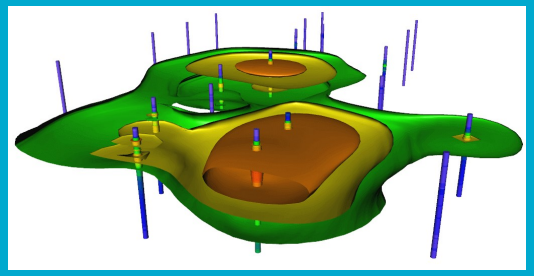


CSIRO Discovery
Innovation in data utilisation:
Automated domaining of multivariate gamma and geochemistry data for rapid drill hole logging

MINERAL RESOURCES
www.csiro.au

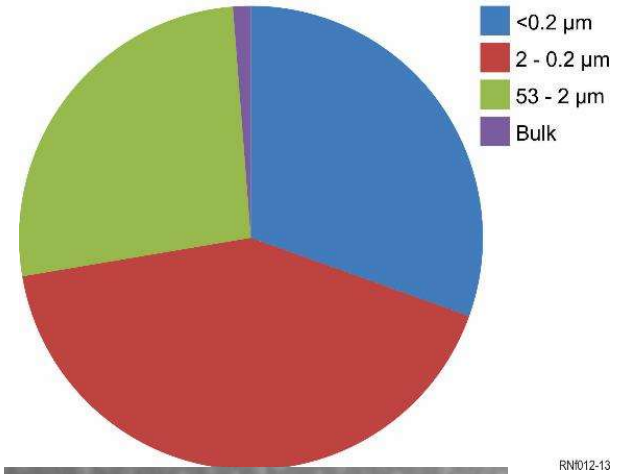
Alex Otto

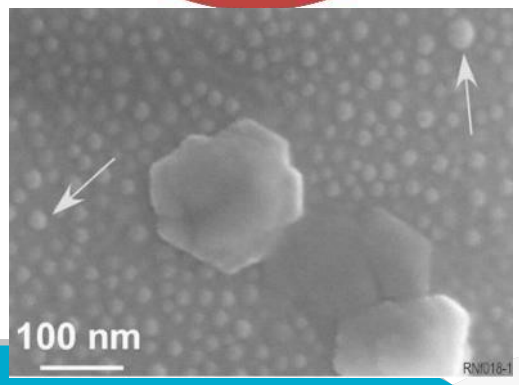
Discovery program

Exploration through cover

- M462 - Multi-scaled near surface exploration using ultrafine soils

Mineral	Diameter (µm)	Surface/exchange area (m^2/g)
Sand	50-2000	0.04
Silt	2-50	0.1
Clays	**< 2**	**5 - 800**



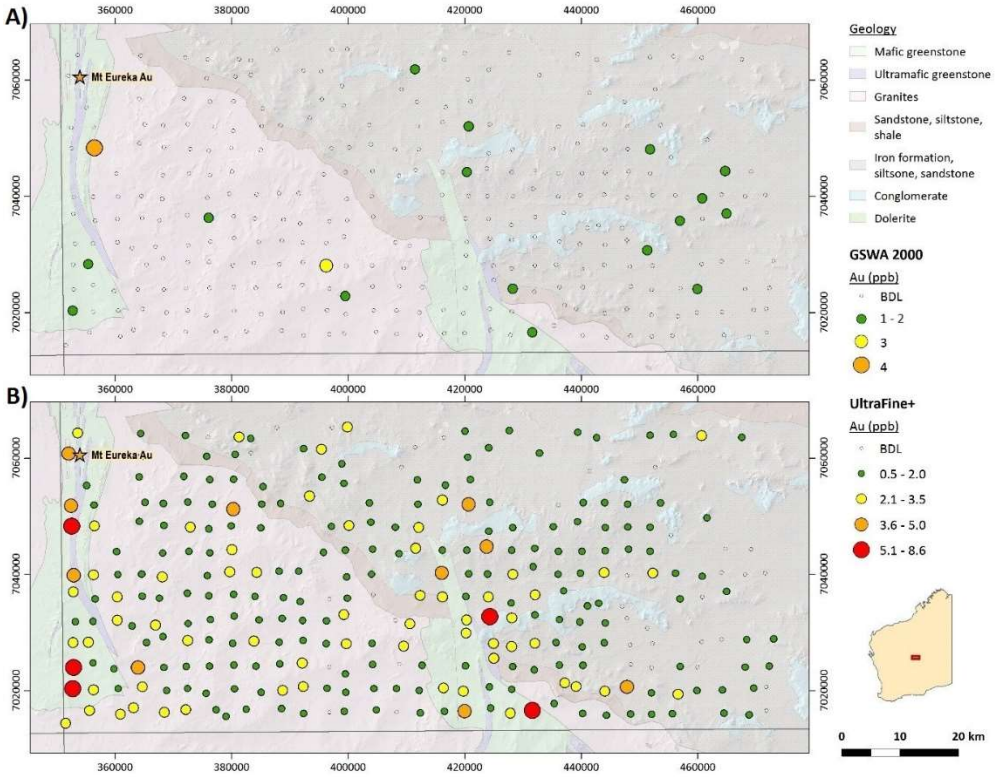


Benefits of fine fraction concentration

- Enhance concentrations from dune sands to 10s ppb
- More reproducible/reliable
- Big upside for detection, reproducibility and exploring through cover for subtle Au, Cu, Zn signatures

soils commercialised workflow

- A) Original sampling and analysis by GSWA (2000)
  - <180 µm/80 mesh, milled. 18 of 300 with Au
- B) Same samples using UltraFine+
- Additional spectral and physical properties
- *Future will be Machine learning/uncertainty maps for industry at a click of a button to come*

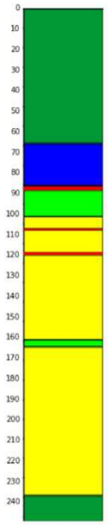


Current Practice:

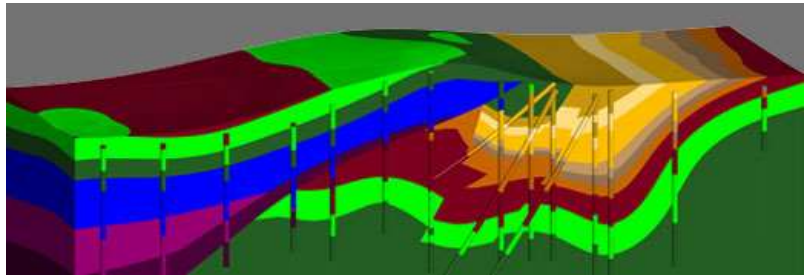
Traditional methods of building a 3D model from drill core:

- **subjective**

visual core logging



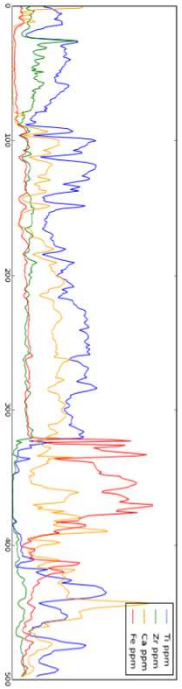
geology model



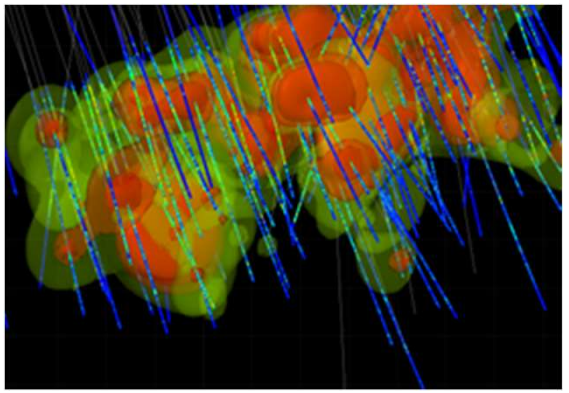
Current Practice:

collect numerical data:

- non-subjective



but 3D models of numerical data have limited geological meaning



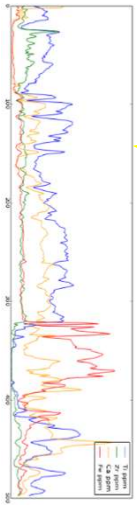
isosurface “blob model”

What We Want:

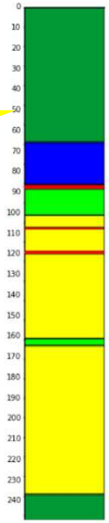
- integrated data
- categorical labels
- meaningful geological boundaries

numerical data:

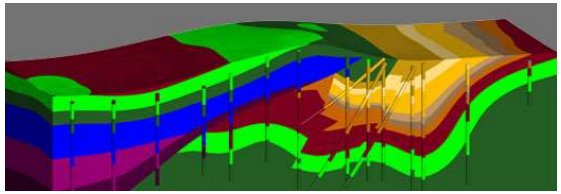
- non-subjective



Automated methods



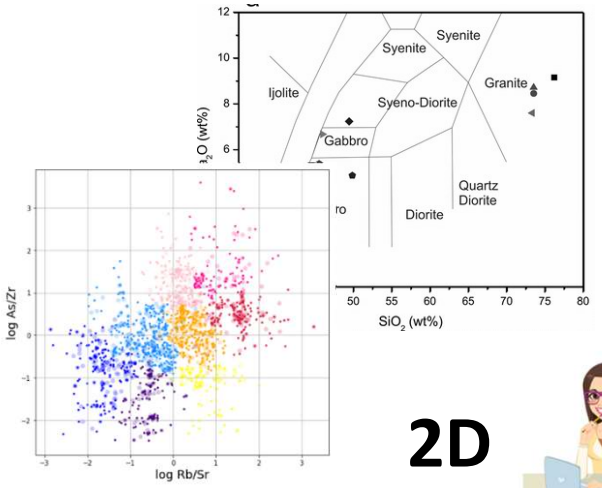
geology model



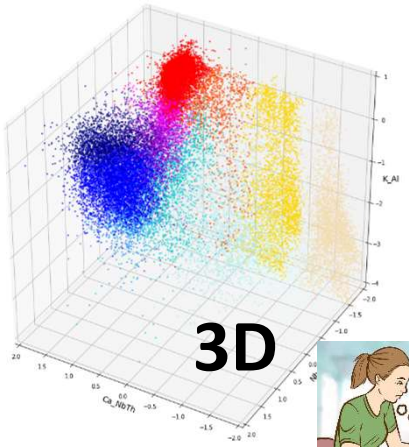
Can we use machine learning for classifying samples as rock types?

What Is Machine Learning?

A very powerful method for analysing and classifying samples when there are lots of variables (i.e. high dimensional data)



2D



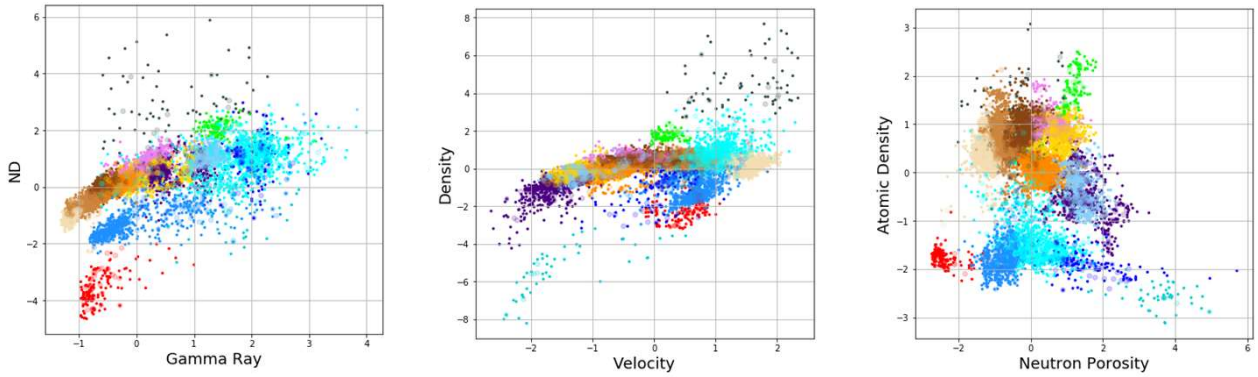
3D

higher dimensions

Unsupervised Machine Learning

Data exploration - I don't know how I want to divide my data up into classes, I need some ideas ⇨ "Clustering"

Try 15 clusters

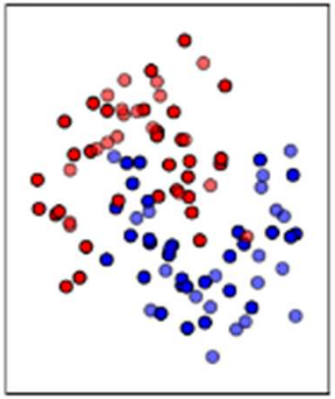


Supervised Machine Learning

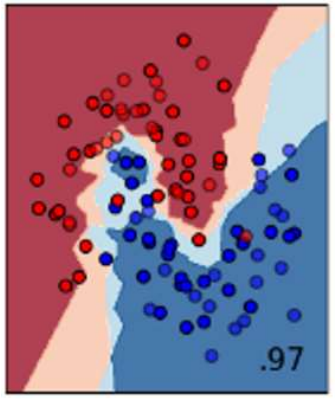
I have some labelled data I can use to train a classifier.

Algorithm will segment the space up into class regions.

input data



nearest neighbours

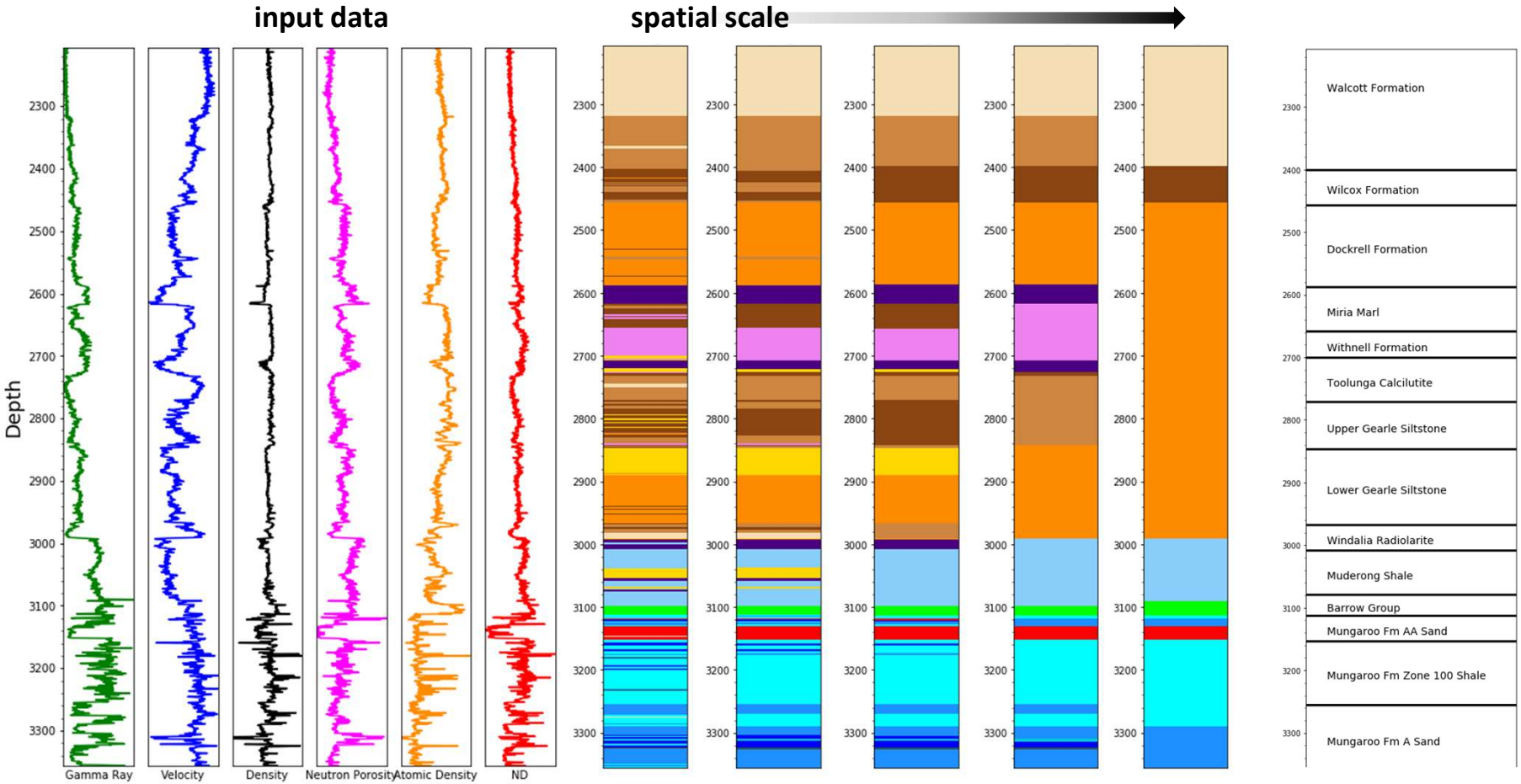


plot from : scikit-learn

Incorporating spatial information is important

But at what scale?

What if you could apply classification at any spatial scale with accurate boundary locations?

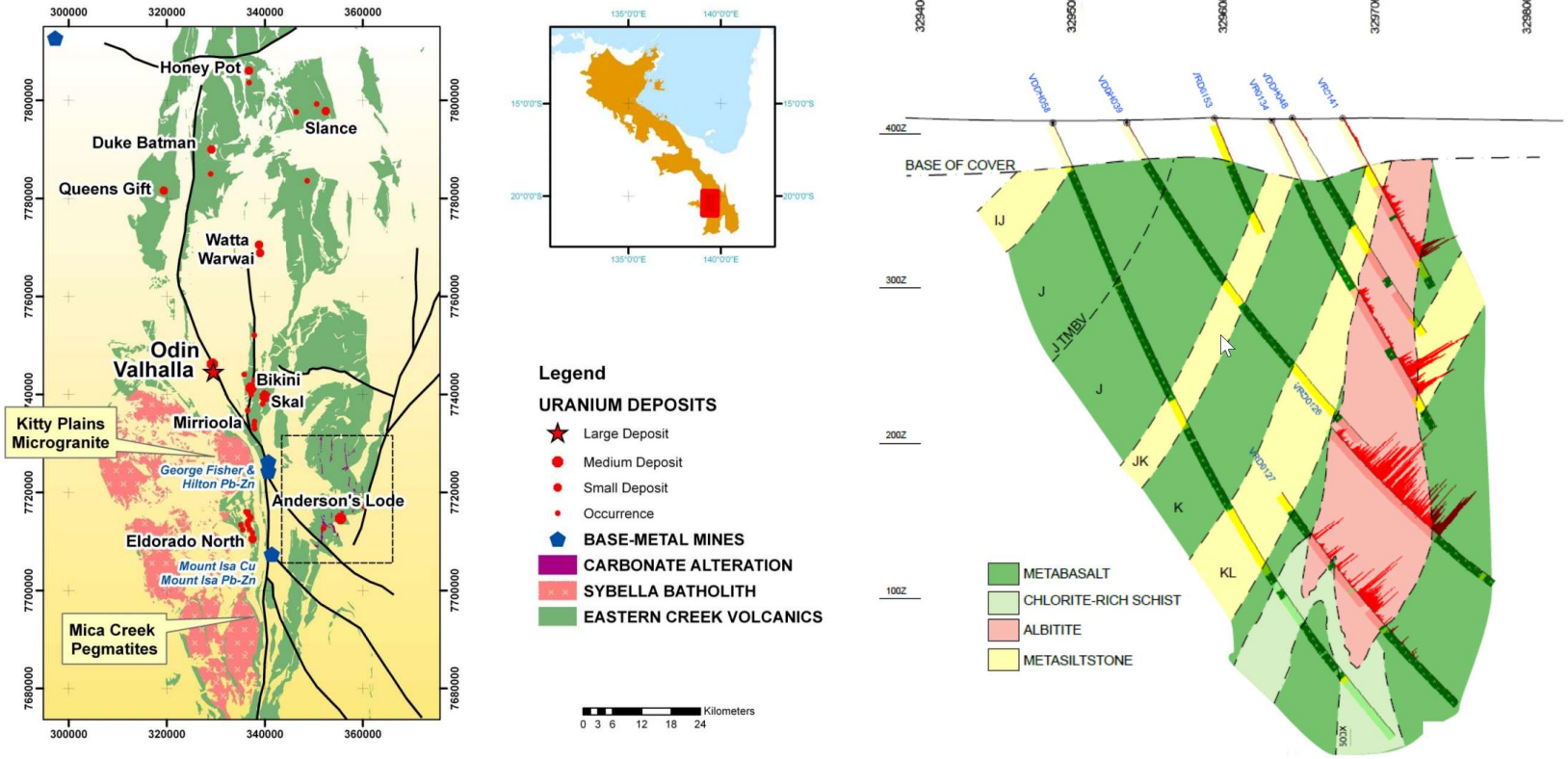

input data
spatial scale
Depth
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200
3300
Gamma Ray
Velocity
Density
Neutron Porosity
Atomic Density
ND
Walcott Formation
Wilcox Formation
Dockrell Formation
Miria Marl
Withnell Formation
Toolunga Calcilutite
Upper Gearle Siltstone
Lower Gearle Siltstone
Windalia Radiolarite
Muderong Shale
Barrow Group
Mungaroo Fm AA Sand
Mungaroo Fm Zone 100 Shale
Mungaroo Fm A Sand

Wavelet Tessellation Method

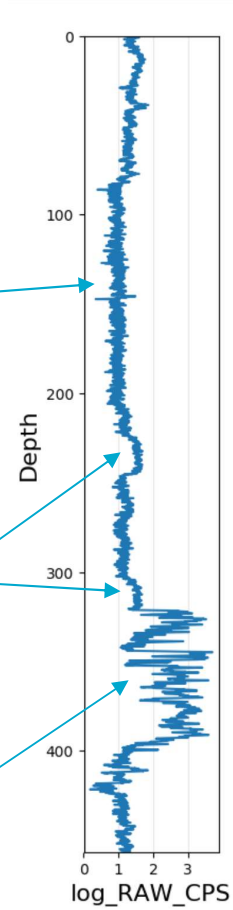
an example

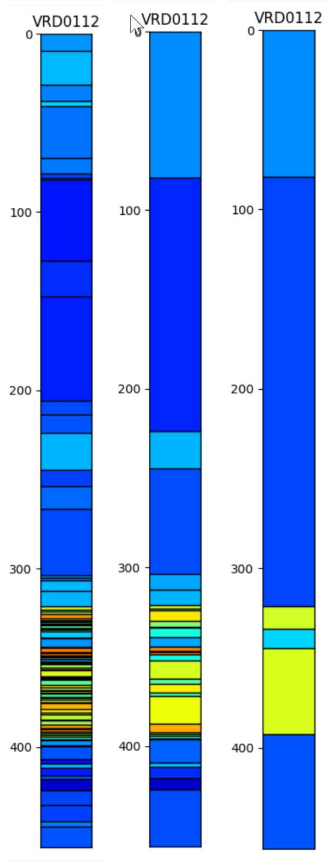
Valhalla Uranium Deposit

hosted in the Eastern Creek Volcanics – basalts and siltsones



Downhole gamma

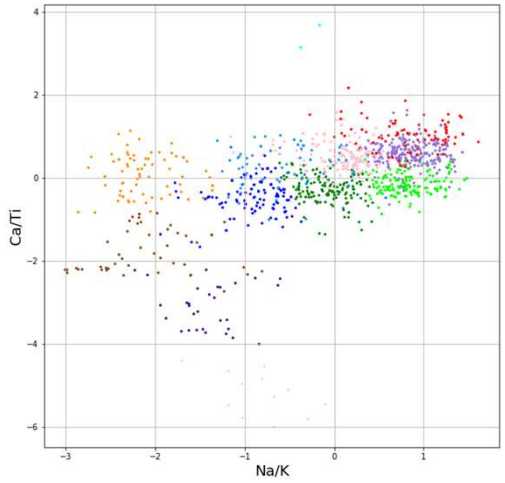


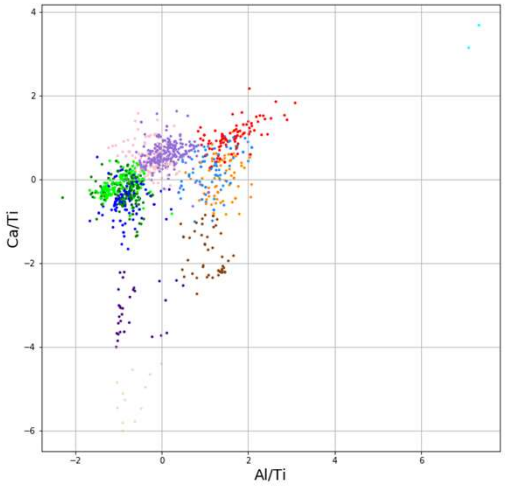


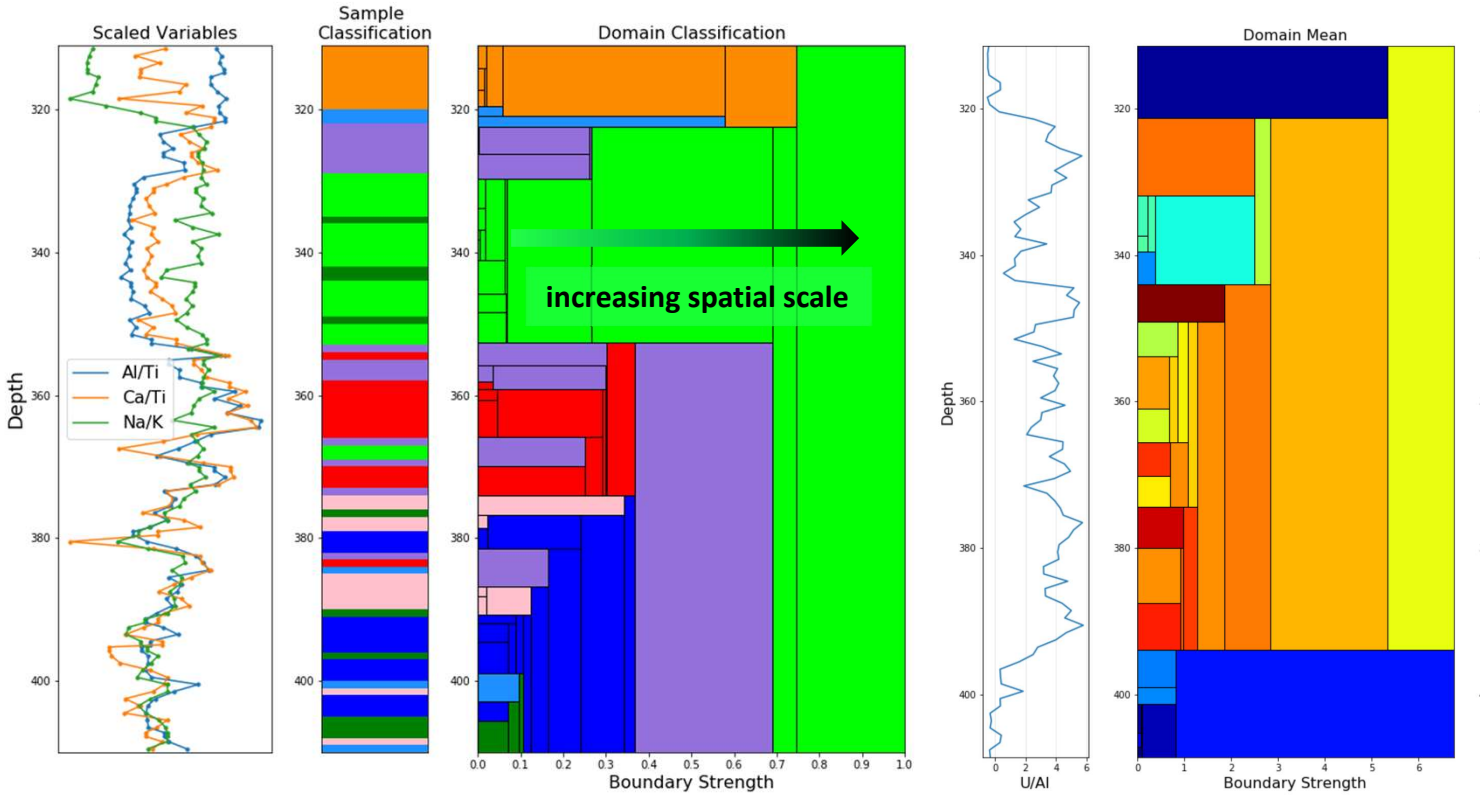
Multi-Element Geochemistry and downhole gamma

Valhalla Uranium Deposit
hosted in the Eastern Creek Volcanics – basalts and siltsones

5 elements used: Al, K, Na, Ca, Ti
K-means clustering, 12 clusters

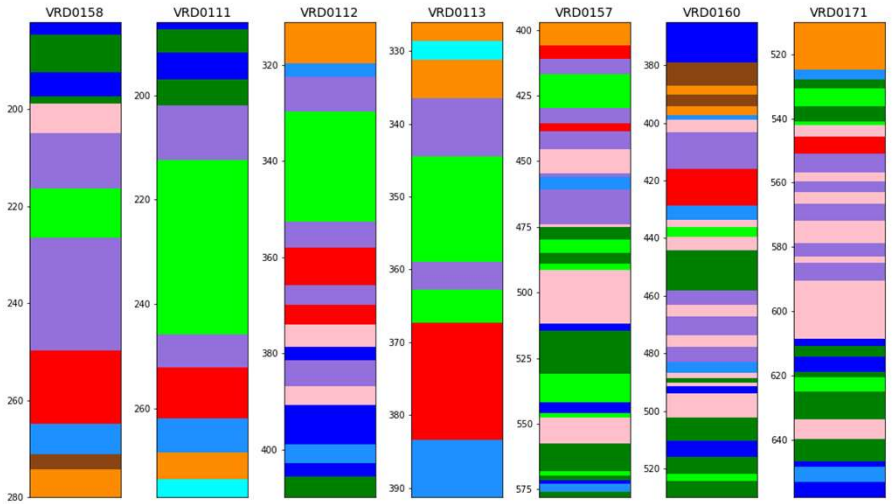


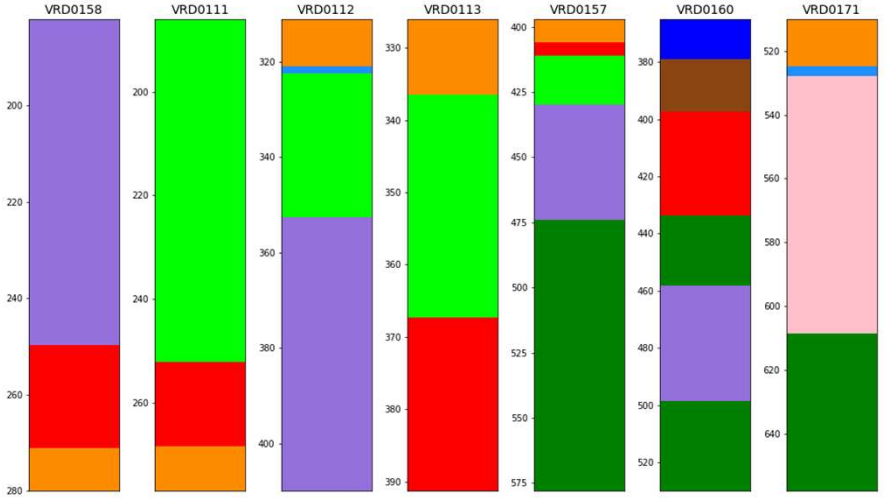



Scaled Variables
Sample Classification
Domain Classification
Domain Mean
Depth
Al/Ti
Ca/Ti
Na/K
increasing spatial scale
Boundary Strength
U/Al
Boundary Strength

259 drill holes analysed in minutes

what scale do you want to model at?





small scale ***large scale***

Contact us and we will show you how to do **faster, less subjective and consistent interpretation** of complex data sets

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