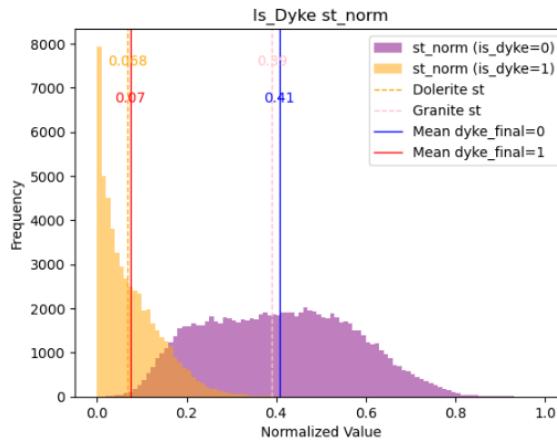
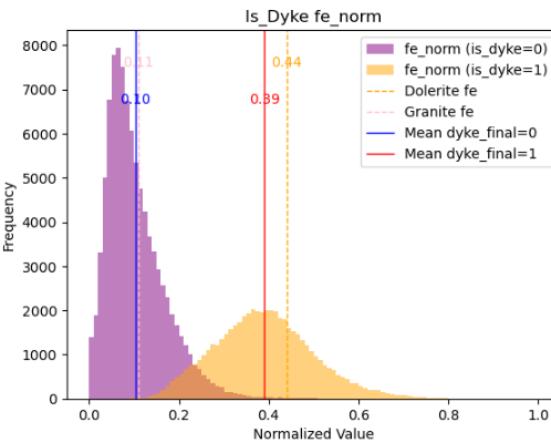
# K-Means Declustering & Downhole Average ST

## Grade Control Model Scale Example



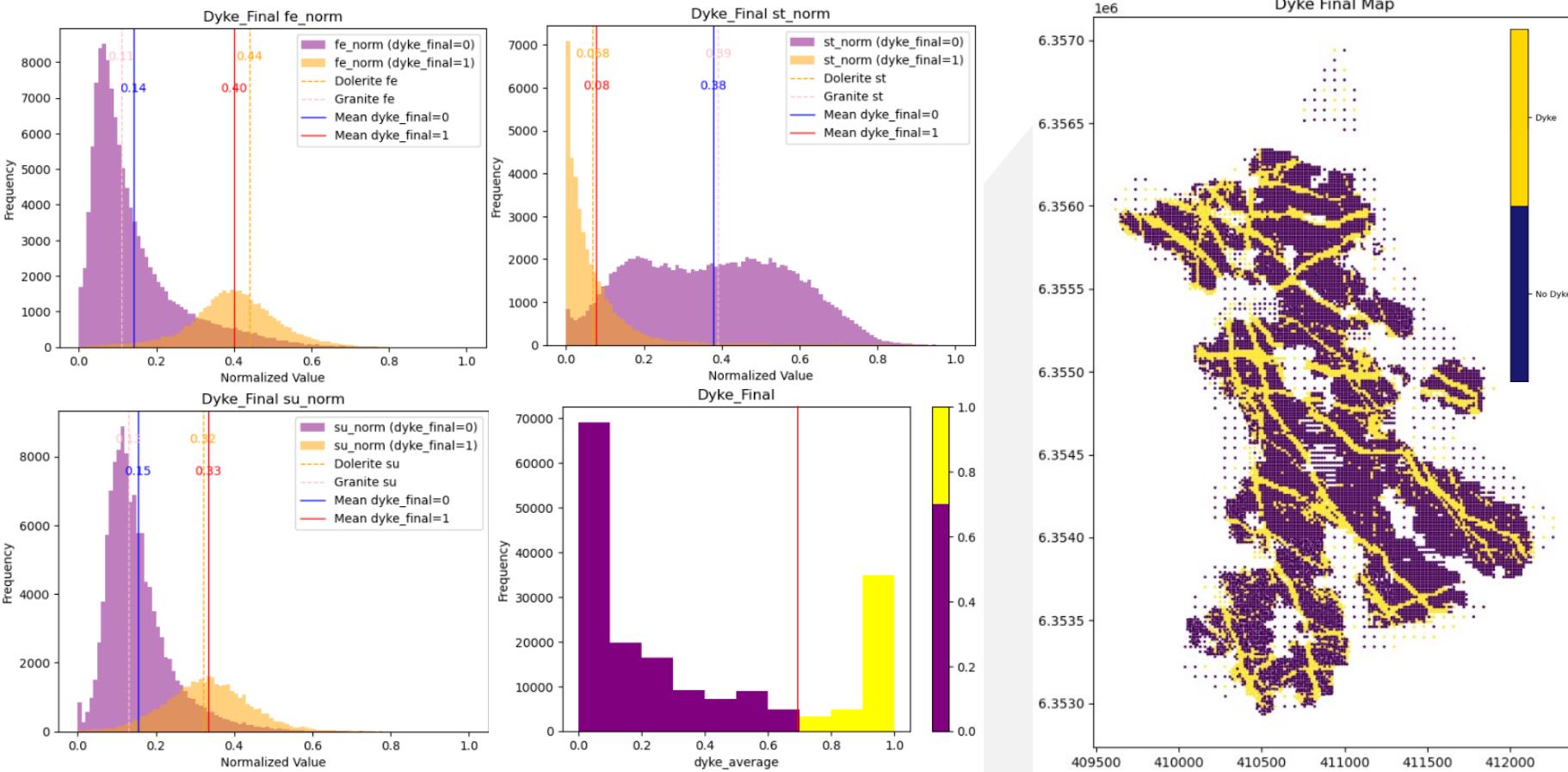
# Population Splitting Histograms

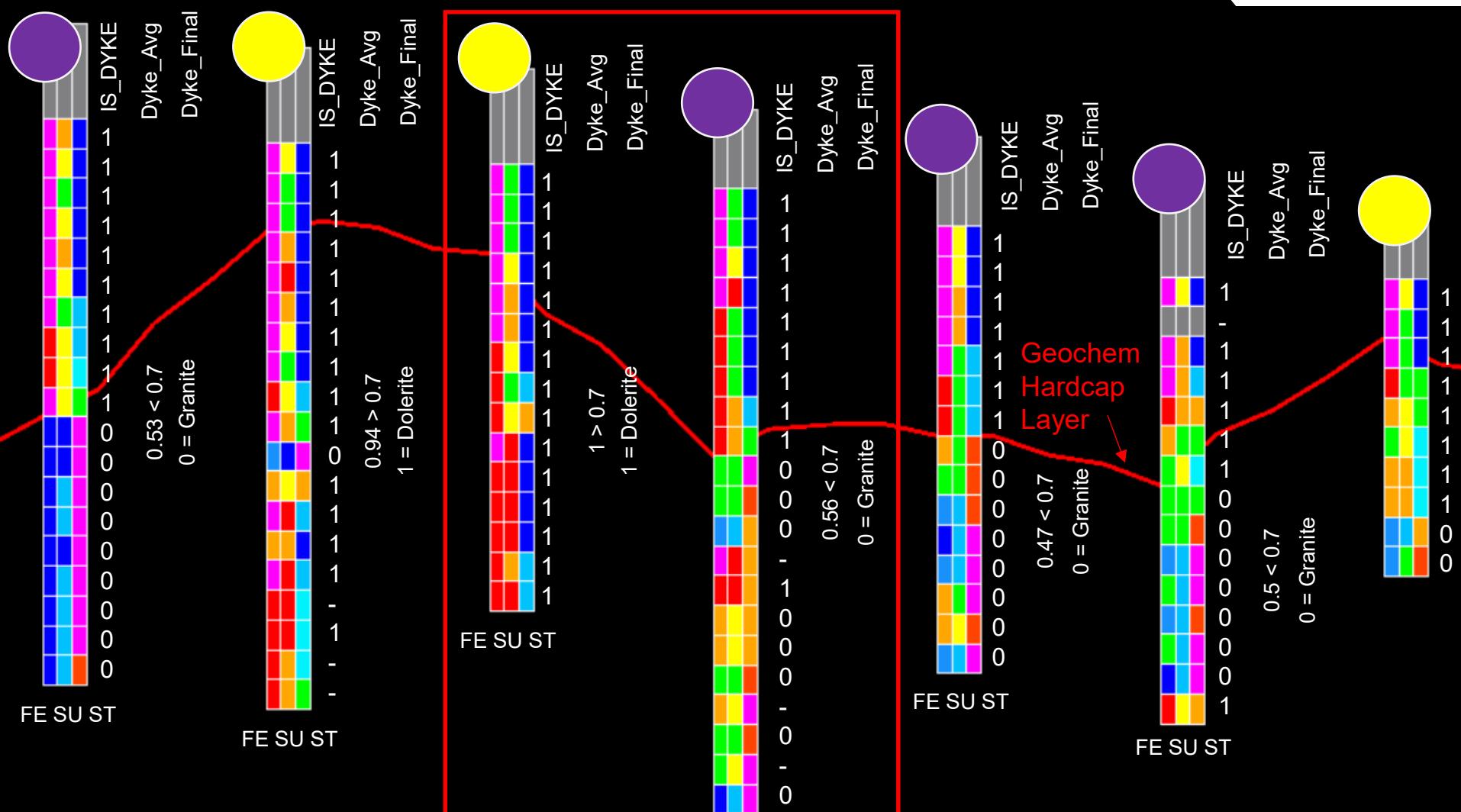
Resulting Population Means relative to K-Means Input: Doleritic Samples vs Granitic Samples



# Population Splitting Histograms

Resulting Population Means relative to K-Means Input: Dolerite Holes vs Granite Holes

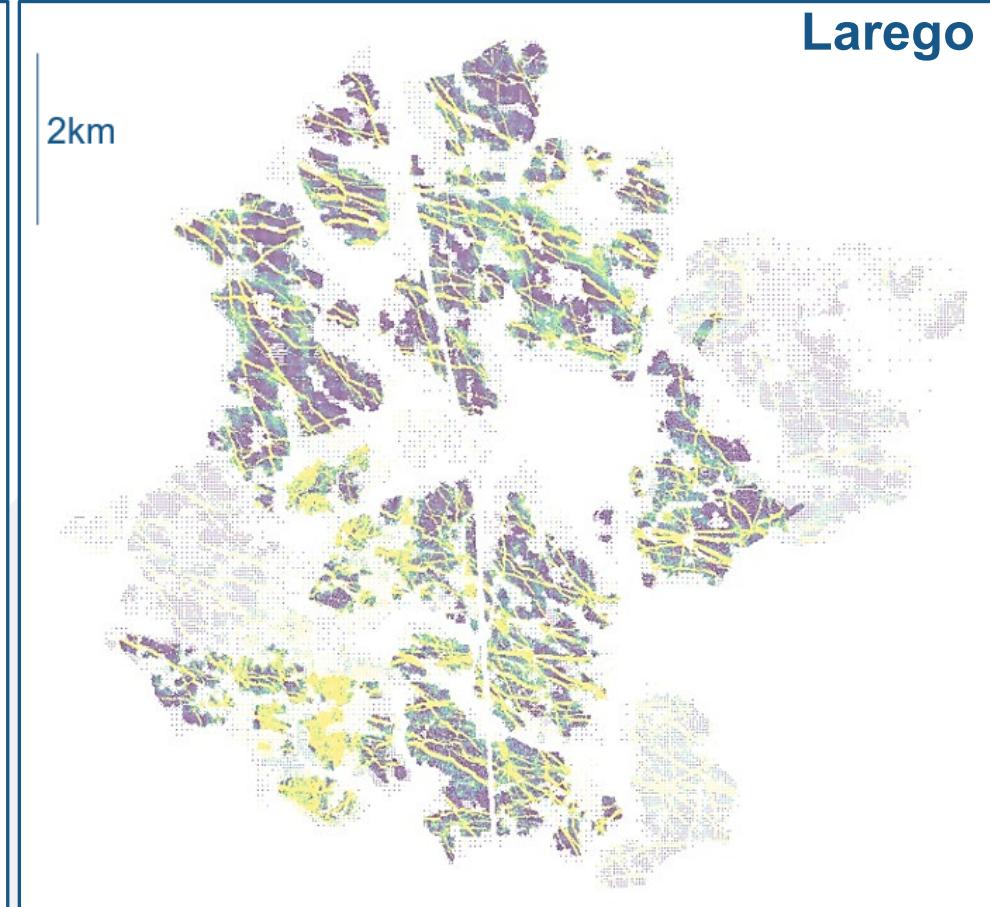
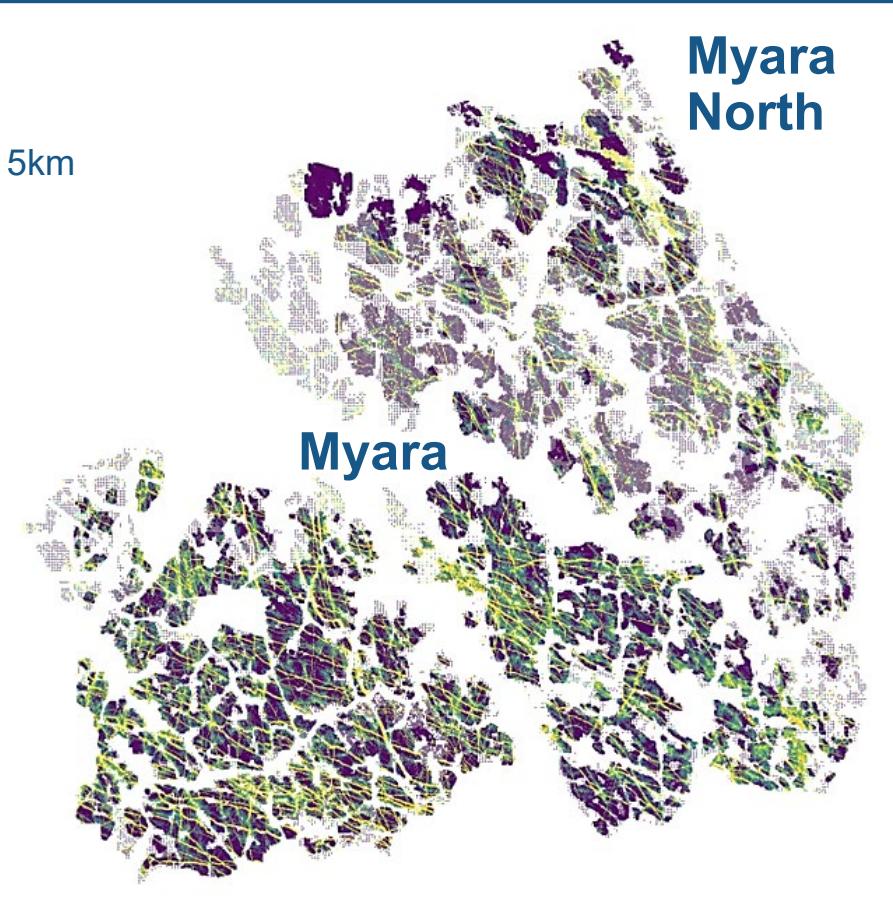




# Myara & Larego Combined Drill Data



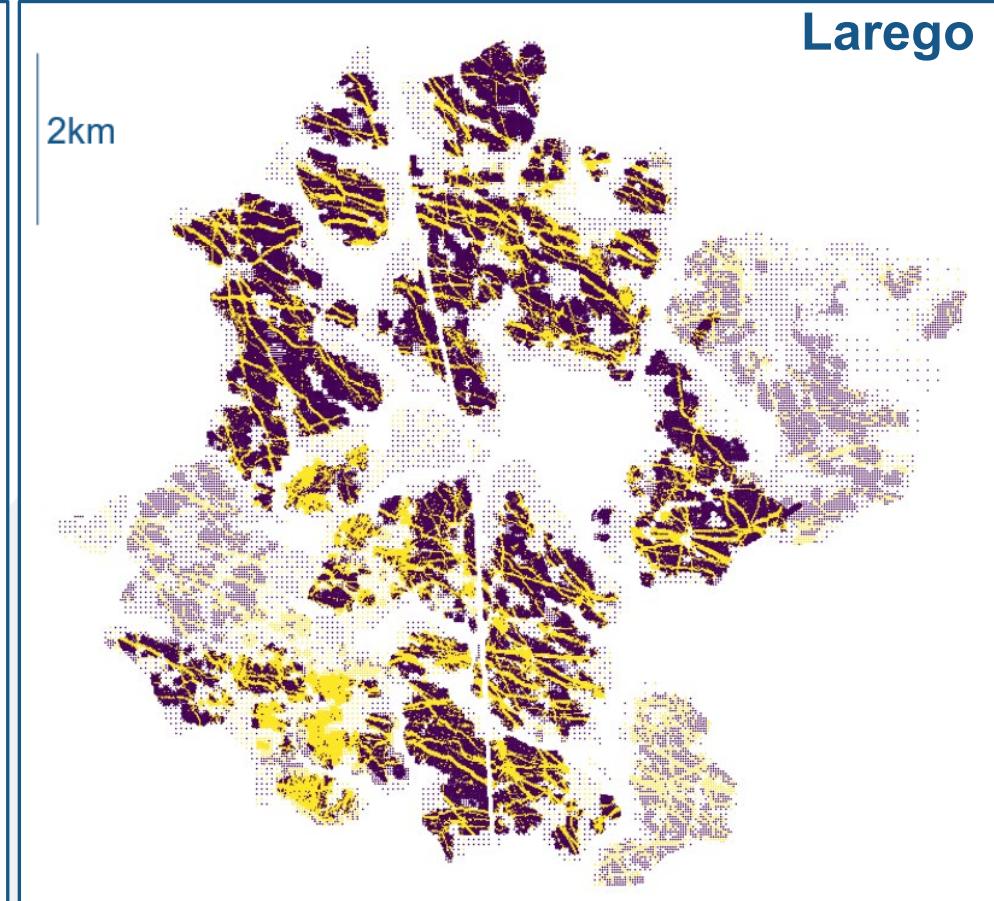
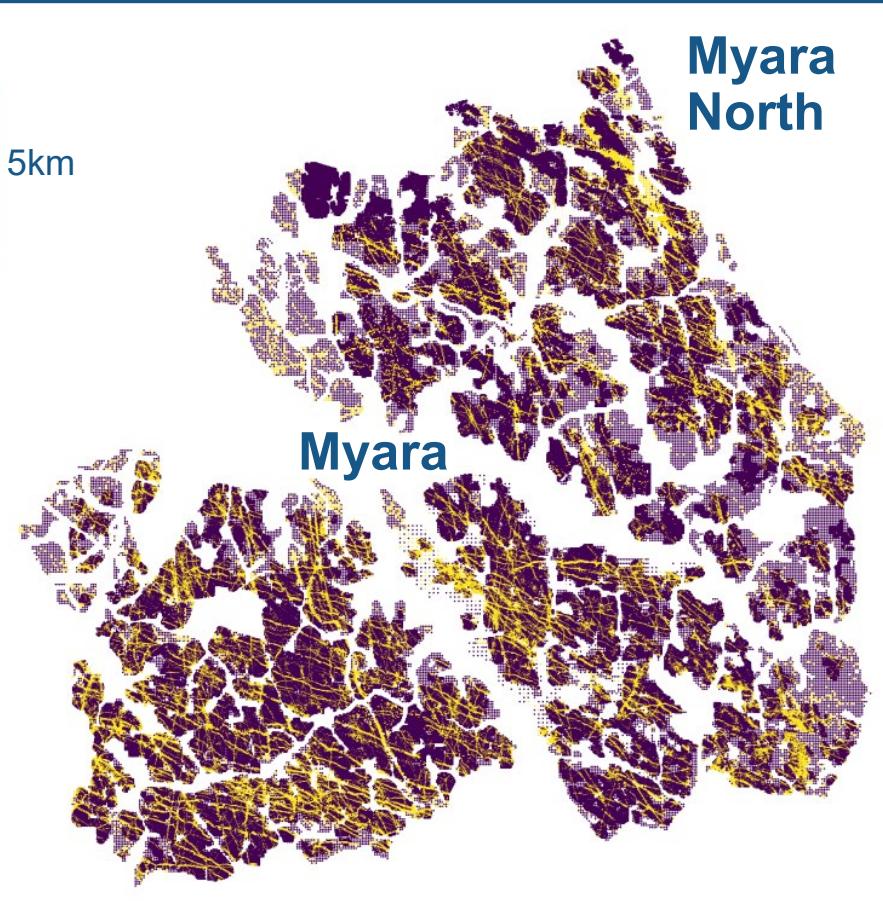
Dyke Average Flagging



# Myara & Larego Combined Drill Data



Dyke Final Flagging



# Aerial Imagery In Pit Validation

Cleared & Mined example of Larego Grade Control Model Area



# Aerial Imagery In Pit Validation – Aerial Interp

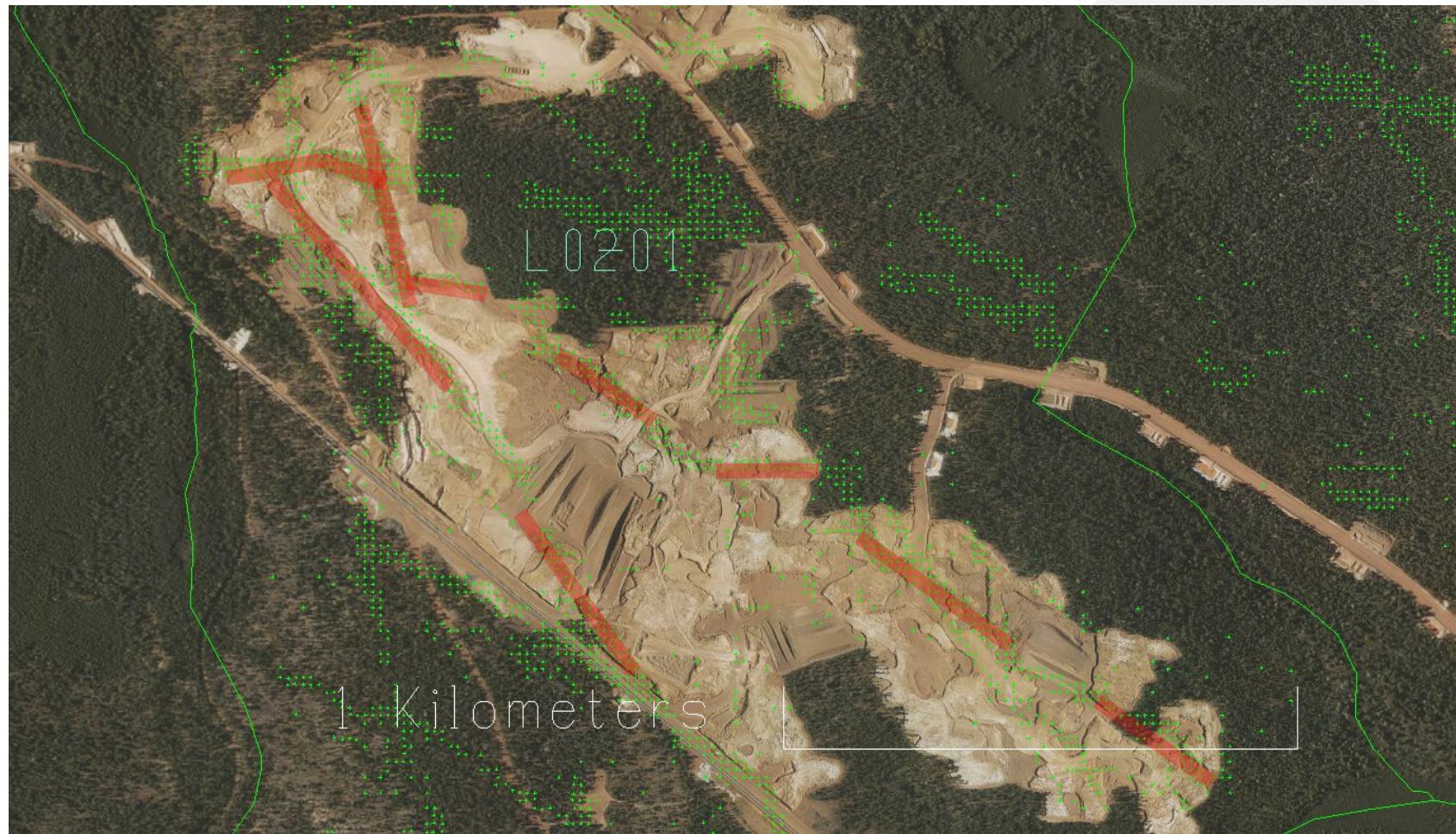


Cleared & Mined example of Larego Grade Control Model Area



# Aerial Imagery In Pit Validation – Dyke Final drillhole coded

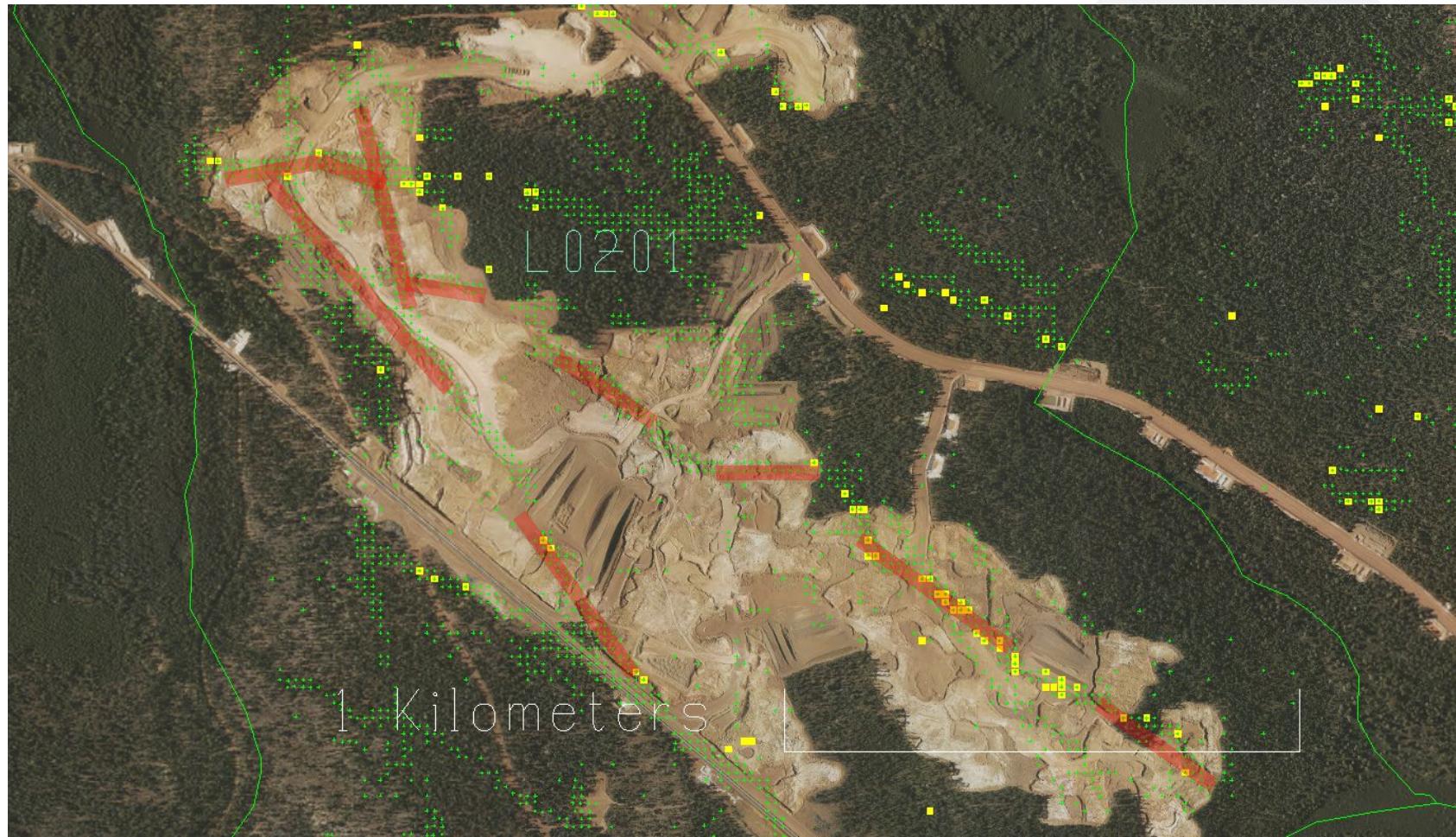
Cleared & Mined example of Larego Grade Control Model Area



# Aerial Imagery In Pit Validation – Drillers EOH Dolerite Points



Cleared & Mined example of Larego Grade Control Model Area



# Hardcap Identification

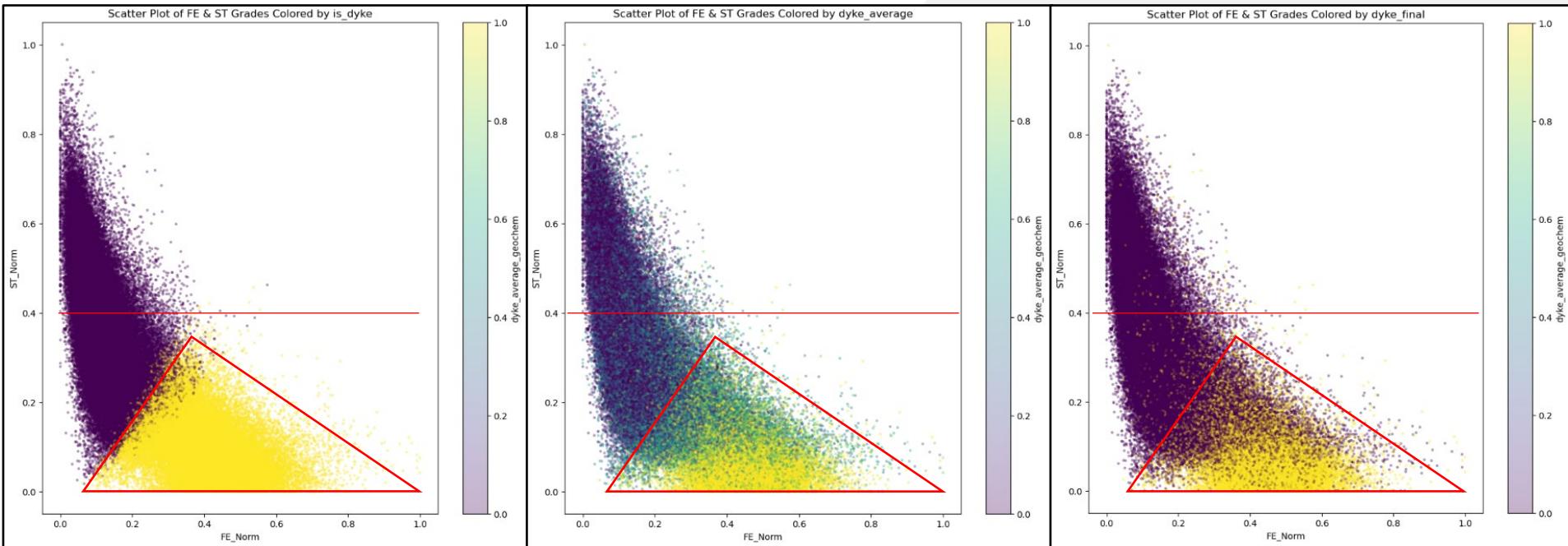
Declustering Granite flagged holes into Hardcap & Bauxite



# Dolerite Coding & Identifying Hardcap samples

Myara Example from individual sample coding, hole averaging & final definition

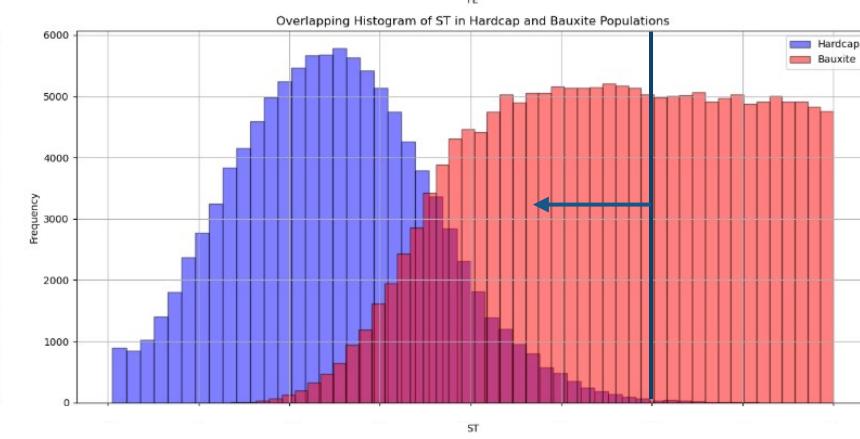
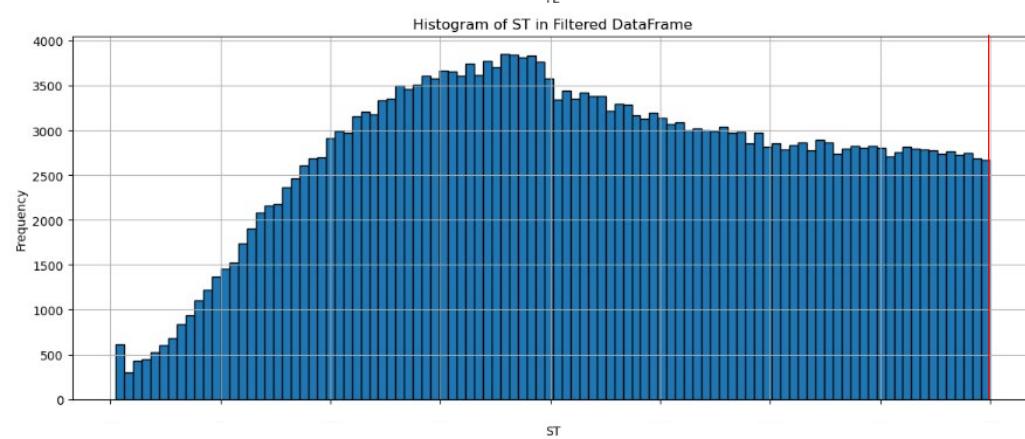
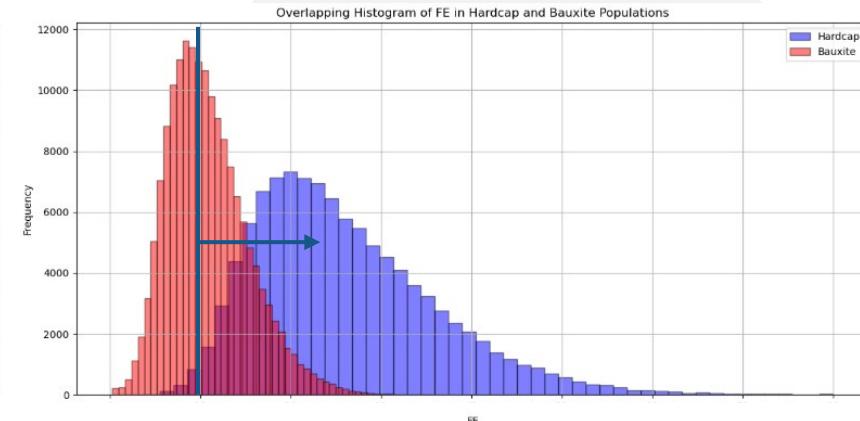
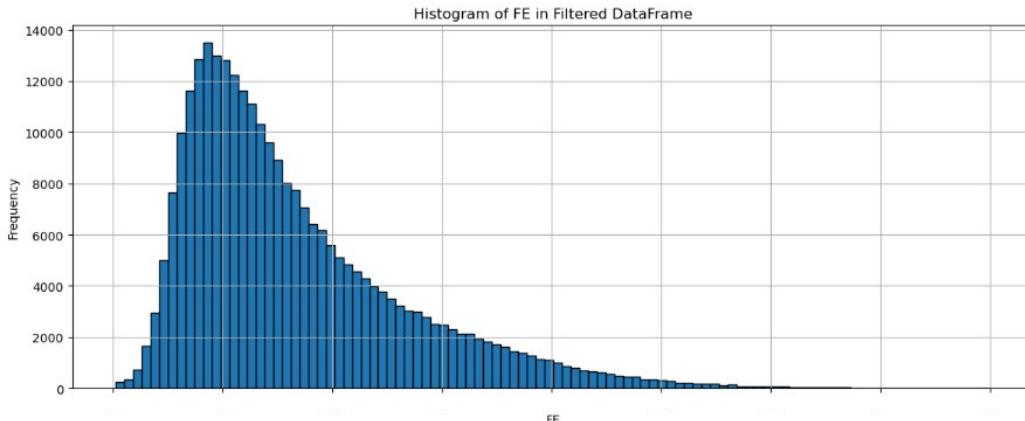
- Purple Samples within red triangle represent hardcap samples in Dyke Final scatter plot
- High FE, Low ST granitic hole samples – Identify cut off grades for coding formula
- Need to re-flag these samples & identify where they sit in the profile



# Merged Myara Granitic Holes: K-means declustering

Filtered Data: Dyke Final = 0, ST < X, Clay Domain Removed

- Declustered granitic populations reveal approx. min & max values of each element assay to be used in coding

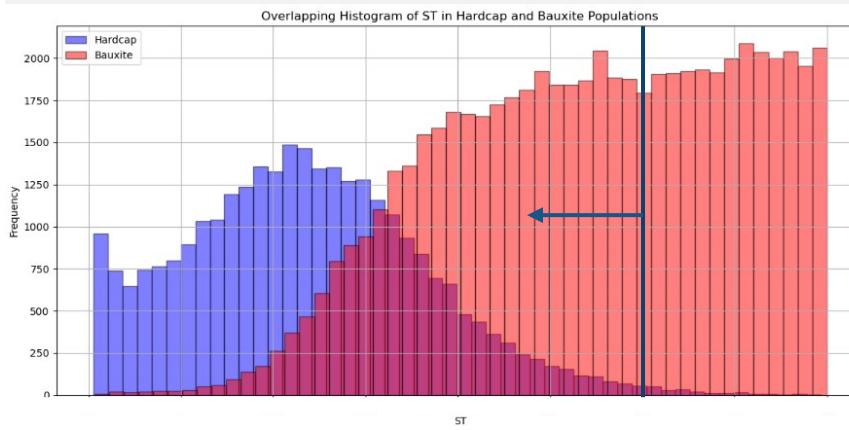
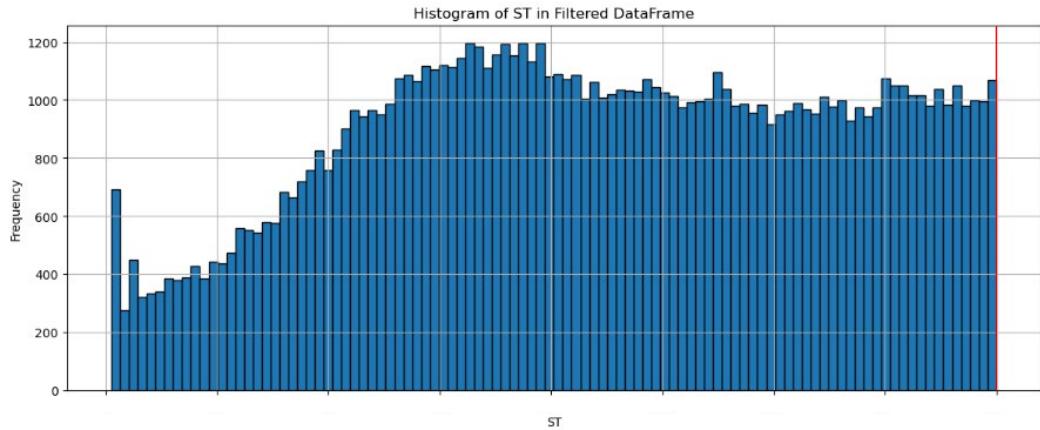
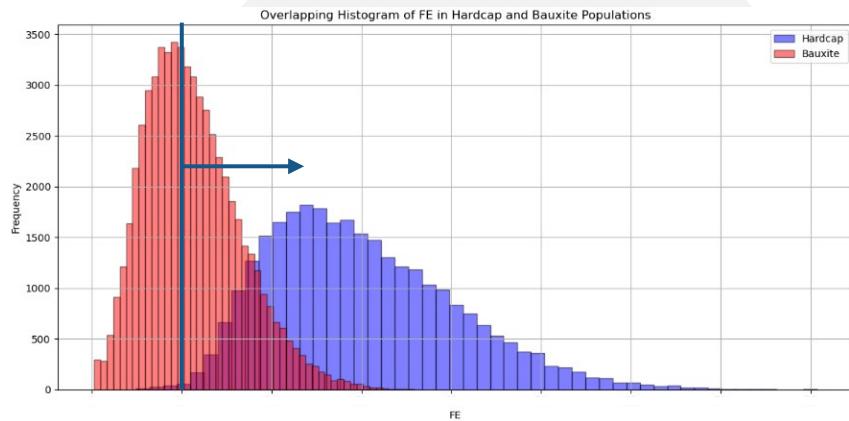
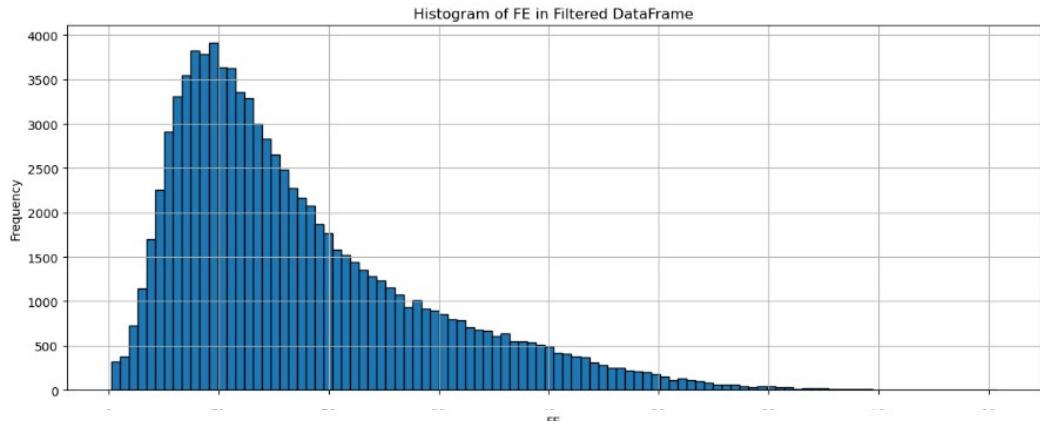


# Merged Larego Granitic Holes: K-means declustering



Filtered Data: Dyke Final = 0, ST < X, Clay Domain Removed

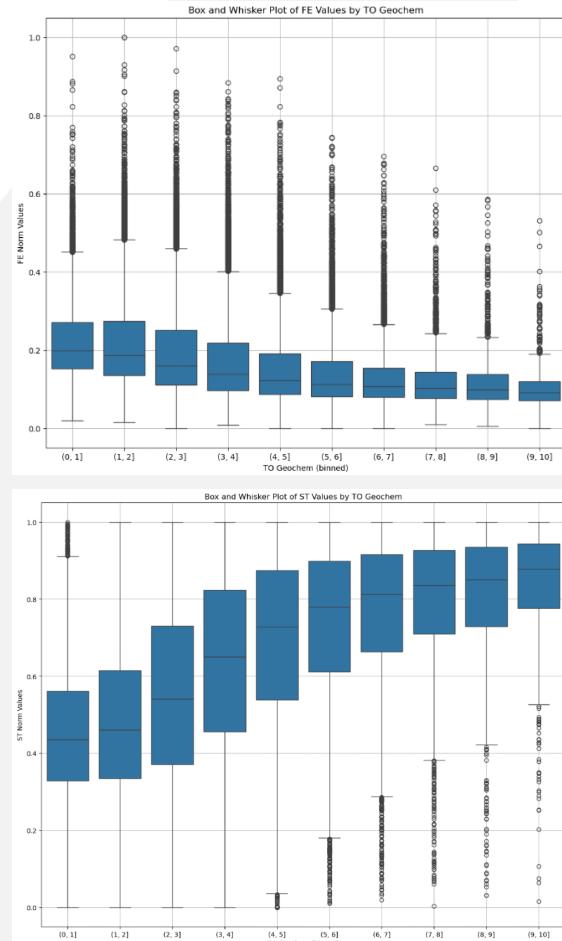
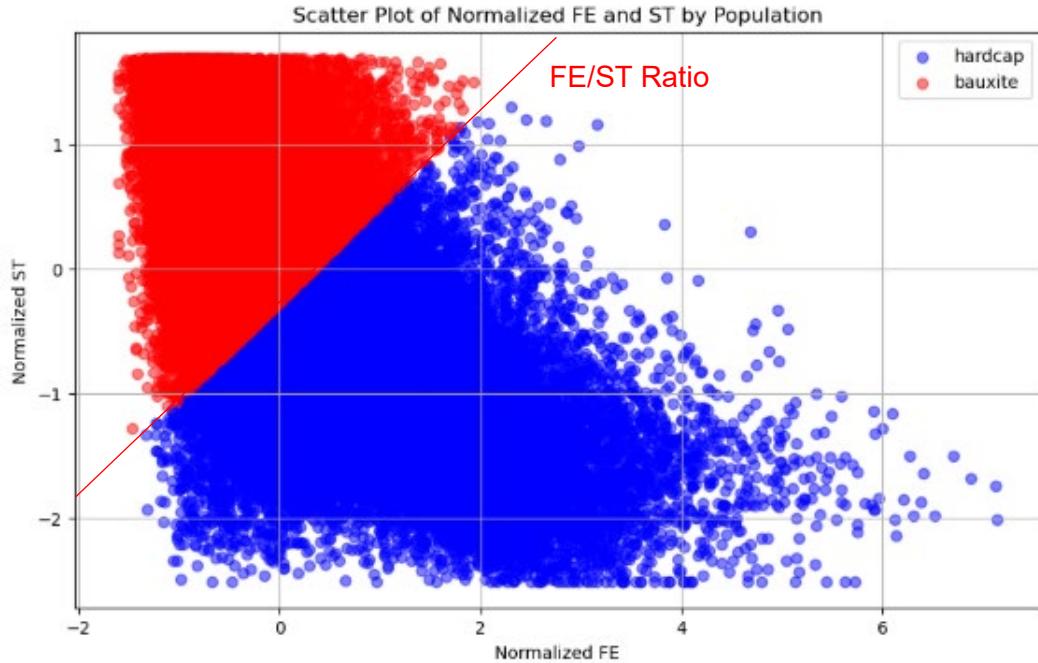
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# Dolerite Coding & Identifying Hardcap samples

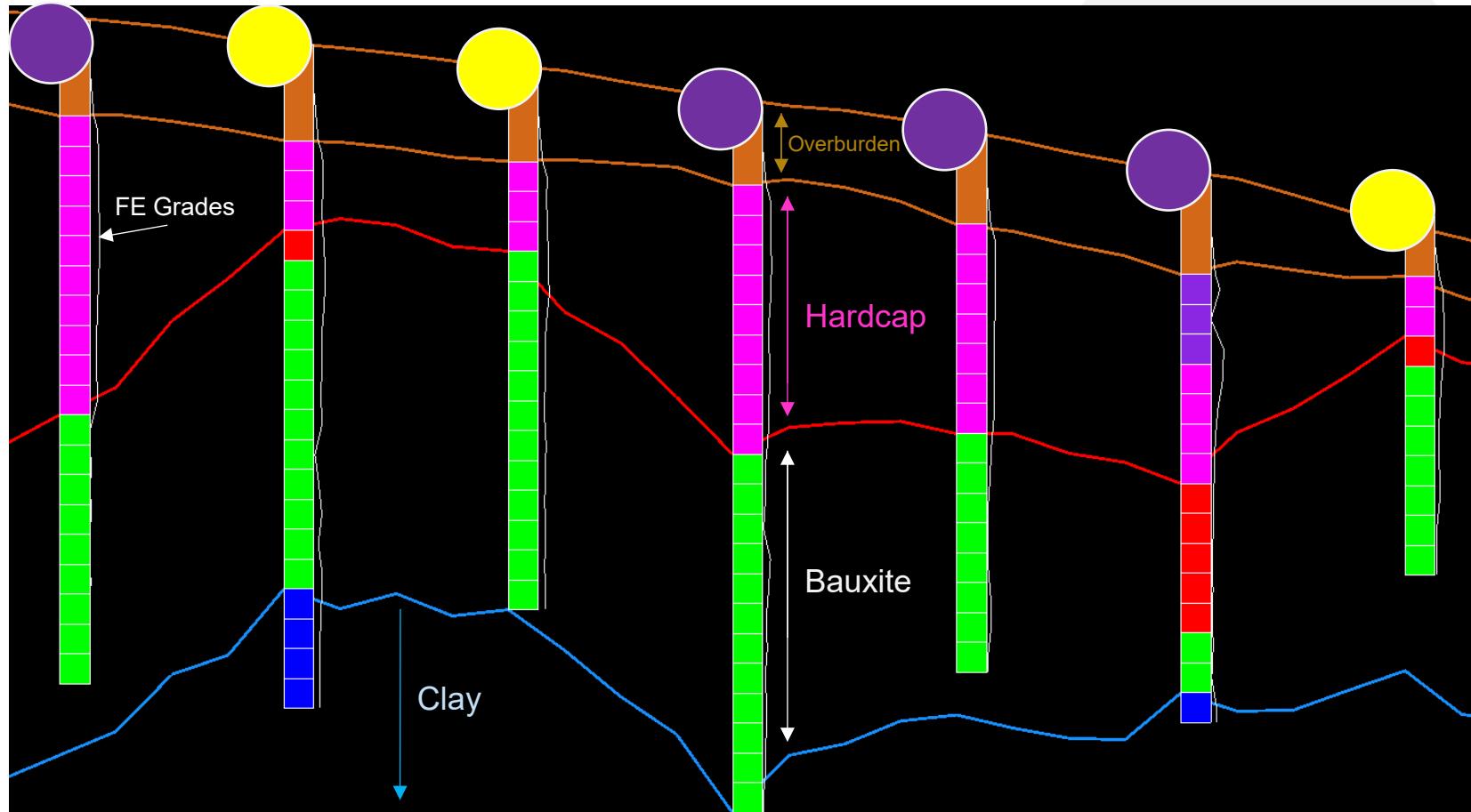
Myara Example from individual sample coding, hole averaging & final definition

- Where they sit in the profile:
  - Inverse relationship between FE/ST & their RL
- FE/ST ratio used within the formula to further identify hardcap samples – Ratio values highest at surface
  - $FE > X \text{ & } ST < Y \text{ & } FE/ST > Z$



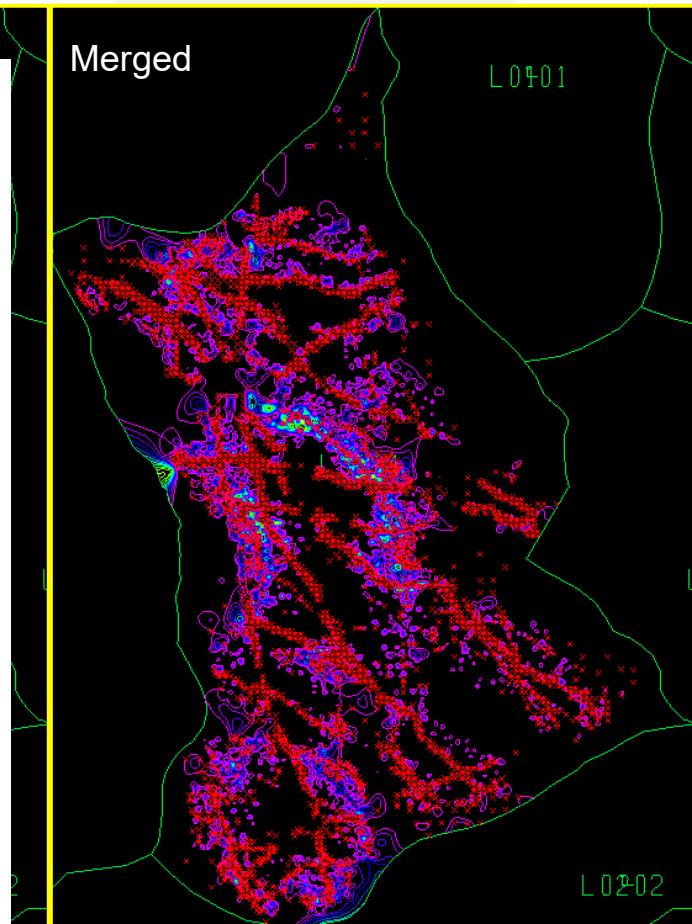
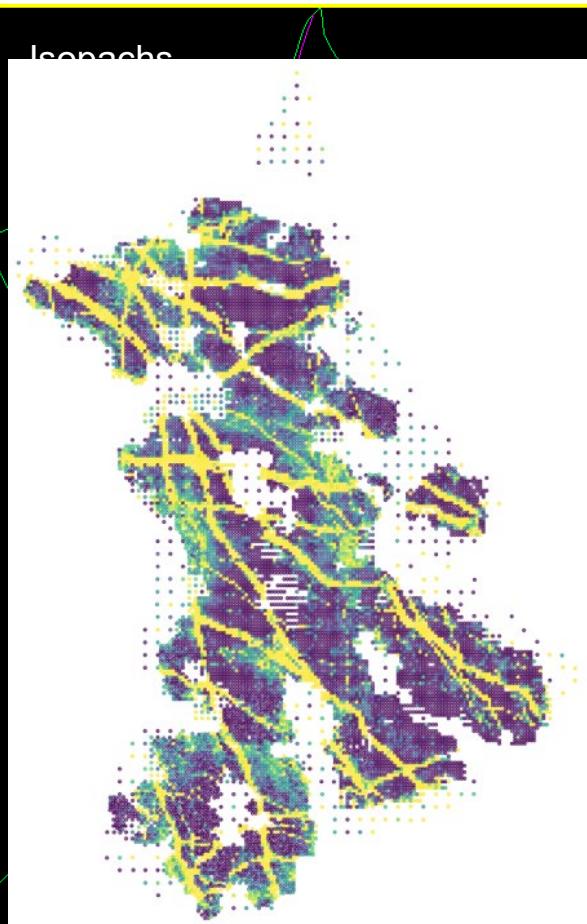
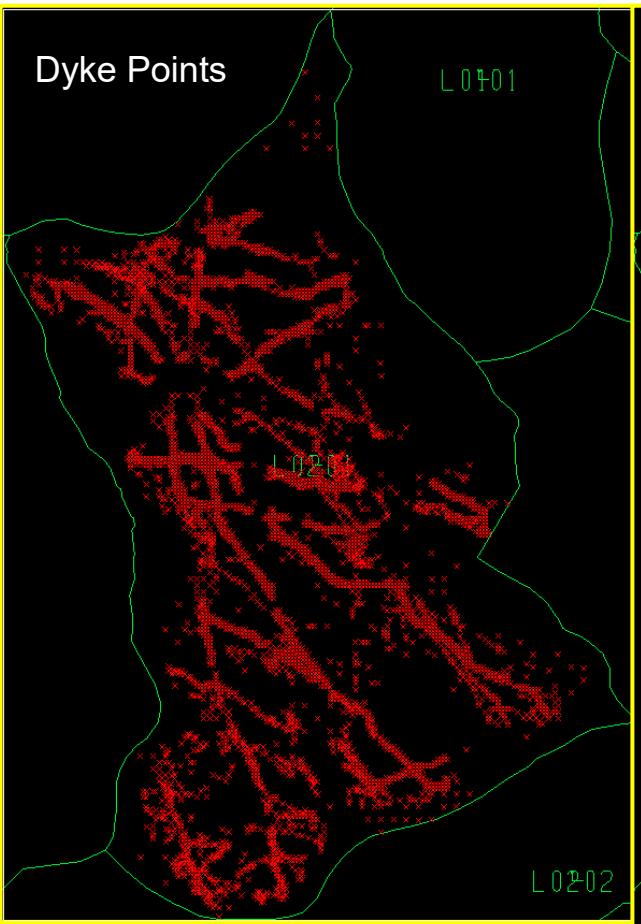
# Cross sections of hardcap vs drillers log

Granite Holes Geochemically defined Hardcap – Dolerite Holes Drillers Log defined Hardcap



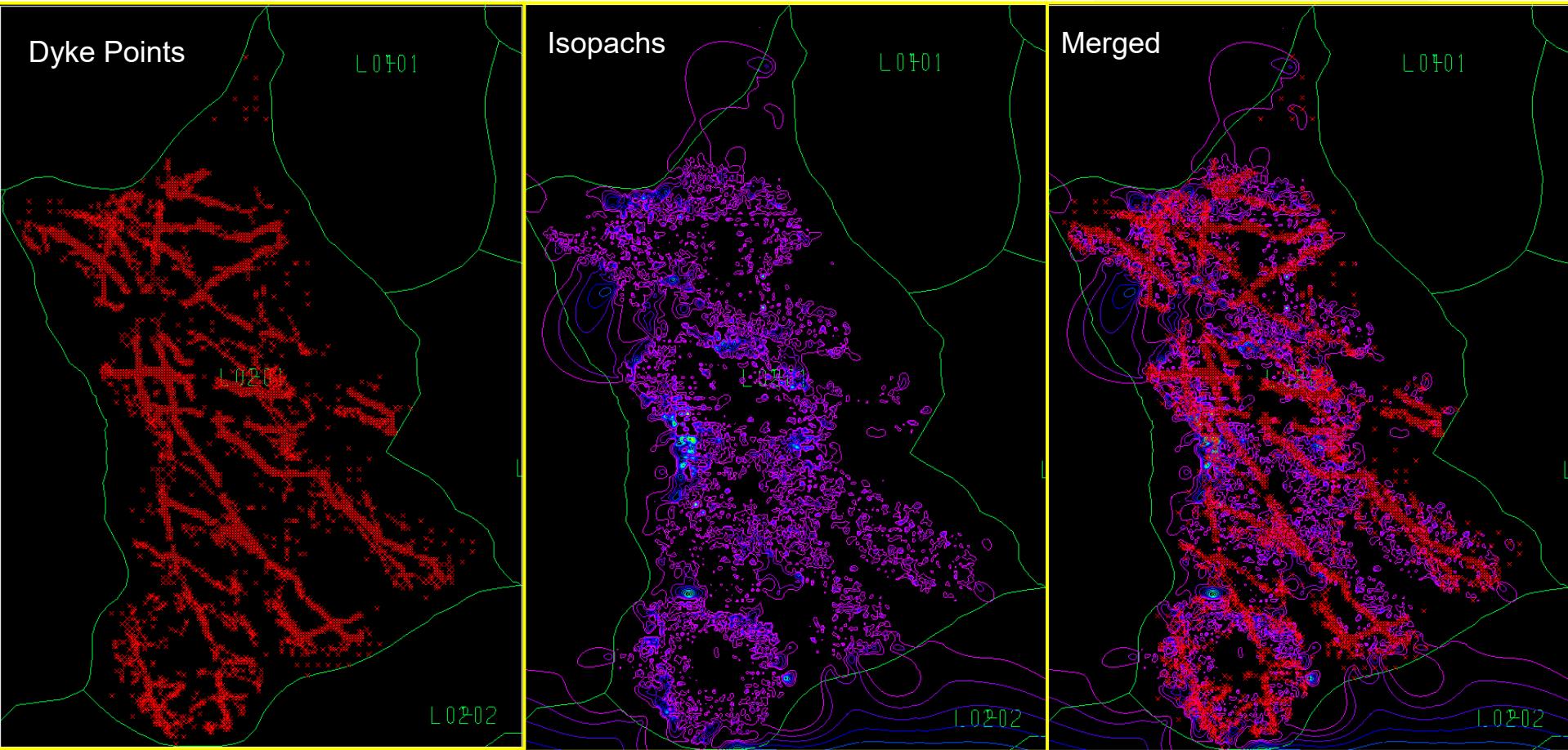
# Isopachs vs Dykes

Hardcap Thickness to Dykes – Geochemical Modelling



# Isopachs vs Dykes – Drillers Logged

Drillers Logged Base Overburden to base of Hardcap



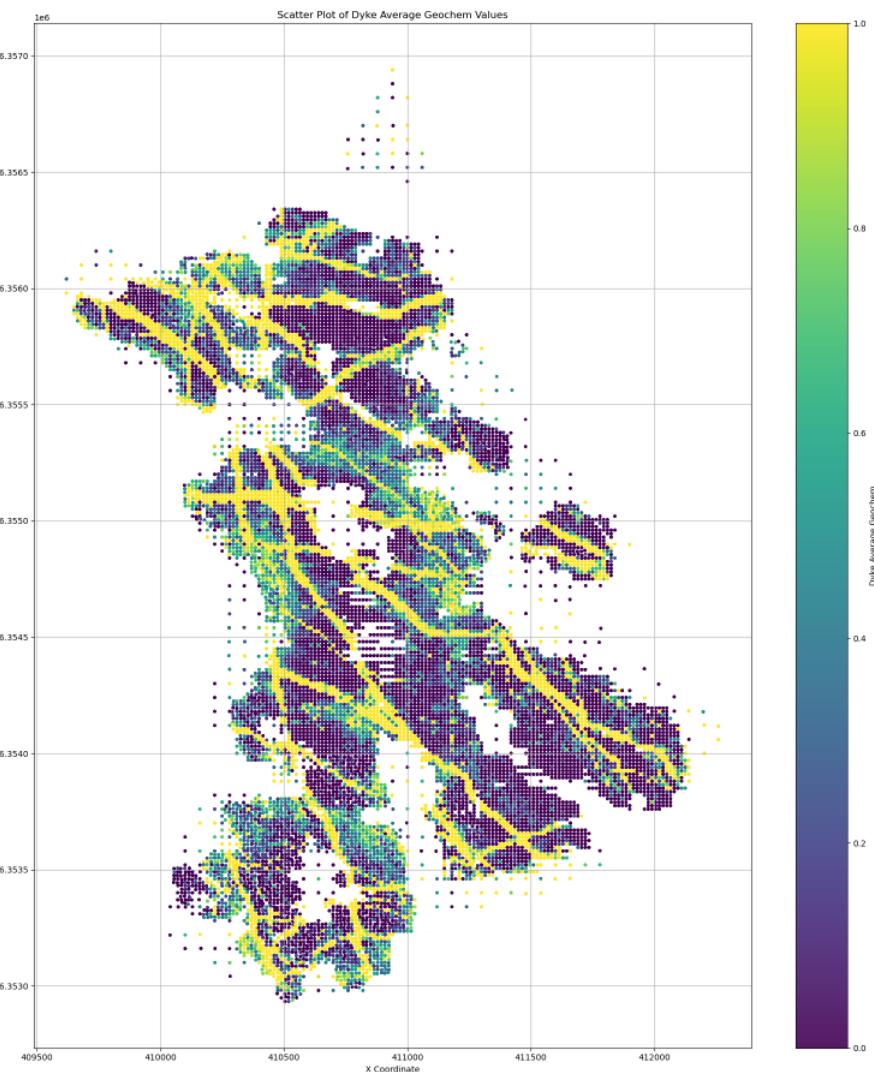
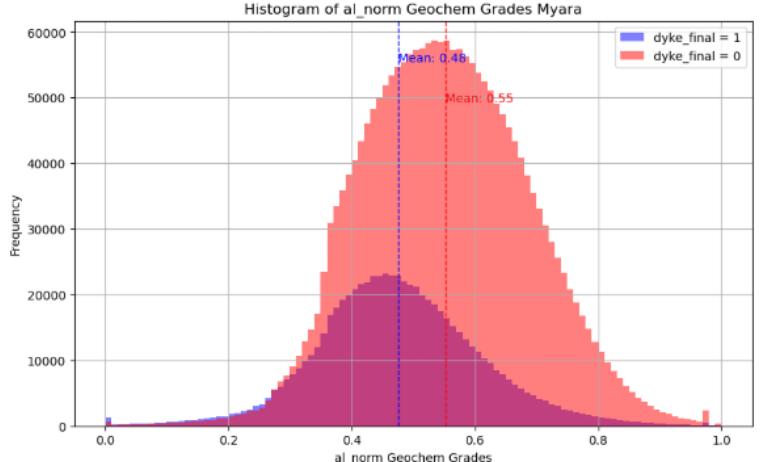
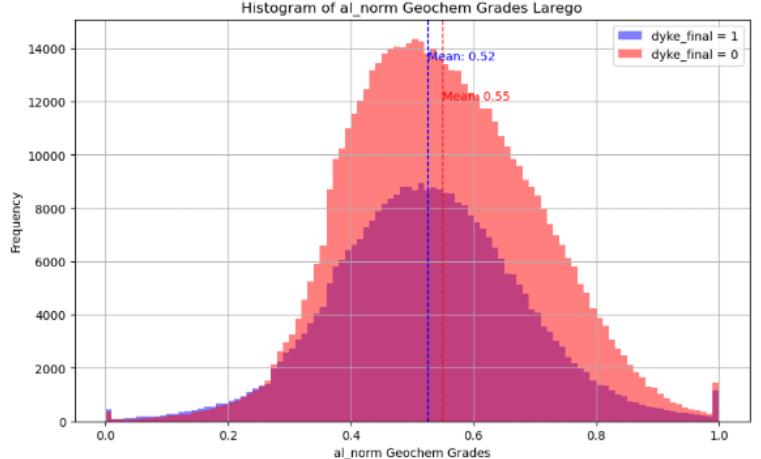
# Estimation Impacts

Geological differentiation of Alumina variability



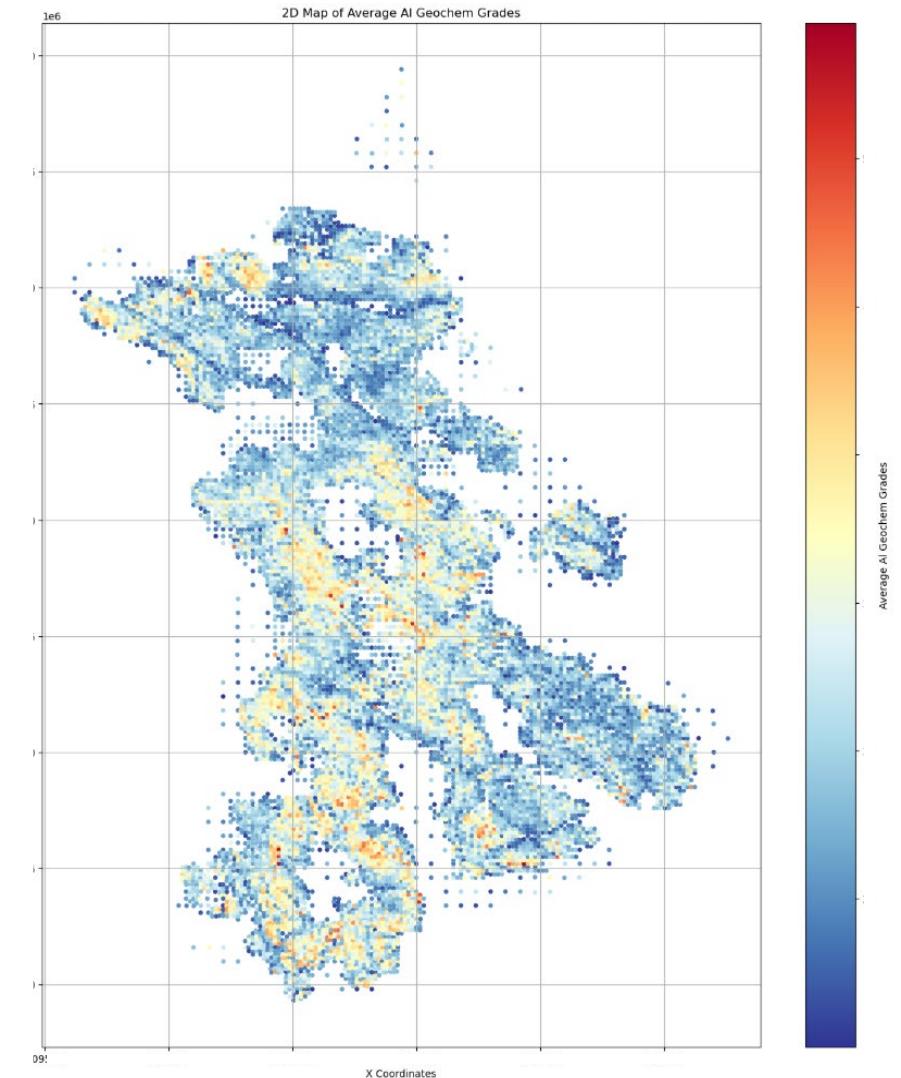
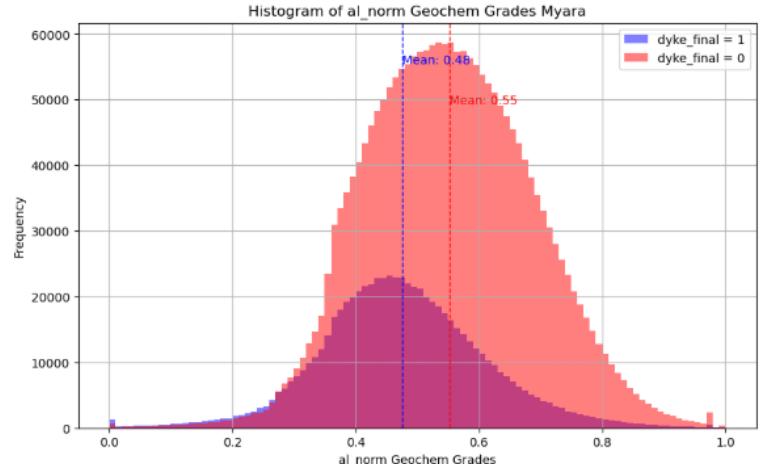
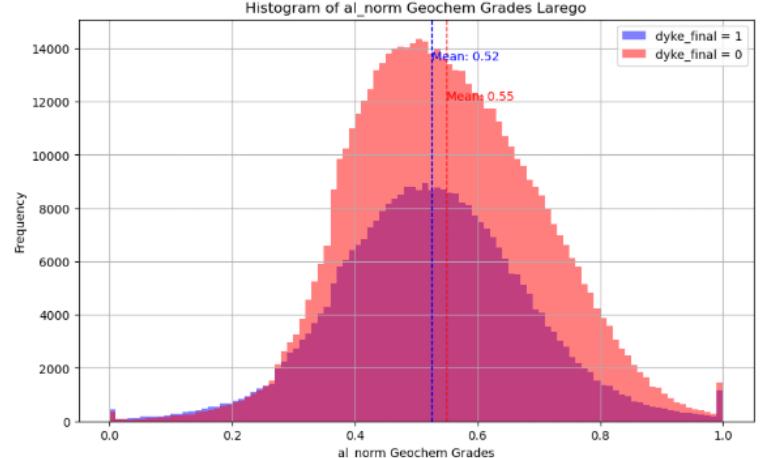
# Bauxite Estimation Impacts – Larego

Doleritic and Hardcap relationships with Alumina Grade: Histogram & Map showing AI values where Clay is filtered out



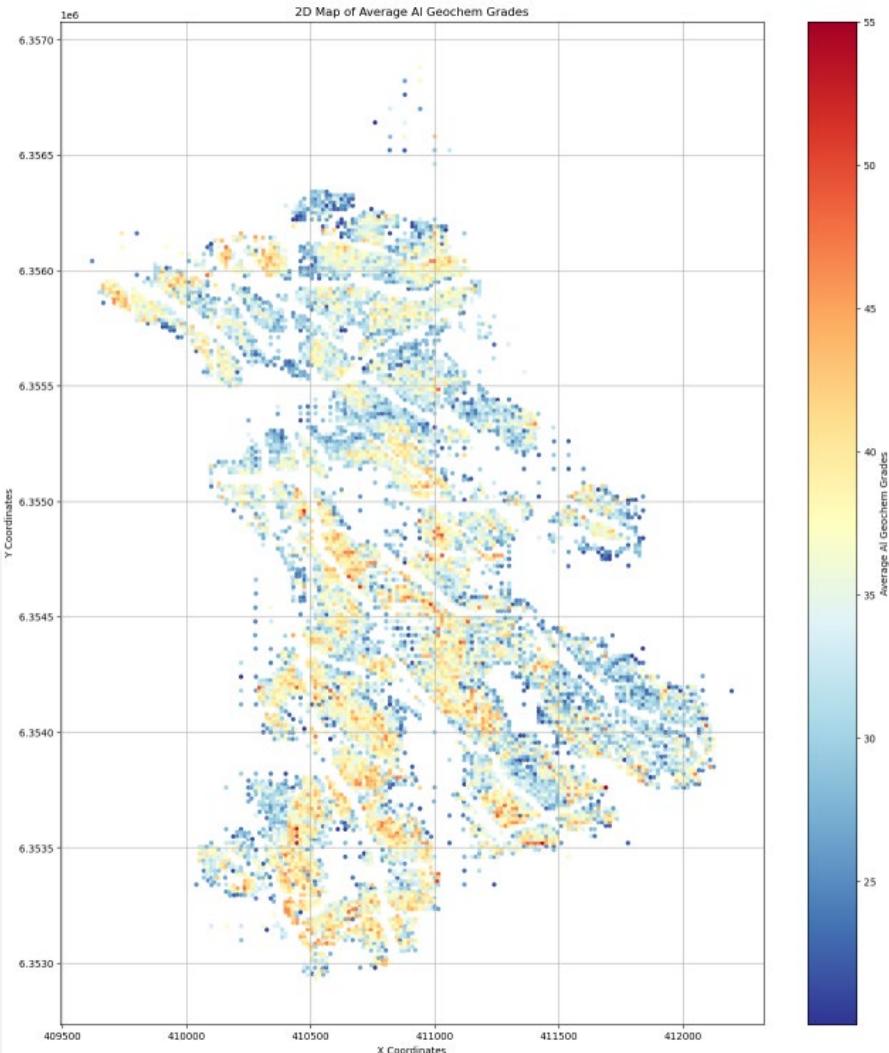
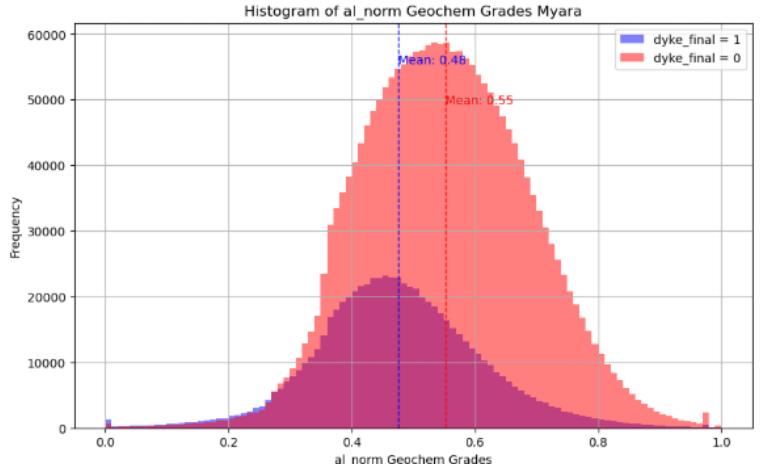
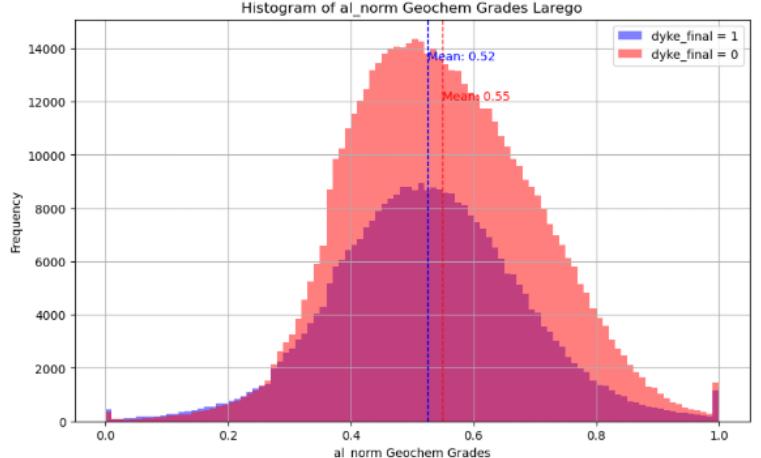
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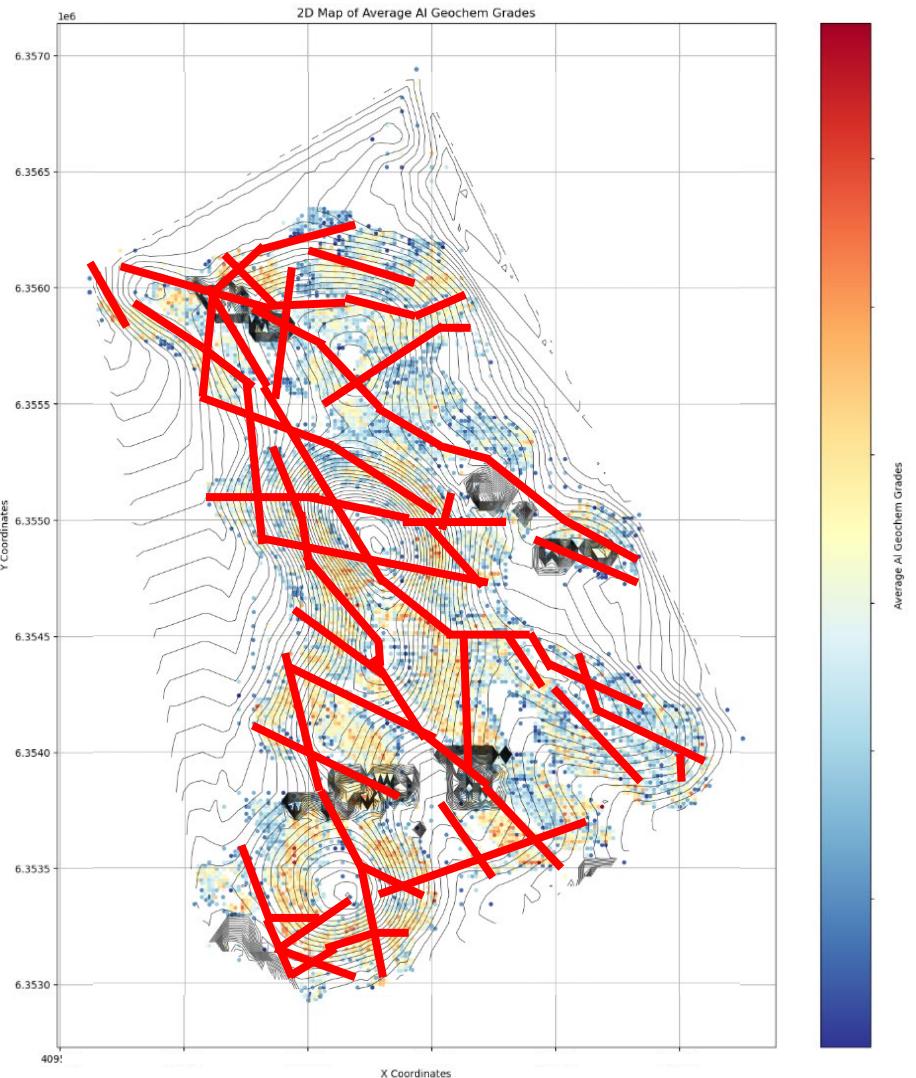
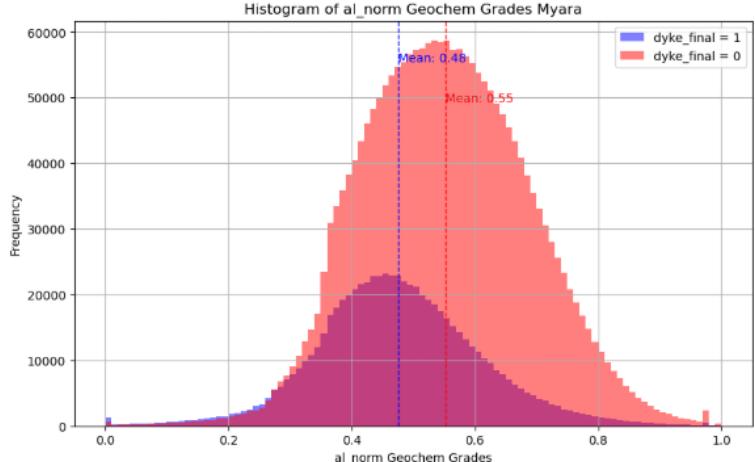
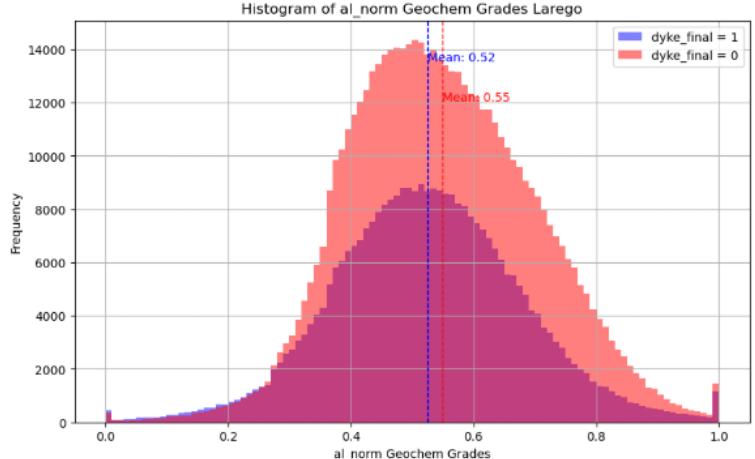
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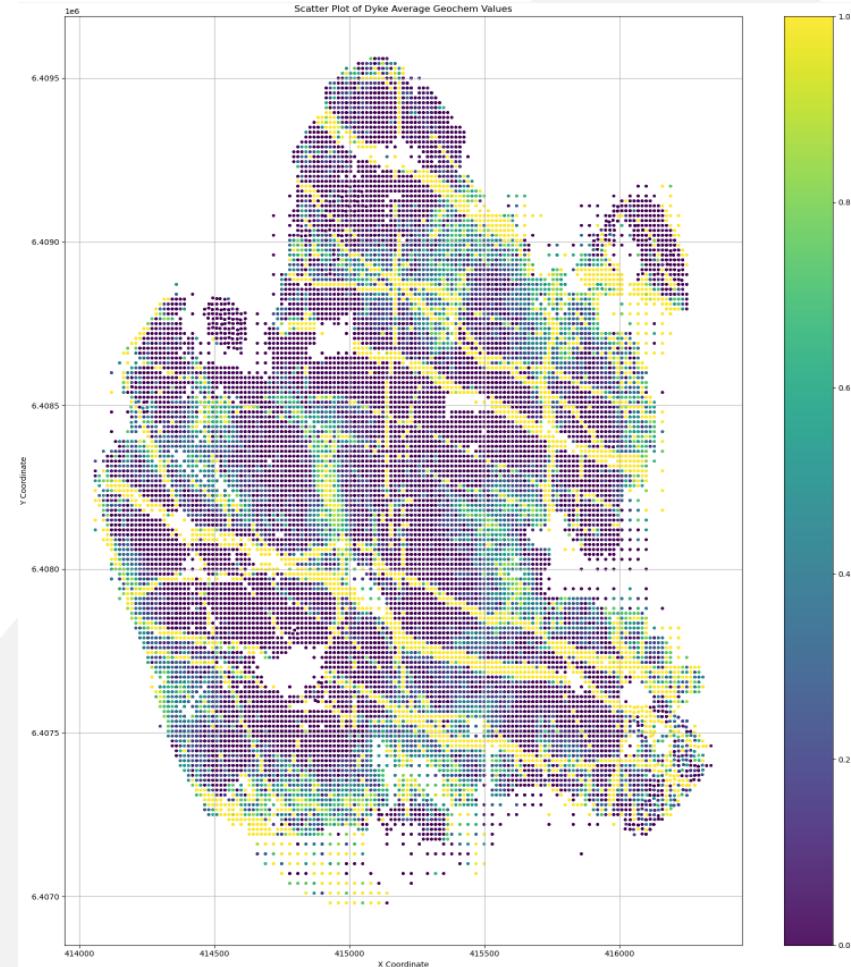
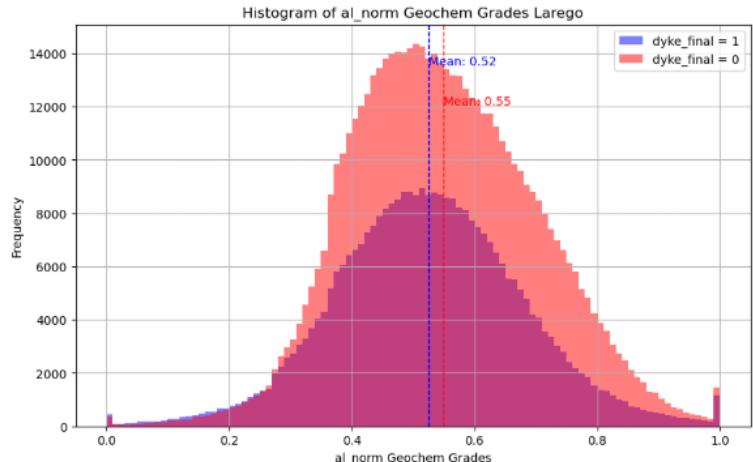
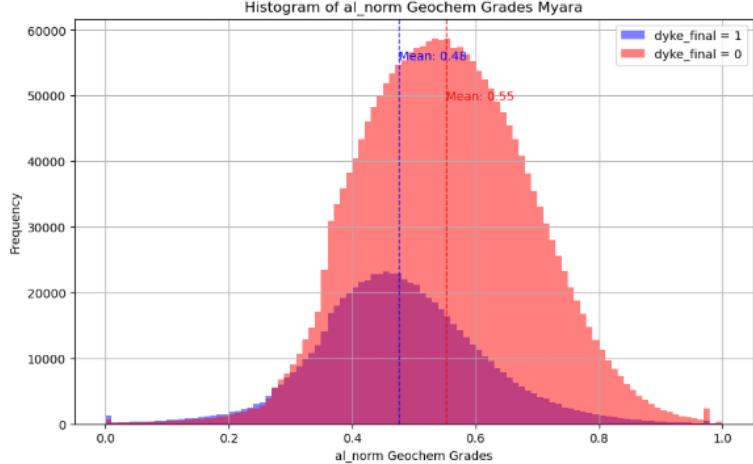
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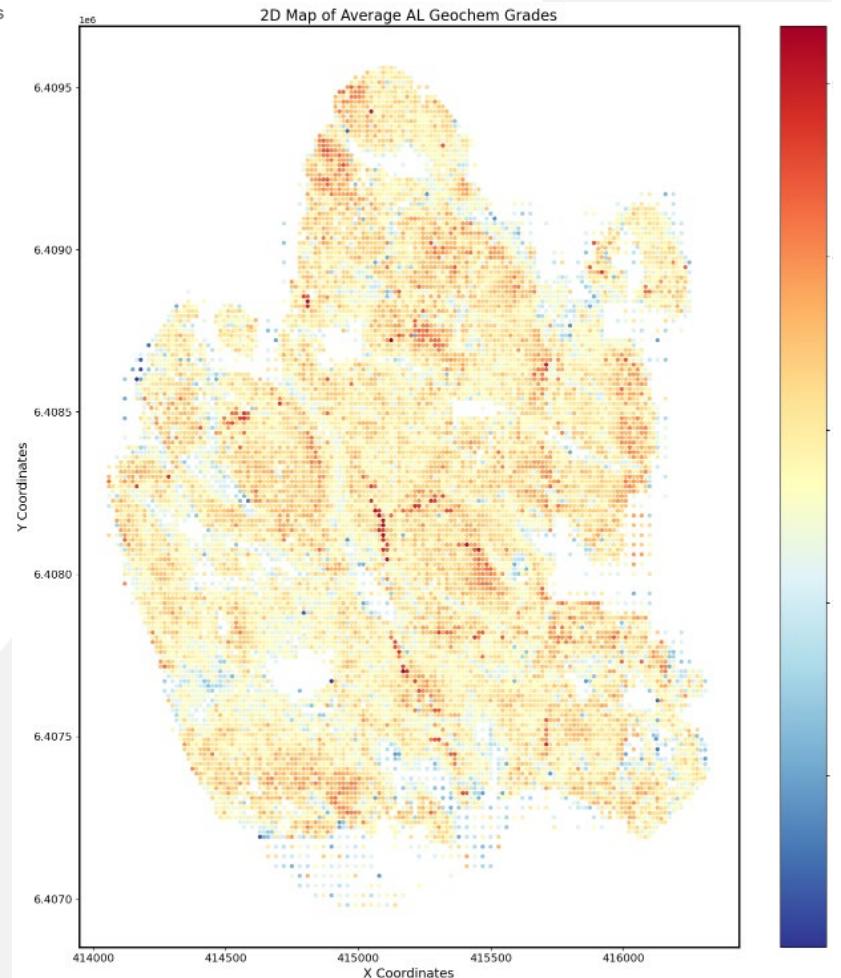
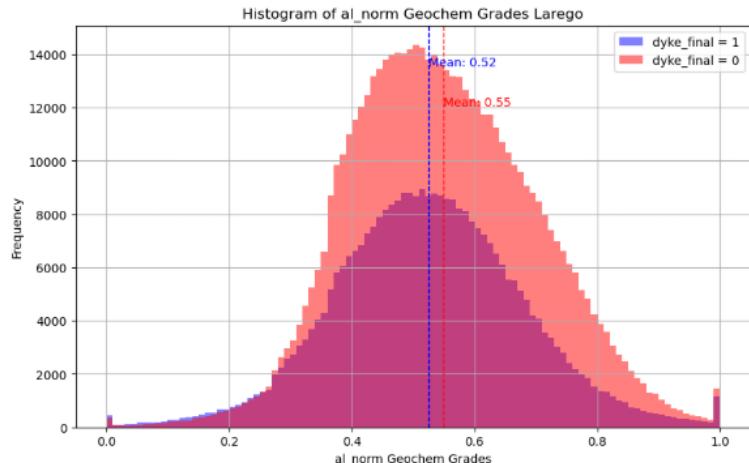
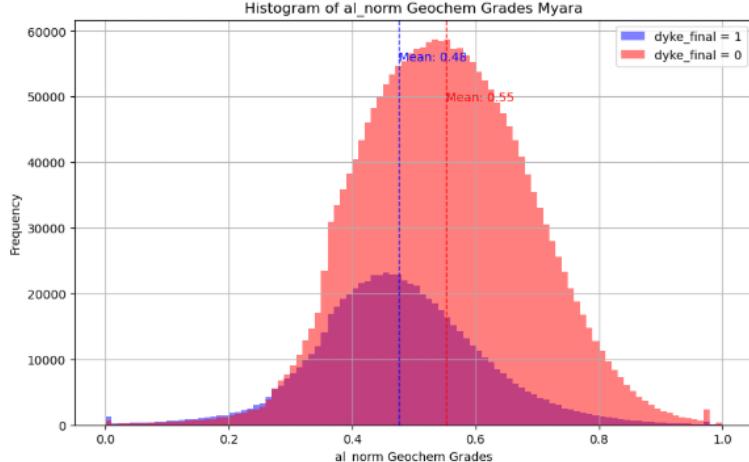
# Bauxite Estimation Impacts – Myara

Doleritic and Hardcap relationships with Alumina Grade: Histogram & Map showing AI values where Clay is filtered out



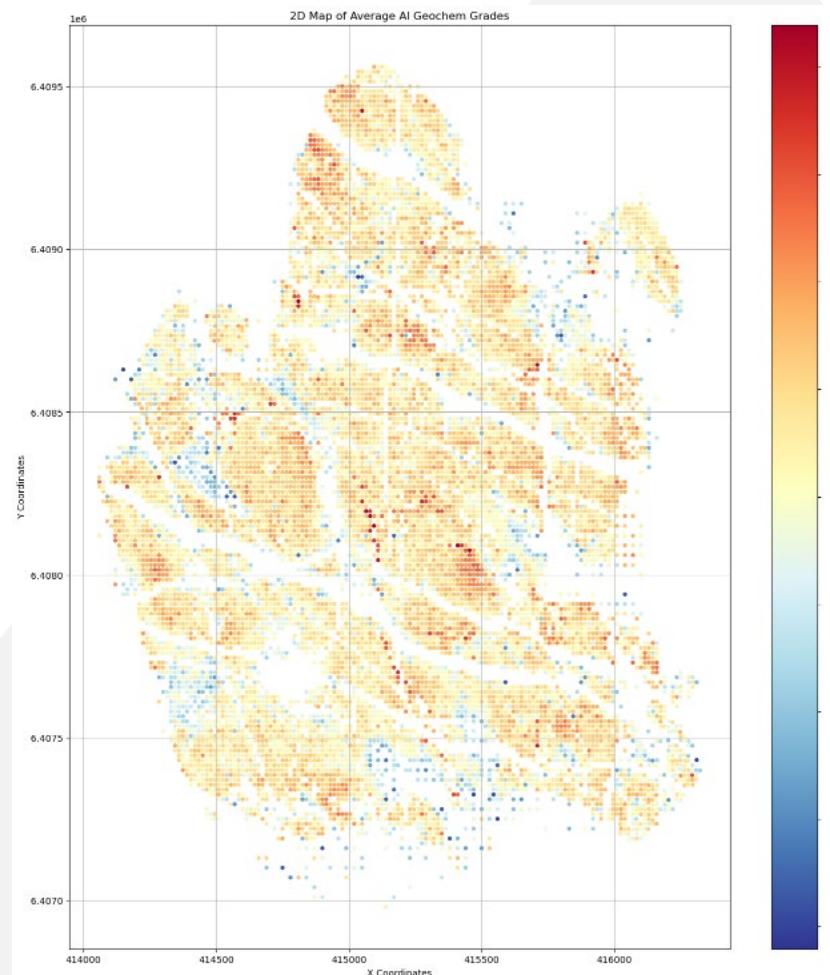
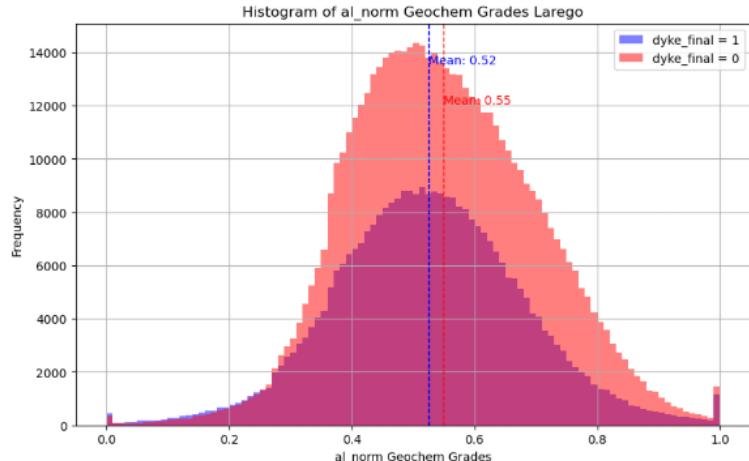
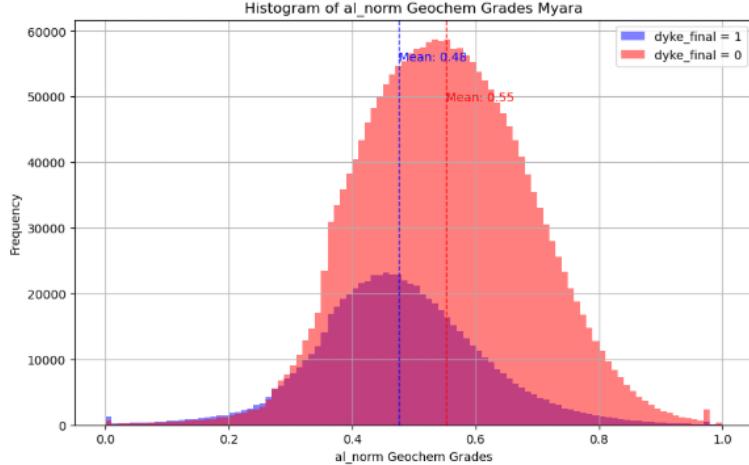
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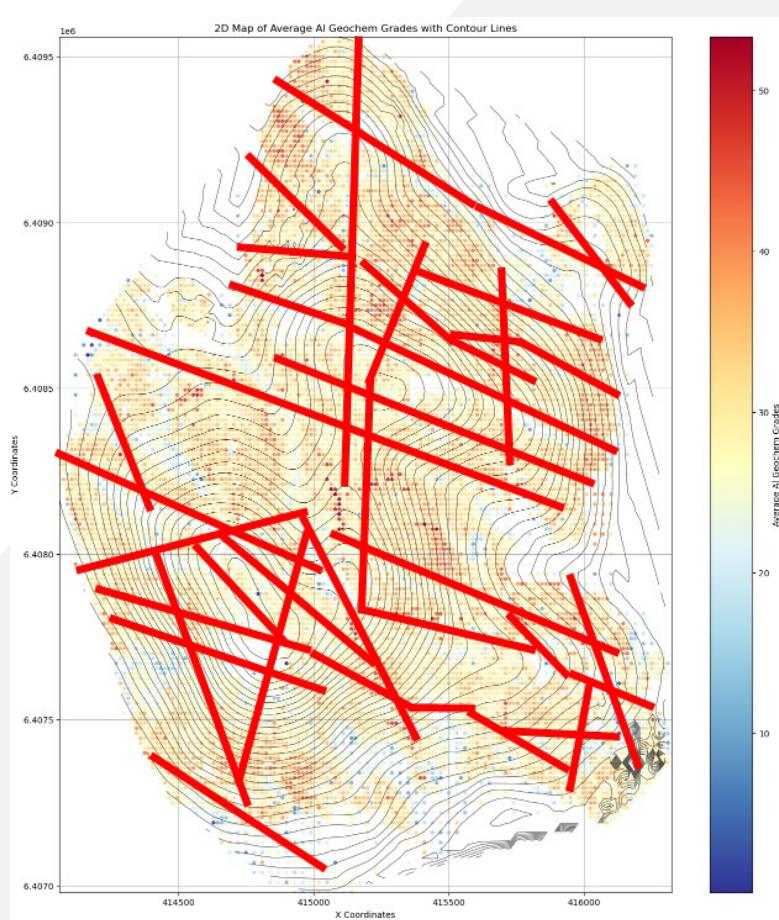
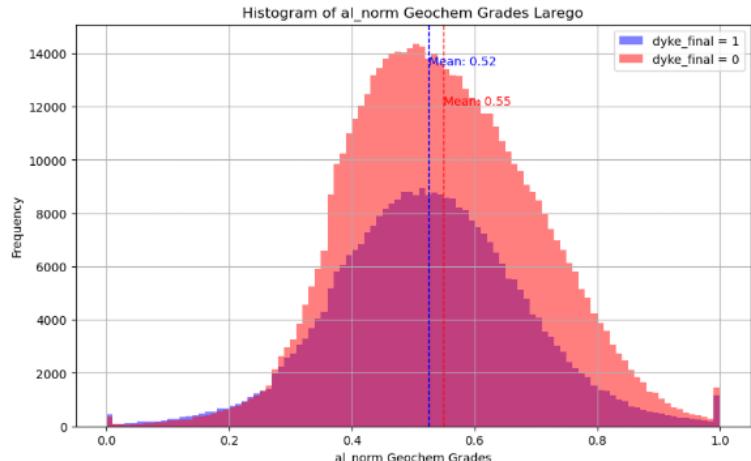
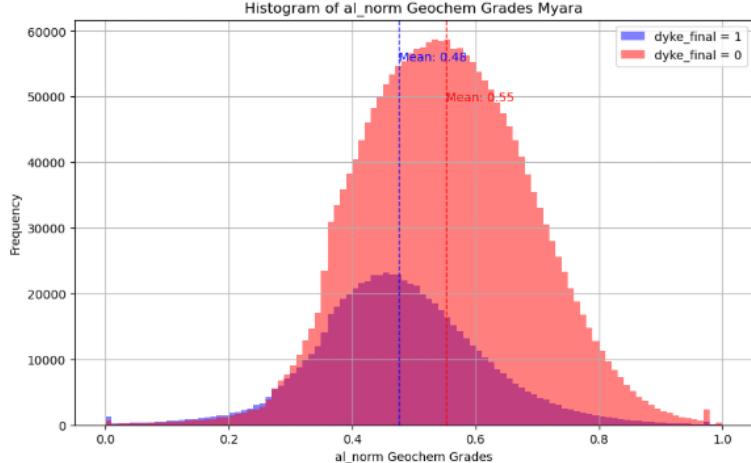
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Doleritic and Hardcap relationships with Alumina Grade: Histogram & Map showing AI values where Clay is filtered out



# Thank you Questions



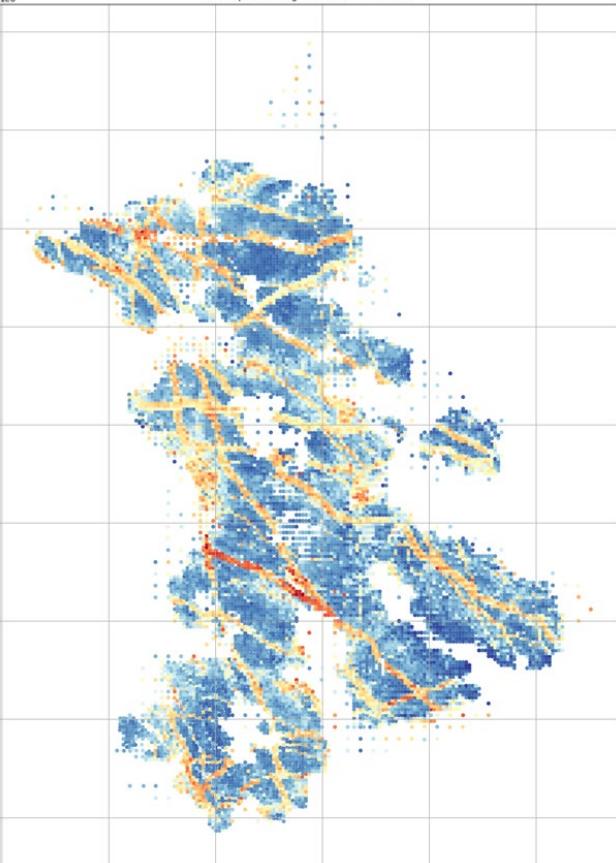
**Slides below are  
supplementary if  
required to show**



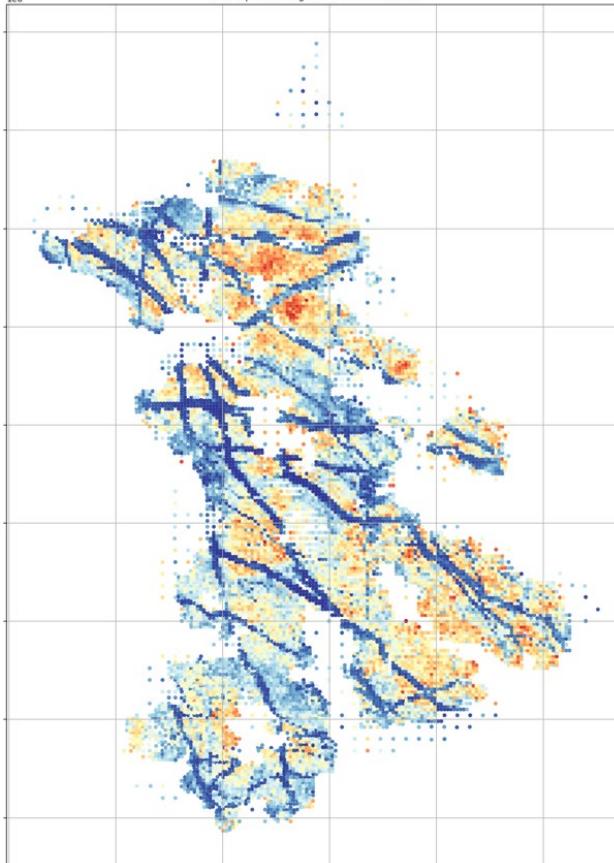
# Downhole Grade Averages



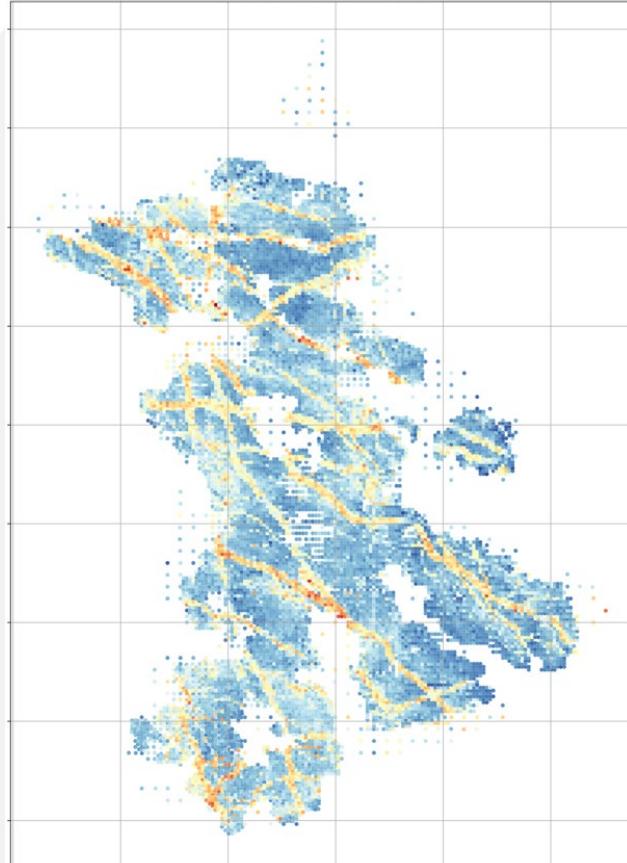
2D Map of Average FE Geochem Grades



2D Map of Average ST Geochem Grades

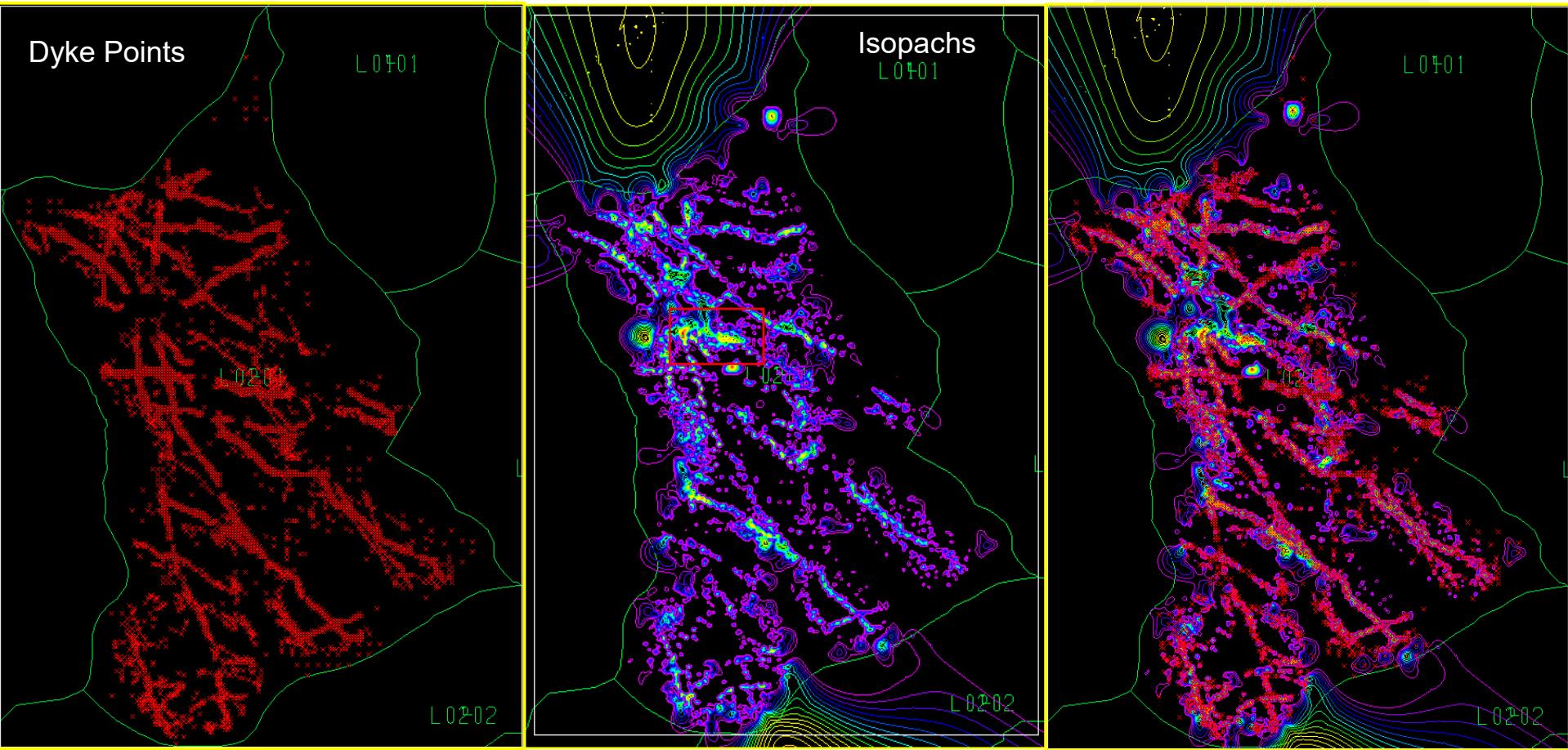


2D Map of Average SU Geochem Grades



# Isopachs vs Dykes

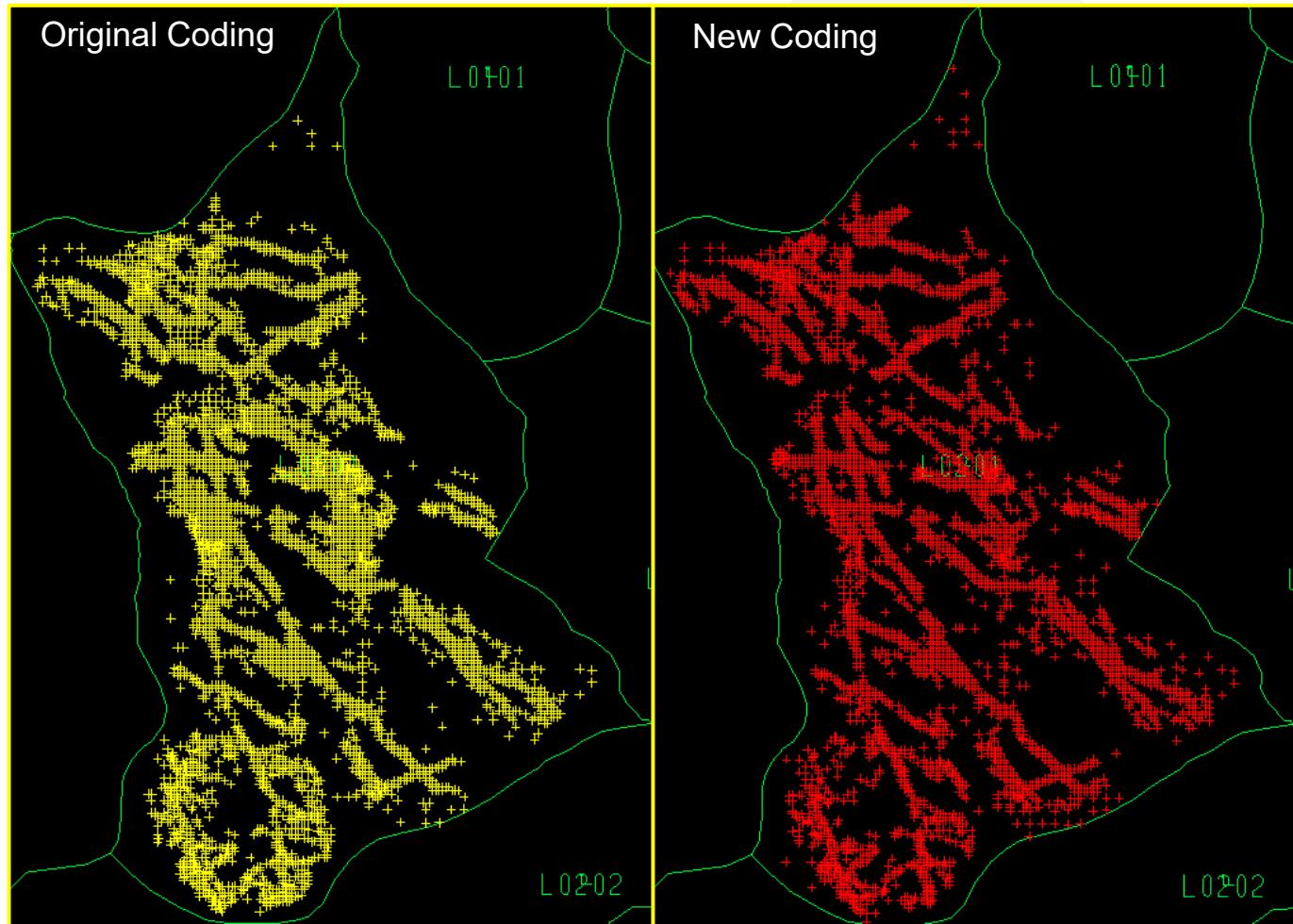
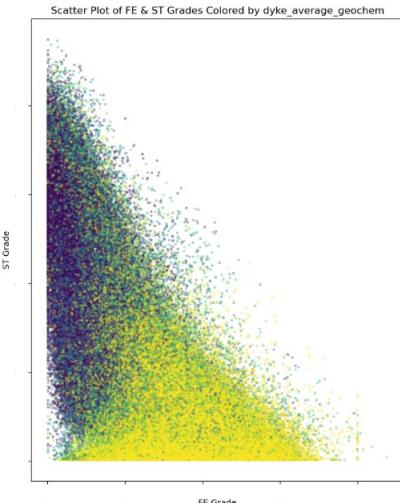
Original Combined Hardcap Thickness compared to New Dolerite Coding



# L0201 Dyke Flagging

## Prior Coding vs New:

- Updated definition of Dolerite Dyke flagging
- Clearer delineation of linear features
- Some presence of non-linear 'random' samples
  - Under-drilling can result in flagging of dolerite if top of hole is iron enriched
  - Drillhole doesn't

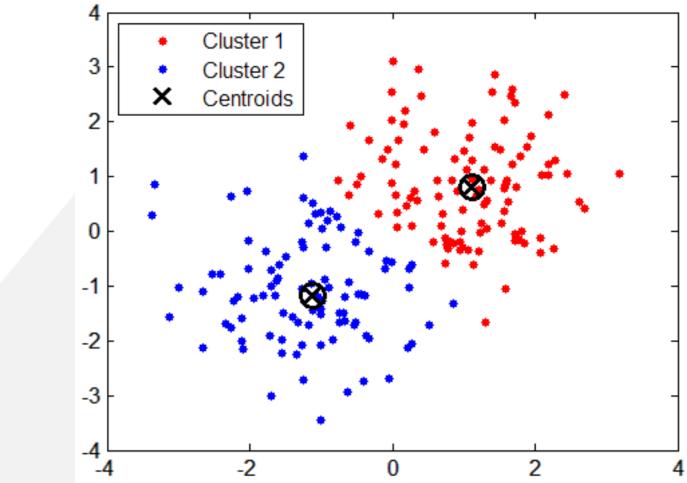


# K-means Sum of Squares Declustering Formula

number of clusters      number of cases  
case  $i$       centroid for cluster  $j$

objective function  $\leftarrow J = \sum_{j=1}^k \sum_{i=1}^n \|x_i^{(j)} - c_j\|^2$

Distance function

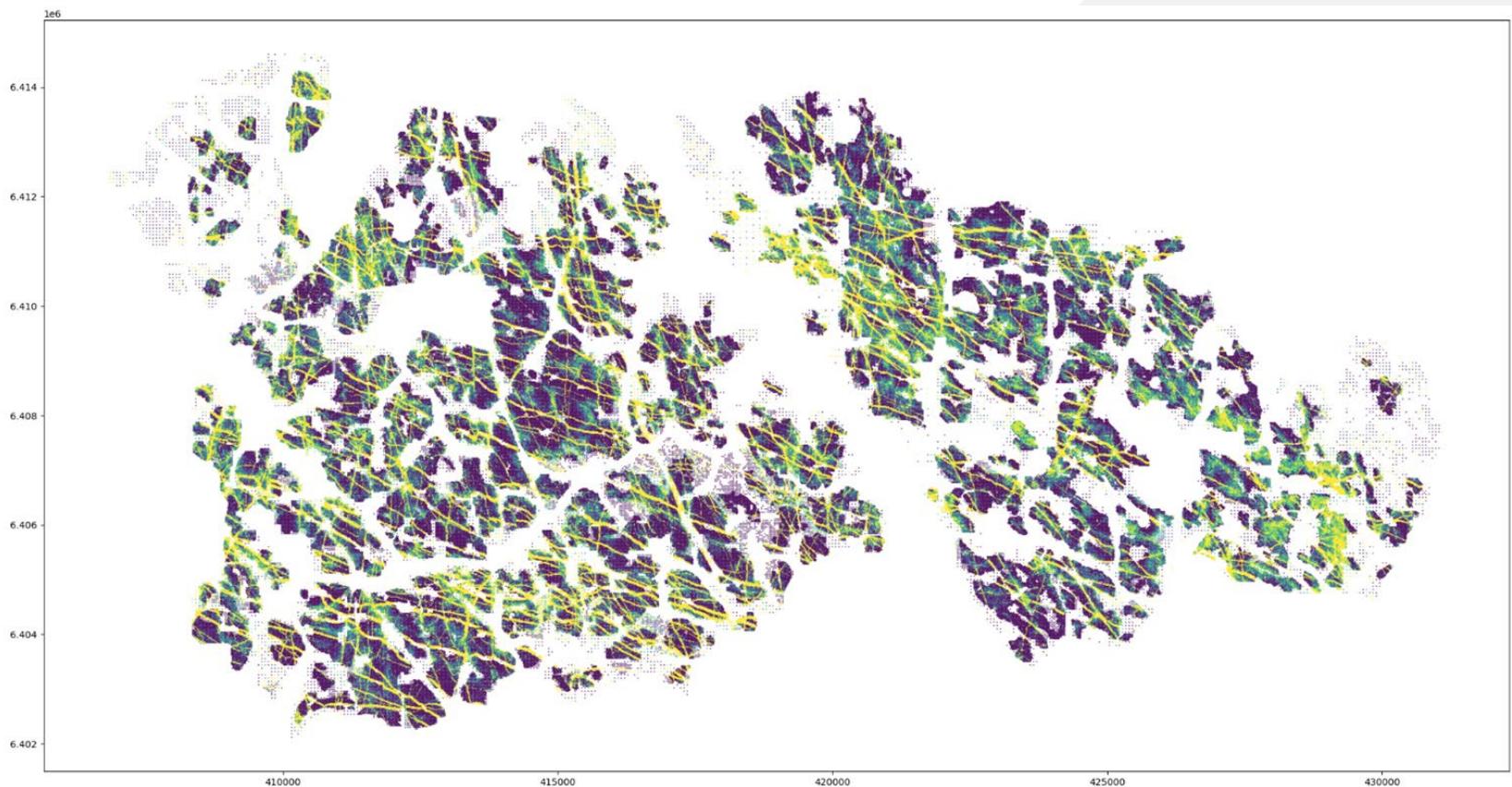


- Using Supervisor – We can skip repetition of these steps to find convergence values
- Means can be estimated accurately using Bimodal distributions histogram peaks
- Peak of bimodal bellcurves are used as final values

Square root of  
$$[((\text{Fe Assay} - \text{Fe population 1 mean})^2) + ((\text{Fe Assay} - \text{ST population 1 mean})^2) + ((\text{Fe Assay} - \text{SU population 1 mean})^2)]$$

Square root of  
$$[((\text{Fe Assay} - \text{Fe population 2 mean})^2) + ((\text{Fe Assay} - \text{ST population 2 mean})^2) + ((\text{Fe Assay} - \text{SU population 2 mean})^2)]$$

# Myara Dyke Final Drillhole Map



# Myara Dyke Final Drillhole Map

