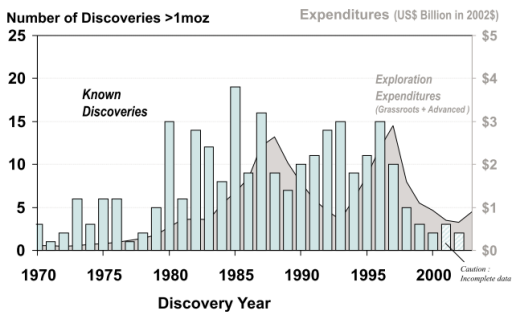
# Mineral Prospectivity Mapping

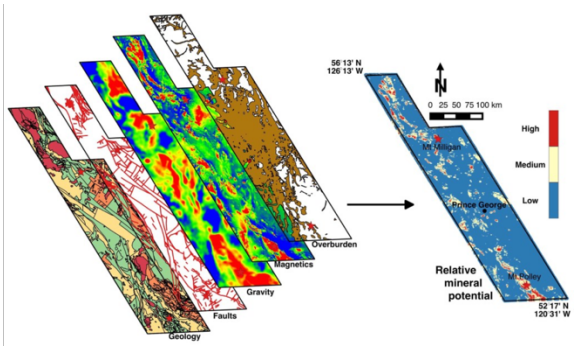
## More data, less discoveries

During the last decade a shift has occurred in the mining industry towards better adoption and application of advanced technologies to assist in the exploration process. This was motivated by the discouraging trend that despite increased expenditures and field efforts, the number of major mineral discoveries globally was in decline.




*Decreased discoveries despite increased expenditures.*

A new paradigm was necessary, and the tools to get us there were already in development. The proliferation of computational power and big data combined to create optimal conditions for the application of artificial intelligence and machine learning solutions. One of the earliest and most ambitious realizations of this is the advent of automated mineral prospectivity mapping.




*Mineral prospectivity mapping combines geoscientific data to estimate likelihood of mineral potential*

## Intelligent Mineral Exploration

Mineral prospectivity mapping can be defined as a method to combine and integrate numerous geoscientific datasets (ie: geological mapping, geophysical surveys, geochemical assays) in a quantitative way so as to optimize the likelihood of discovering new mineralization. This is typically done using a set of known mineral targets to train an algorithm to recognize and detect the signature of the desired mineralization. Such algorithms can then be deployed in exploration environments to map out new potential regions of interest and focus field efforts on the most prospective ground.

The advantages of applying a data-driven solution to this historically manual task are multiple:

- Less sensitive to bias from human interpretation
- More holistic approach than traditional exploration teams
- Better able to interpret subtle signatures across numerous datasets
- More scalable and quantitative approach

## CGI Multidisciplinary Advantage

Multiple algorithms and approaches exist to apply mineral prospectivity mapping, ranging from simple weights of evidence to complex deep neural networks. At Computational Geosciences our advantage lies in our multi-disciplinary expertise, spanning geoscience, artificial intelligence and data processing. We understand that the complexities of this problem require strength in all three disciplines. With over a decade of experience working with exploration geoscience teams and a strong track record in developing cutting edge deep learning solutions, CGI is your best option for prospectivity mapping.

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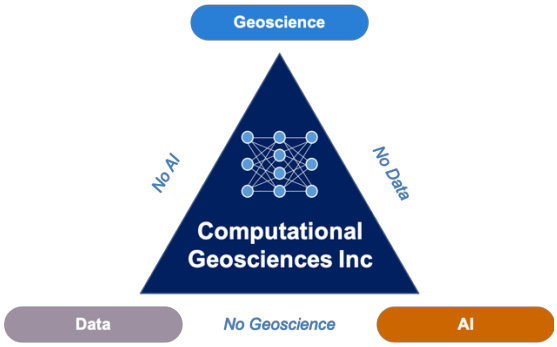



*Computational Geosciences combines the best of AI, data processing & geoscience.*

## A Proven Solution

For any AI solution, success begins with the data. Our approach combines your proprietary datasets with publicly available databases to build a comprehensive suite of geoscientific inputs with which to train our algorithm. This can include inputs such as:

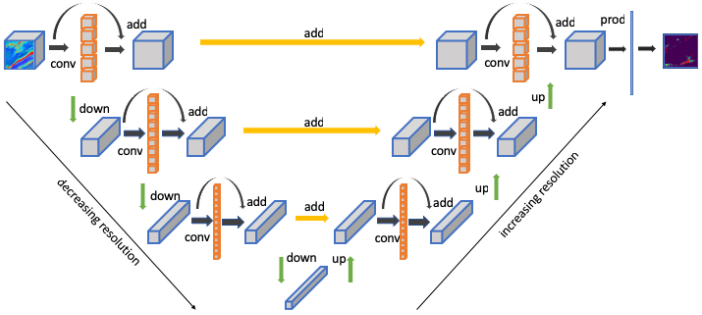
- Potential field data
- Electromagnetic data
- Geochemical assays
- Geological mapping
- Faults
- Satellite imagery
- Multispectral imagery

At CGI, our proven track record in geophysical data processing means that we are very familiar with geoscientific data. The old adage of "garbage in – garbage out" for machine learning algorithms holds true for geoscientific data, and the variety and complexity of the available datasets is far greater than most other applications. Working with your team, CGI will ensure that your data is properly prepared so as to extract maximum information.

One size does not fit all. AI comes in many flavors, and a proper understanding of both the application and the algorithm are crucial for selecting the appropriate methodology.

At CGI we take the best deep learning technology available today, and modify it to suit our specific geoscientific applications.

For prospectivity mapping, this algorithm is our VNet deep neural network. The algorithm can handle arbitrarily many geoscience data inputs in either 2D or 3D, is sensitive to multiple resolutions of features (ie: regional trends vs local anomalies), sparse training information (ie: very few mineralized example targets) and handles very large regions contiguously – not as patches.




*VNet architecture: the neural network incorporates features at multiple scales.*

The VNet and these modifications were developed through experience applying mineral prospectivity mapping over the last 5 years and collaborating with leading researchers in the AI field.

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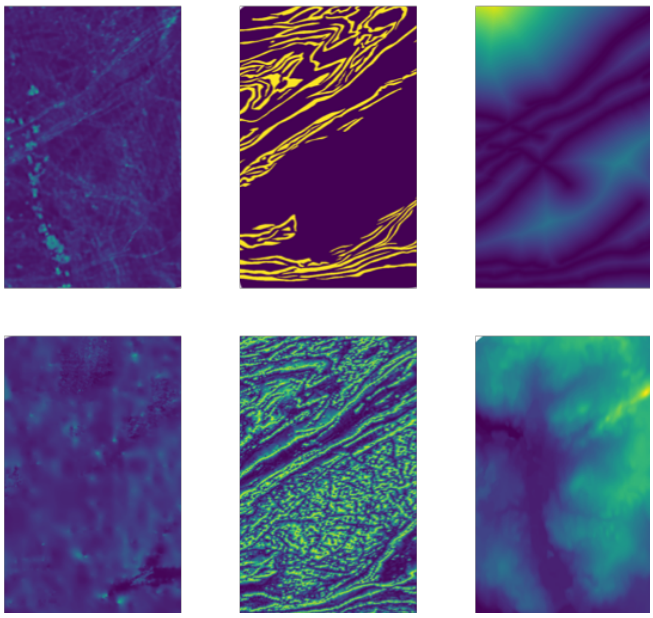
## Field Example

CGI teamed up with Auryn Resources to apply this deep learning prospectivity algorithm to generate new gold exploration targets on their expansive land package in the Canadian Arctic.

The property of interest has seen extensive exploration work over the years and contains many existing geoscientific datasets, including airborne electromagnetics, magnetics, geological mapping, structural interpretation, as well as a full suite of geochemical assaying.

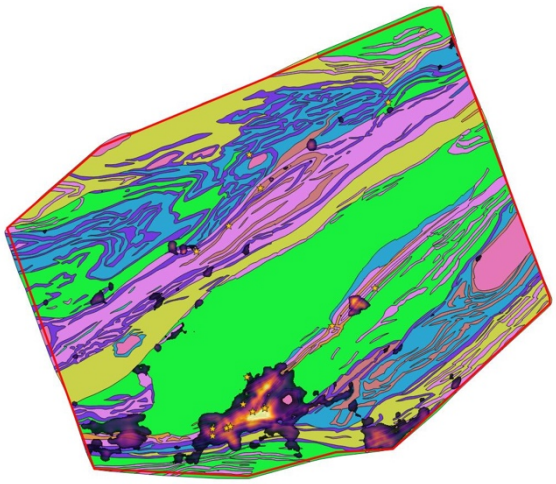
Gold had previously been identified in a handful of locations via hand-samples and drilling intercepts, and the goal of the project was to use these examples to train our VNet to highlight new targets in the region.



*Sample geoscience inputs from the Auryn property*

The algorithm was trained using a variety of different parameters and input combinations, and the resulting gold prospectivity maps were shown to the Auryn team to help identify new exploration targets to drill later in 2019.

To validate the results, gold predictions were generated on a nearby region without using the known drill hole and rock sample information from that area. The algorithm was able to locate the existing gold drill intercepts and known mineralization with a high degree of accuracy, which generates confidence in the methodology and its usefulness for exploration targeting.



*Predicted prospectivity map overlaid on the simplified geological interpretation. Known mineralized locations are plotted as gold stars.*

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