Digital transformation of geoscience to enable analytics in mineral exploration

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Ministry of Energy, Mines and Low Carbon Innovation

Introduction

Recent advancements in data science and analytics is changing the way geoscientists approach mineral potential modelling and mineral exploration. As part of our digital transformation efforts, the British Columbia Geological Survey is developing a digital strategy to identify opportunities and prioritize solutions for our future digital capabilities. We define 'digital capability' as the ability to enable analytics by improving skills, processes, and technology to optimize the acquisition, management and delivery of geoscience data, products and services that are analytical ready. We use 'analytics' as a general term for computational analysis of data to uncover patterns.

The BCGS has a long history of digital geosciences, with efforts such as digitally compiling geological maps at regional scales in the late 1980s, province-wide seamless digital coverage in the mid-1990s, and delivering digital contents via geospatial web services with GIS tools since 1995. We have developed a streamlined process to update and integrate new maps into the provincial database. In 2018, the BCGS transformed province-wide detailed bedrock geology and mineral occurrences to the GeoSciML and EarthResourceML Lite models, available as interoperable OGC Web Map Service (WMS) and Web Feature Service (WFS) on OneGeology.

Developing digital capabilities

The British Columbia Geological Survey (BCGS) operates conceptually on three groups of services driven by business needs and the lifecycles of geoscience data (Figure 1). Digital transformation requires digital capabilities in each of our services by developing skills, improving processes, adopting open standards, and building a common Spatial Data Infrastructure (SDI).

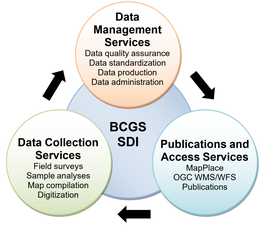

Figure 1. BCGS business drivers and high-level system components on a common Spatial Data Infrastructure (SDI).

Access and metadata

The BCGS provides two levels of metadata to discover and access data, publications and web services (Figures 2 and 3):

- DataBC Data Catalogue: to find the BCGS data and web services (ISO 19115 metadata standard compliant)
- BCGS Publication Catalogue: to search the BCGS publications and digital data, inherited from the Canadian Geoscience Knowledge Network (CGKN) data catalogue standard

Feature level 'metadata' would be useful in treating data at varying granularity in computational analysis (e.g., level of details, scales, confidence level, accuracy, precision, and data density).

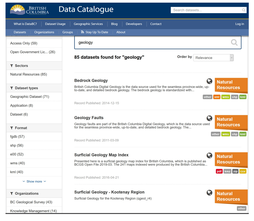

Figure 2. DataBC Data Catalogue to find data, applications and services, including those available from the BC Geological Survey.

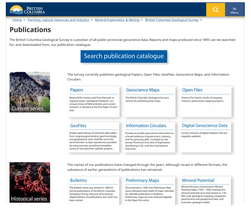

Figure 3. British Columbia Geological Survey Publication Catalogue.

Interoperability

Syntactic and semantic interoperability is essential to enable analytics in data access, data sharing and computational analysis.

- Syntactic interoperability
  - data models and formats, e.g., GeoSciML, GeoPackage)
  - system: interface/protocols, e.g., WMS and WFS

- Semantic interoperability
  - shared meaning of data among systems
  - classifications/profiles to taxonomy,
  - terms and jargon to controlled vocabularies,
  - geosciences to ontology

Digital transformation in progress

A decade ago, the BCGS envisioned a Spatial Data Infrastructure as the foundation to streamline digital transformation. We have built some of the system components in-house and we need significant IT support to complete the operational database environment and resources for on-going data transformation efforts.

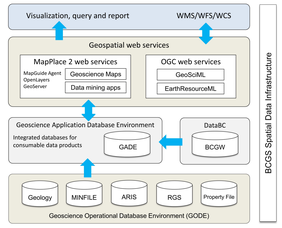

Figure 4. British Columbia geoscience SDI.

Geoscience application database environment (GADE)

GADE is complete and fully functional, based on Foreign Data Wrapper to provide consumable data products from virtual integration of databases and data sources (Figure 5).

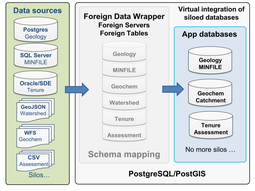

Figure 5. Geoscience application database environment high level view.

Geoscience operational database environment (GODE)

GODE is essential to collect, compile, and process geoscience data (Figure 6). Currently, all databases are in discrete systems of varying vintages of technology, data standards and data models. BCGS is working closely with IT support to identify opportunities and prioritize solutions in building the GODE.

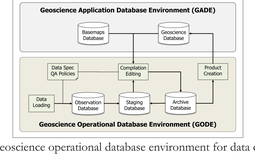

Figure 6. Geoscience operational database environment for data collection, compilation, processing, and interaction with geoscience application database environment.

Geospatial web services

As the front-end to SDI, geospatial web services have been upgraded from the original released in 1997. MapPlace 2 provides tools to browse, visualize, search, report, and analyse data from multiple geoscience, mineral resource, tenure and other databases (Figures 7, 8, and 9). MapPlace 2 is built on MapGuide Open Source, a platform that will need to extend future digital capabilities compatible with HTML5-based web applications and better integration with interoperable OGC web services.

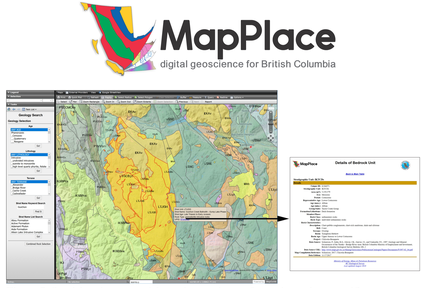

Figure 7. Spatial and non-spatial queries can be preformed to select specific bedrock units, hyper-links provide additional details though maptip.

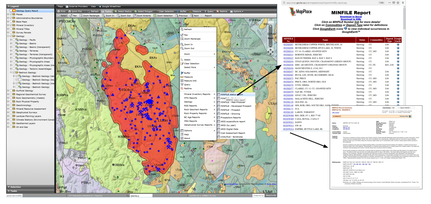

Figure 8. Buffer of selected features (shown in red), spatial overlay to select intersecting features (mineral occurrences in blue), and report summary of selected mineral occurrences.

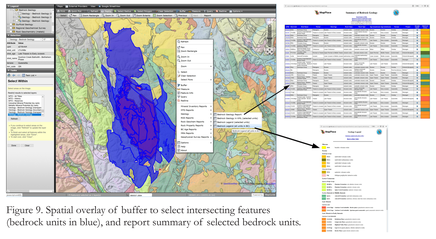

Figure 9. Spatial overlay of buffer to select intersecting features (bedrock units in blue), and report summary of selected bedrock units.

Transformation process examples

Digital transformation to open standards is critical to ensure that data are analytical ready and interoperable to support computational applications. The BCGS has transformed detailed bedrock geology and mineral occurrences to GeoSciML and EarthResourceML Lite models with matching CGI vocabularies (Figure 10). This exercise has helped us to identify gaps in our digital capabilities: technical skills, data specifications, database management systems, data processes, feature types, and feature level metadata. We have initiated digital compilation of field stations, structural measurements, geochemical data and drill hole data from assessment reports.

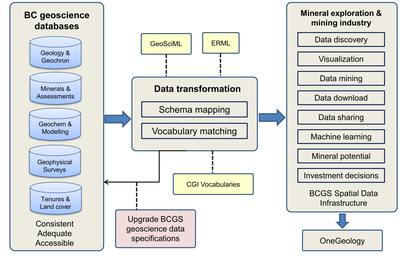

Figure 10. Data transformation of geoscience to open standards.

Detailed bedrock geology and mineral occurrences are available as WMS and WFS web services and also via OneGeology (Figure 11) for interoperable access and applications.

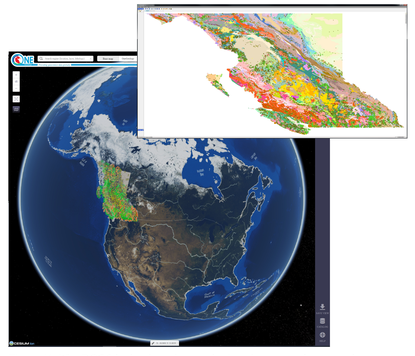

Figure 11. The BCGS bedrock geology and mineral resource data posted on OneGeology via interoperable WMS and WFS web services.

BC digital geology in transformation

BC digital geology has the highest number of downloads among the data products that the BCGS offers and is one of the top priorities in our digital transformation efforts. At the BCGS, every regional map and compilation must follow the Geospatial Frame Data (GFD) model and workflow (Figure 12), to ensure that the digital data can be integrated into the provincial digital geology database (Figure 13), in addition to cartographic geoscience map products. To further make the digital geology analytical ready, we need more feature-level metadata, such as presentational scales, to help generalize bedrock units for small-scale geological maps and machine learning with a balance of data density.

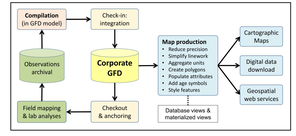

Figure 12. Workflow of geological mapping, compilation, integration to publication.

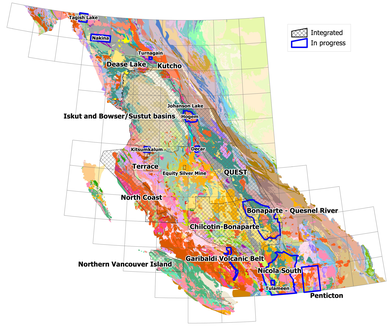

Figure 13. Compilation and integration progress of BC digital geology.

Summary

The British Columbia Geological Survey continues efforts in digital transformation to offer more geoscience data that are analytical ready and to enable computational analysis and applications in mineral potential modelling and mineral exploration. We need to identify and prioritize solutions to complete a Spatial Data Infrastructure as a common foundation to build future digital capabilities in data collection, management, and publication. We have made progress in our digital transformation efforts in province-wide seamless digital coverage of bedrock geology and other geoscience data, implementation of open standards and interoperable web services, digital compilation of field data and sourced from assessment reports, and an upgrade of geospatial web services to MapPlace 2.