Abstract # 19
Category: *Technical developments in exploration*

Title: *Improving geological mapping with airborne geophysics and unsupervised machine learning*

Presenter: *Charles Berube, Researcher - Geophysics and machine learning, Goldspot Discoveries*

Abstract: In mineral exploration, resources spent on the acquisition of geophysical data usually aim to improve the geological mapping of a property. Geophysical data is especially valuable when the amount of geological knowledge is limited (e.g. greenfield exploration). Despite many recent advancements in supervised learning, a prediction model trained with limited geological information will most likely yield poor predictions. Also, geology and rock physical properties are usually site-specific, limiting the application of supervised models trained on abundant geological data to new, under-explored areas. Unsupervised machine learning algorithms, on the other hand, are useful in greenfield exploration as they do not require systematic labelling of geophysical data with geological knowledge. Specifically, dimension reduction and clustering techniques represent a valuable set of tools to facilitate the translation of geophysical data into geological maps, especially when geophysical data consists of multiple layers.

We present a workflow integrating airborne geophysical data (multi-layered grids) and prior geological information (shapefiles) through state-of-the-art dimension reduction and unsupervised clustering algorithms. The workflow consists of: (1) importing the evenly gridded geophysical data and geological shapefiles, (2) projecting the geophysical data using Uniform Manifold Approximation and Projection (UMAP), (3) clustering the projected data using Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN), and (4) exporting the optimal georeferenced clusters as new improved shapefiles. While a geophysicist can use completely unsupervised learning methods to aid in their interpretation, it would be unwise not to guide the model with geological information if any is available. This can be done by monitoring the similarity between available geological data and geophysical clusters (in step 3).

The proposed workflow was used to improve the lithological map of the Dog Bay Line area, a Silurian suture with significant gold potential located west of Gander, NL, Canada. In this study the raw geophysical data consisted of residual magnetic intensity, chargeability, and transient electromagnetic data. Initial geological constraints were based on shapefiles from the Geological Survey of Newfoundland and Labrador. The cluster map revealed units that had not been identified previously and makes optimal use of new information in the geophysical data and prior geological knowledge. The improved geological map is validated using new outcrop data collected in September 2018 and maps of the model uncertainties are provided using the soft clustering ability of HDBSCAN.

Authors: *Charles Berube, Goldspot Discoveries*