

DIGITAL MAPPING TECHNIQUES 2019

The following was presented at DMT'19
(May 19 – 22, 2019 - Montana Technological
University)

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2019)

<http://ngmdb.usgs.gov/info/dmt/>

Digital Geological Mapping: from the Field to Interoperable Geospatial Web Services

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Different classification systems and terminology are commonly used to capture geology and mineral occurrence data, causing difficulties in data sharing, data exchange, and data integration. At the British Columbia Geological Survey (BCGS), we carry out field-based digital geological mapping and integrate data not only from our mapping projects, but also from other groups such as the Geological Survey of Canada and universities. Inconsistent and incompatible geological data will prevent advanced computation including machine learning based on data from multiple jurisdictions. To address these issues, the International Union of Geological Sciences (IUGS), through its sub-committee Commission for the Management and Application of Geoscience Information (CGI), developed international geoscience standard Geoscience Markup Language (GeoSciML) and adopted vocabularies to describe bedrock geology.

The BCGS is in the process of reviewing and implementing the international geoscience standard to deliver geoscience data via interoperable geospatial web services. As a first step, we transformed our province-wide bedrock geology to be compliant to the 'Lite' model of the standard, and matched our bedrock geology classification and terminology to the vocabularies adopted by IUGS/CGI. These data are available as OGC Web Map Service (WMS) and Web Feature Service (WFS), accessible through OneGeology, the portal for worldwide geoscience data. From our limited experience, we recognized that significant effort and time are required to make our data fully compliant to the GeoSciML models and the CGI vocabularies. Some of our data lack certain features set out in the international geoscience standards. Similarly, the simplified 'Lite' models and CGI vocabularies lack terminology to adequately represent all our data. While WMS is useful, WFS and WCS require significant technical capability on the client side to build sophisticated information systems to benefit. There are many challenges to exchanging data at the feature or coverage levels, including impediments in web-based authentication. Currently the OneGeology Portal is rudimentary in functionality and performance. Most geological maps available on OneGeology are at scales of 1:1 million or smaller, which are of limited use to most applications for the mineral exploration and mining industry.

At the BCGS, our geological mapping has evolved from traditional map compilation for cartographic representation (e.g., as hardcopy maps or in PDF format), to digital geology that is ready for spatial and non-spatial analyses (Figure 1). We define 'digital geology' as: 1) the authoritative data source for deriving map products, 2) containing all available details (e.g., from 1:20,000 to 1:250,000), 3) seamless digital coverage and updatable, and 4) consistent nomenclature and encoding to support computations. At the core of this evolution is the implementation of the Geospatial Frame Data (GFD) model, a data 'checkout' process and 'anchoring' mechanism to 1) simplify the capture, compilation and integration of digital geology, and 2) manage digital mapping's lifecycle from field to corporate GFD database. To have consistent and GeoSciML compliant data, we are expanding data capture in the field and have designed a simplified graphic user interface to efficiently enter essential data on digital devices, followed by consistent encoding of lithology, event process and environment, and a new scheme for bedrock unit labels in map compilation.

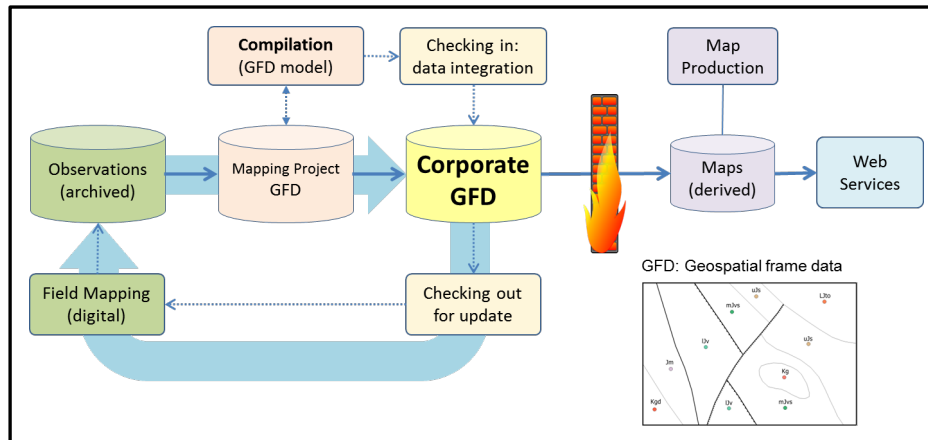


Figure 1. Lifecycle of digital mapping and treatment of digital geology and derived geological maps.

To support our clients in the mineral exploration and land use management sectors, the BCGS will continue to provide digital geology as data download (including in the new open data format GeoPackage, more details at <https://www.geopackage.org>) and make it available on MapPlace 2, our geospatial web services. MapPlace 2 not only allows visualization, but also has advanced spatial and non-spatial functions for query and analysis of province-wide bedrock geology in the context of other geoscience, mineral titles, land ownership, natural resource and topographic base maps (Figure 2). MapPlace 2 is available as a desktop application, and has versions for tablet and mobile devices as well. The application database system behind MapPlace 2 makes extensive use of Foreign Data Wrapper to integrate data sourced from various external databases such as Oracle, SQL Server, and PostgreSQL/PostGIS that are maintained by other government agencies.

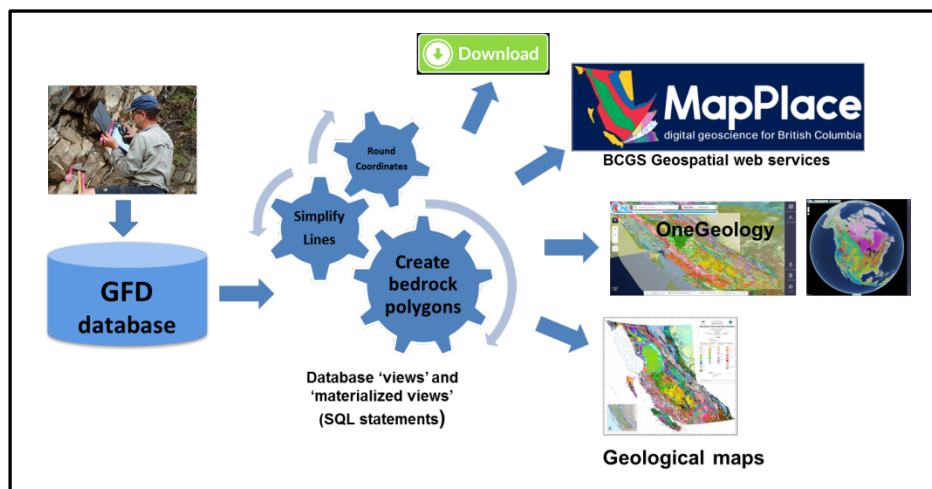


Figure 2. High level view from field survey, map compilation, to geospatial web services.

The British Columbia Geological Survey follows closely the progress in the international geoscience standard and the Deep-Time Digital Earth program. We take these developments as opportunities to update our data models and specifications in digital geology to produce consistent data. We also encourage others to adopt our GFD model, data checkout process, and anchoring mechanism, to not only simplify map compilation data integration of digital geology, but also to resolve data boundaries crossing jurisdictional borders, to eventually enable interoperability in data sharing and data exchange.

Digital Geological Mapping

from the field to interoperable geospatial web services

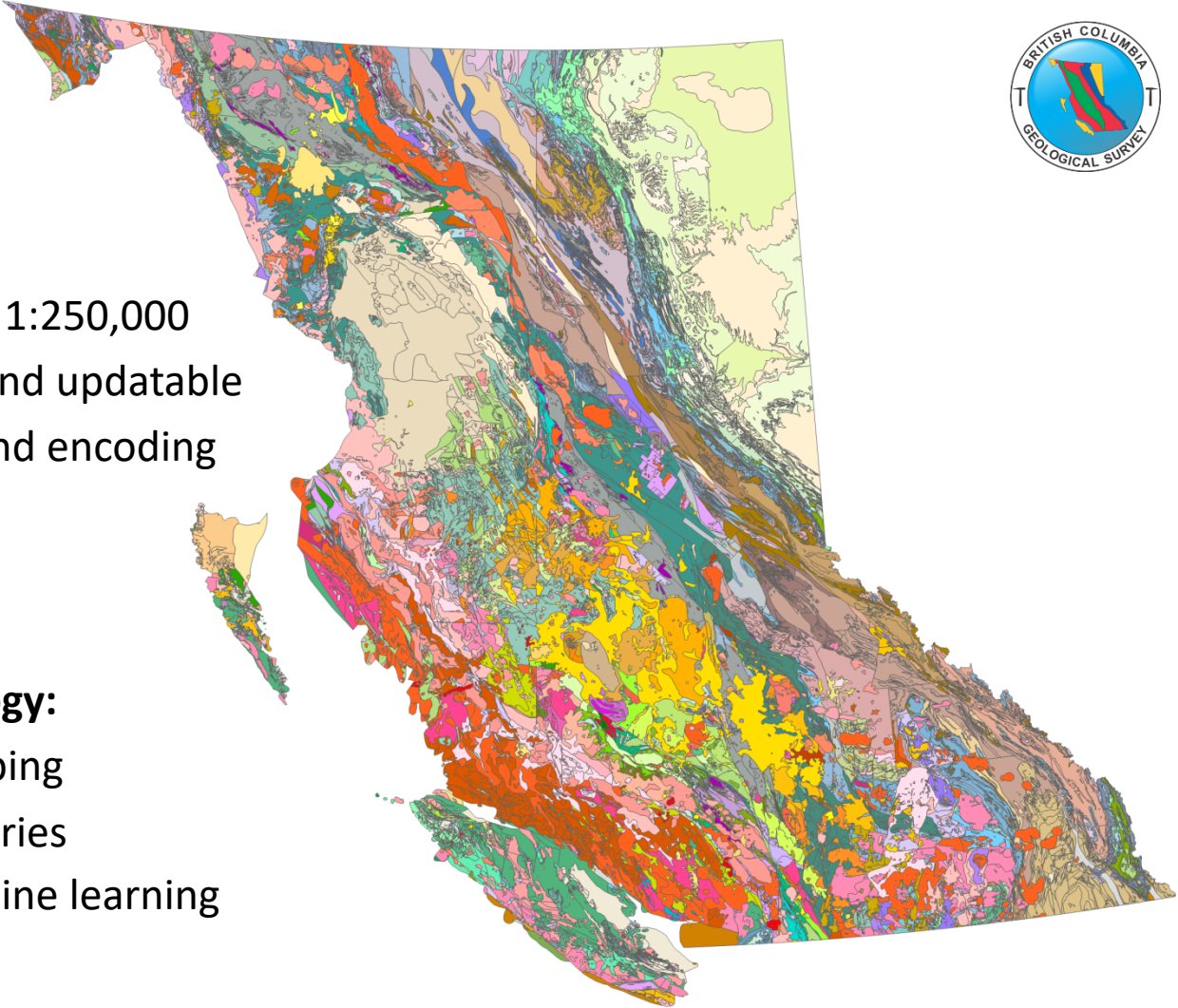
Yao Cui, P.Geol.
British Columbia Geological Survey

Digital Mapping Techniques Workshop
Butte, Montana
May 19-22, 2019



British Columbia Geological Survey





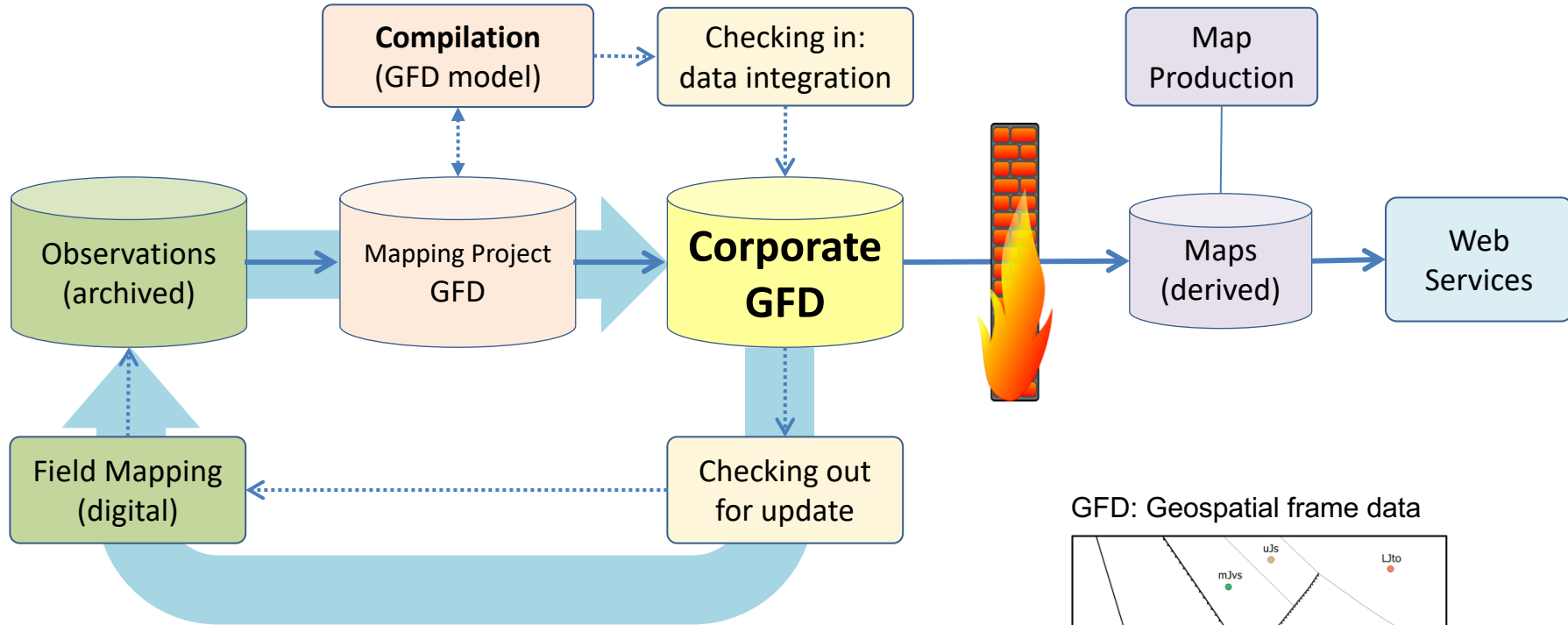
British Columbia Digital Geology

- authoritative data source
- all details from 1:50,000 to 1:250,000
- seamless digital coverage and updatable
- consistent nomenclature and encoding to support **computation**

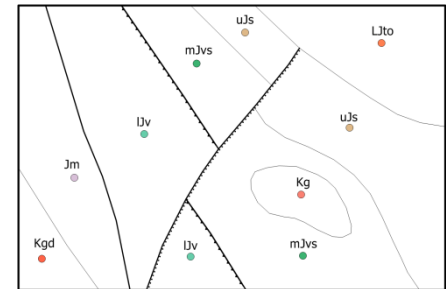
Why do we need digital geology:

- mineral prospectivity mapping
- spatial and non-spatial queries
- GeoSciML to support machine learning

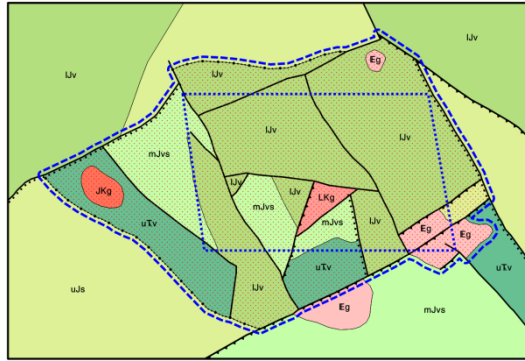
Lifecycle of geospatial data



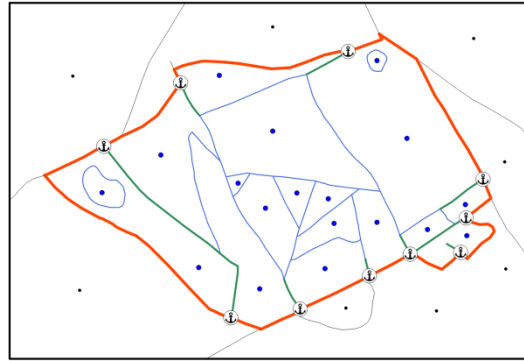
GFD: Geospatial frame data



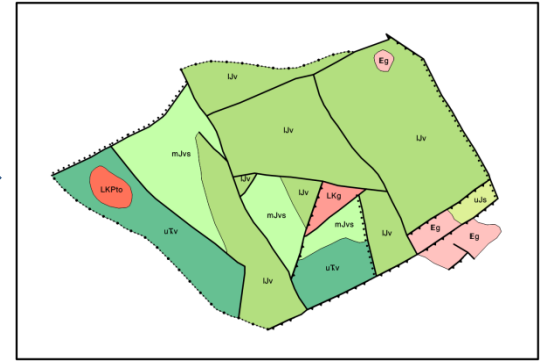
GFD checking out and checking in to update and integrate



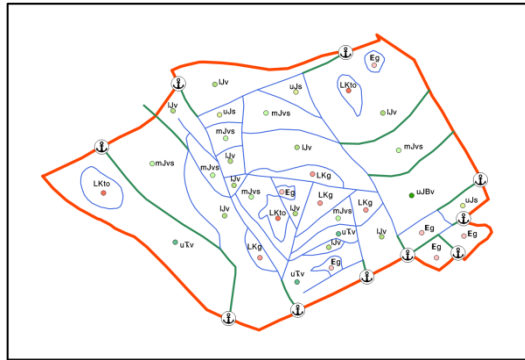
1) Data selection: extended to include entire units



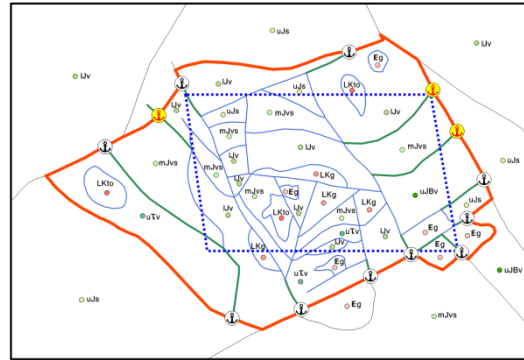
2) Anchoring: guarded boundaries and intersections



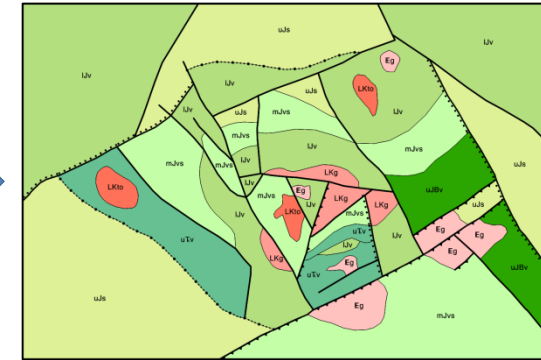
3) Checked out: complete package ready for field mapping



4) Updated project GFD from field mapping and compilation



5) Check in and update corporate GFD

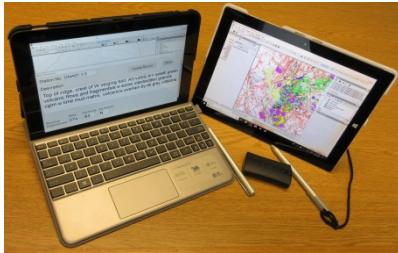


6) Derived geological map

Field mapping

Digital data captured to observation database

- outcrop descriptions
- structural measurements
- samples: hand specimen, age dating, assay, fossils
- alternation and mineralization
- magnetic susceptibility
- photos



Inexpensive tablets
Inexpensive software



GSBmainForm

PREFIX IRAV STN SUB STATNUM
 LDI18 1 2 0 LDI18-1-2

WEATHER

DATE AREA
 2018-06-07

EASTING NORTHING ELEVATION GPS ±m
 ± 0

LocationID 689

Lithology Sample Structure MagSus Photo

ROCK NAME: sandstone ROCK UNIT

DESCRIPTION: Heading northeast up slope from previous station, limited exposures of the same sandstone unit; at this station, sandstone rich with feldspar, interlayered with conglomerate dominated by volcanic and pluton dasts; minor lava flows.

MINERALOGY/
ALTERATION:

STATNUM: LithologyID
 LDI18-1-2 2

Record: 1 of 1 No Filter Search

Num Lock



Station# LDI18-2-8-7

Station Type outcrop

Update Record (ID = 29644)

Description map unit Nicola - sandstone unit rock name sandstone

Close

Heading northeast up slope from previous station, limited exposures of the same sandstone unit; at this station, sandstone rich with feldspar, interlayered with conglomerate dominated by volcanic and pluton clasts; minor lava flows.

Type	Strike	Dip	Direction	Reliability
Structure	fault	327	53	NE 2

Photo (#, caption; ...)

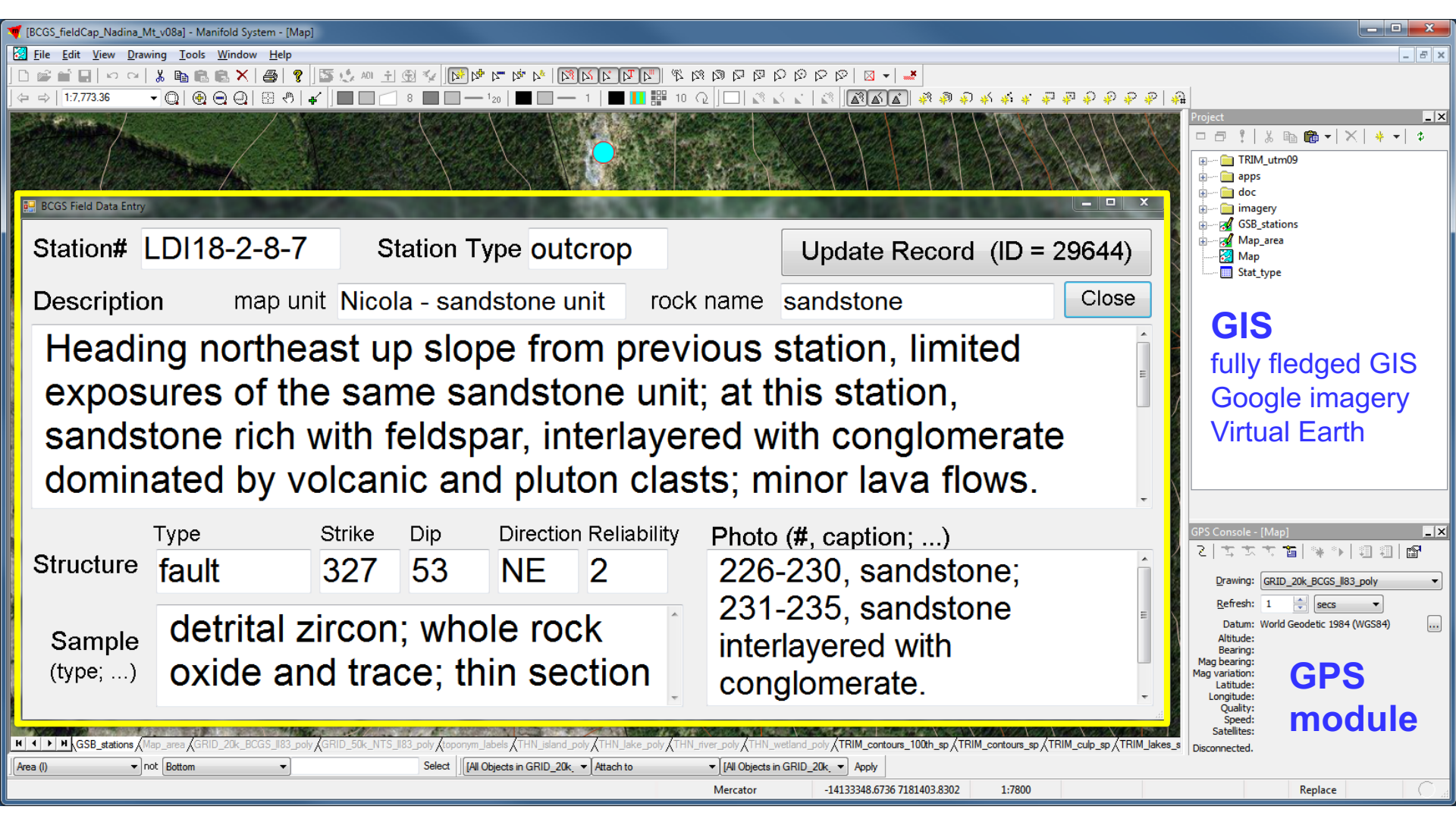
Sample
(type; ...)

detrital zircon; whole rock
oxide and trace; thin section

226-230, sandstone;
231-235, sandstone
interlayered with
conglomerate.



- Quick data entry, extra-large font to read, semi-colon to parse entries
- Local map unit and rock name (field interpretation) to style stations



Station# LDI18-2-8-7

Station Type outcrop

Update Record (ID = 29644)

Description map unit Nicola - sandstone unit rock name sandstone

Close

Heading northeast up slope from previous station, limited exposures of the same sandstone unit; at this station, sandstone rich with feldspar, interlayered with conglomerate dominated by volcanic and pluton clasts; minor lava flows.

Structure	Type	Strike	Dip	Direction	Reliability
	fault	327	53	NE	2

Photo (#, caption; ...) 226-230, sandstone; 231-235, sandstone interlayered with conglomerate.

Sample (type; ...) detrital zircon; whole rock oxide and trace; thin section

GIS
fully fledged GIS
Google imagery
Virtual Earth

GPS
module

Disconnected.

Better way to label bedrock units?

BCGS label format, meaningful and scalable?

- 1) Bedrock age (Epoch, in uppercase for lithodemic or lithotectonic units) or position (Series, in lowercase for lithostratigraphic units);
- 2) Group|Suite, Formation|Lithodeme| *_member names*, in uppercase
- 3) Lithology code, in lowercase
- 4) Extension code (designative/diagnostic/characteristics), in lowercase, following a dot (.)

uTrVK_Fvb.tfh → **uTrVKvb.tfh** → **uTrVKvb** → **TrVv**

Upper Triassic Vancouver Group – Karmutsen Formation

– *flow member*; basalt, hyaloclastic flow



Lithologic code and extension code: mapping to GeoSciML / CGI vocabulary

Simplified lithology and code (partial...)

rock_class	rock_subclass	rock_type	rock_code
sedimentary_rock	clastic	clastic	sc
sedimentary_rock	clastic	arenite	sa
sedimentary_rock	chemical	limestone	sl
sedimentary_rock	chemical	dolomite	sd
volcanic_rock	flows	undivided, lava flows	vf
volcanic_rock	pyroclastic	undivided, pyroclastic rocks	vpv
volcanic_rock	compositional	rhyolite or acidic rock	vr
volcanic_rock	compositional	dacite	vd
volcanic_rock	compositional	basalt or basic rock	vb
intrusive_rock	granitic	granite	gg
intrusive_rock	granitic	granodiorite	gd
intrusive_rock	dioritic	diorite	d
intrusive_rock	dioritic	gabbro	dg
intrusive_rock	Alaskan type	pyroxenite	up
metamorphic	contact	skarn / calc-silicate	skm
metamorphic	barrovian	marble	lm
ultramafic	mantle tectonite	peridotites	updm
structural	dynamic	mylonite	my
hydrothermal	dynamic	imbricate zone	imy

Designative/diagnostic/characteristic extension code (partial...)

ext_rock	ext_type	ext_sub_type	ext_character	f_code
sedimentary_rock	conglomerate	distinctive clasts	chert	.cc
volcanic_rock	pyroclastic	size classification	lapilli tuff	.pl
volcanic_rock	pyroclastic	resedimented	debris flow / lahar	.pd
volcanic_rock	pyroclastic	flow	ignimbrite/ash-flow tuff	.pi
volcanic_rock	analyzed	composition	calc-alkaline	.aca
volcanic_rock	flow texture	autoclastic submarine	hyaloclastite	.tfh
volcanic_rock	flow texture		amygdaloidal	.tfa
volcanic_rock	flow structure	submarine	pillows	.tp
volcanic_rock	pyroclastic texture		welded / eutaxitic	.tw
volcanic_rock	intrusive texture		megacrystic	.tm
volcanic_rock	intrusive texture		trachytic	.tt
intrusive_rock	texture		pegmatitic	.tpe
metamorphic_rock	texture		gneissic	.tg
sedimentary_rock	environment	marine	shelf	.emsh
sedimentary_rock	environment	terrestrial	fluvialite	.etf
volcanic_rock	environment	volcanic	subaerial	.evs
tectonic	environment	tectonic	island arc	.etia
sedimentary_rock	diagnostic feature	cement	calcareous	.dca
	diagnostic	mineral	apatite	.xap
metamorphic_rock	Barrovian (regional)		zeolite facies	.z
metamorphic_rock	Barrovian (regional)	mafic volcanic	greenschist facies	.g
metamorphic_rock	Barrovian (regional)	pelite	amphibolite	.au
metamorphic_rock	mineral		chlorite	.xchl
metamorphic_rock	index mineral-pelite	blueschist faces	lawsonite	.xlws
alteration			serpentinized	.sp



uTrVK**vb**.**tfh**

BCGS stratigraphic unit label specification

age::{epoch::uppercaseLetter | **position**::{epoch::lowercaseLetter}} {period | {range}}::uppercaseLetter} | **unitName**::{<<lithostratigraphic>> {supergroup {group {formation {member {bed}}}}}} | lithodemic {complex {supersuite {suite {lithodeme (pluton) { _intrusion {zone | dyke | sill | plug | vent}}}}}} | composite-genesis {<<metamorphic>> | *cataclastic*::uppercaseLetter | {<<and>> | - | } | {<<or>> | / | }} | **lithology**::{<<rockClass>> {igneous {intrusive {sub-volcanic} | volcanic { explosive | flow | impact}} | sedimentary {clastic | chemical | biogenic} | metamorphic {dynamic | regional | contact | metasomatic | impact | cataclastic | composite-genesis | hydrothermally altered}} | **rockTypeCode** {composition {non-silicate | silicate {acidic | intermediate | basic | ultramafic}}} | . | **extensionCode** {texture | fabric | alteration | alteration | mineralization | structure | colour | fossil content}}::lowercaseLetter

<<metaclass>>

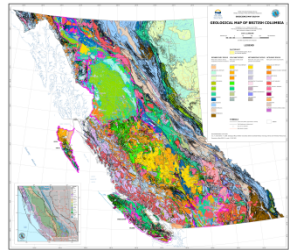
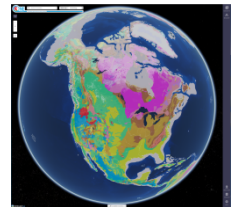
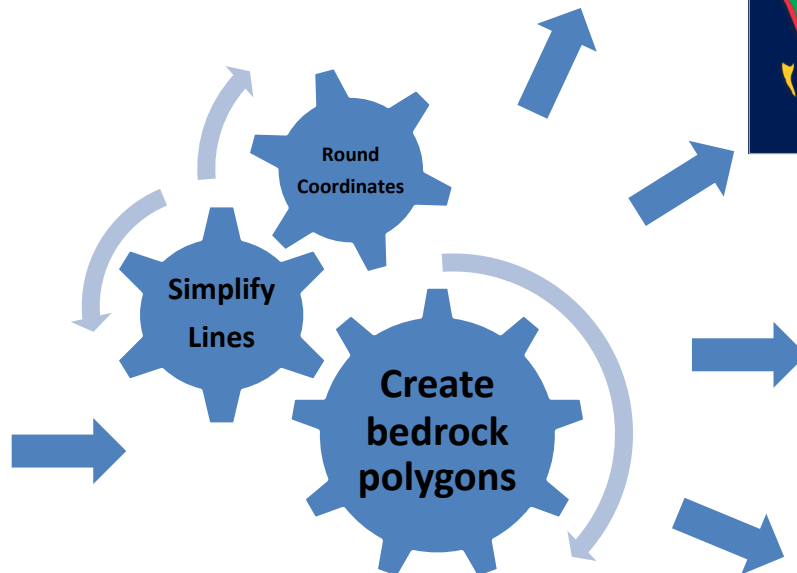
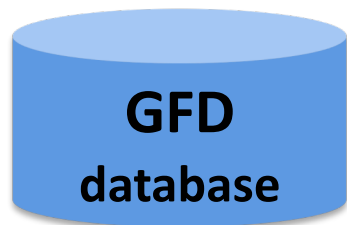
Expressed in extended 'Backus–Naur form' notation (BNF)



Bedrock geology: field mapping to web services



BCGS Geospatial web services



Database 'views' and 'materialized views' (SQL statements)

Geological maps



MapPlace 2

Geospatial web services

Data mining platform to all geoscience and mineral exploration related databases in British Columbia



The screenshot shows the MapPlace 2 web application interface. On the left is a vertical sidebar with a legend, a selection tool, and a task pane. The main area displays a colorful geological map of British Columbia. A tooltip is visible over a specific geological feature, providing details such as "Strat Unit: IJList", "Strat Name: Laberge Group - Inkin Formation", "Rock Class: sedimentary rocks", and "Pid: 806629-1491611". The top of the interface has a menu bar with options like "Print", "Quick Plot", "Refresh", "Maptip", "Select Radius", "Select Polygon", "Clear Selection", "Buffer", "Measure", "Query", "Redline", and "Options". The bottom of the interface shows a status bar with coordinates and a scale.

X: -14418359.8603 m, Y: 8056215.4869 m

No selection

1: 9742273.5671

2933357.96 x 2319878.88 (m)

Powered by MapGuide

Bedrock geology

>33,000 units

>110,000 lines

API to details

The screenshot displays the MapPlace web application interface. On the left is a legend and selection pane. The main area shows a geological map with various units labeled. A pop-up window titled "Details of Bedrock Unit" is open, providing specific information for the selected unit, IKTCDS.

Legend

- Geology
- Geology - Faults
- Geology - Basins
- Geology - Basins (transparent)
- Geology - Terranes
- Geology - Terranes (transparent)
- Geology - Physiographic Boundaries
- Geology - Physiographic Areas
- Geology - Physiographic Areas (transparent)
- Geology - Tectonic Assemblages
- Bedrock Geology
- Geology - Bedrock Geology (1)
- Geology - Bedrock Geology (2)
- Geology - Bedrock Geology (3)
- Geology - Bedrock Geology (4)
- Geology - Bedrock Geology (5)
- Surficial Geology
- Regional Geochemical Survey
- Rock Geochemistry (metals)
- Rock Physical Property

Selection

Geology - Bedrock Geology 1

Attribute	Value
upid	fc3de871
strat_unit	IKTCDS
strat_age	Lower Cretaceous
strat_name	Taylor Creek Group - Dash formation
terrane	Overlap
terr_code	OV

Task Pane Help

From the 'Task List', task pane provides quick access to tools and custom applications developed by the British Columbia Geological Survey.

Details of Bedrock Unit

[Back to Main Table](#)

Stratigraphic Unit: IKTCDS

Details

- Unique ID: fc3de871
- Stratigraphic Unit: IKTCDS
- Area (m²): 3,218,370
- Era: Mesozoic
- Period: Cretaceous
- Representative Age: Lower Cretaceous
- Age (max.): Albian
- Age (min.): Albian
- Group/Suite: Taylor Creek Group
- Formation/Lithodeme: Dash formation
- Member/Phase:
- Rock Class: sedimentary rocks
- Rock Type: undivided sedimentary rocks
- Rock Characteristics:
- Description: Chert-pebble conglomerate, chert-rich sandstone, shale and siltstone
- Belt: Coast
- Terrane: Overlap
- Basin: Tyaughton-Methow
- Basin Age: Upper Jurassic to Lower Cretaceous
- Project: Chilcotin-Bonaparte
- Data Source: Schiarizza, P., Gaba, R.G., Glover, J.K., Garver, J.I., and Umhoefer, P.J., 1997. Geology and Mineral Occurrences of the Taseko - Bridge River Area. British Columbia Ministry of Employment and Investment, British Columbia Geological Survey Bulletin 100, 2
- Data Source URL: http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/Papers/Documents/P1997-02_04.pdf
- Map Compilation Reference: Schiarizza, 2017, Chilcotin-Bonaparte
- Data Edition: 11/17/2017

*Ministry of Energy, Mines & Petroleum Resources
BC Geological Survey
Last updated August 2018*



Bedrock geology
Mineral occurrences
>14,650

Legend

- Places
- Administrative Boundaries
- Base Maps
- Mineral Inventory
 - Assessment Reports (ARI)
 - Coal Reports and Data (C)
 - Prospectors Reports
 - Property File
 - Mineral Occurrences (MIN)**
 - Mineral Production
 - Aggregate Inventory
- Mineral Titles
- Geology
 - Surficial Geology
 - Regional Geochemical Surve
 - Rock Geochemistry (metals)
 - Rock Physical Property
 - Geochronology
 - Mineral Resource Assesmen

Selection

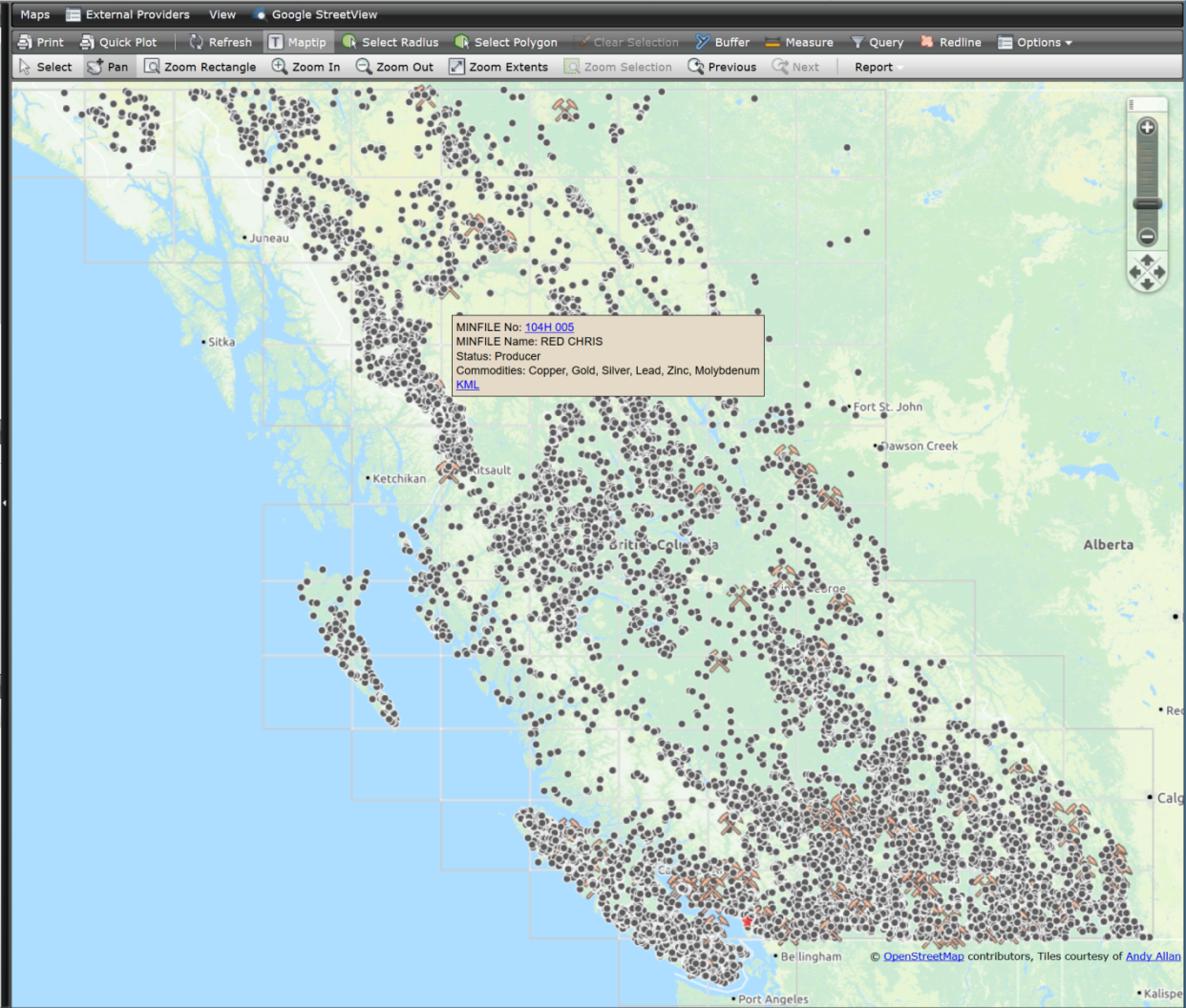

No features selected

Tasks

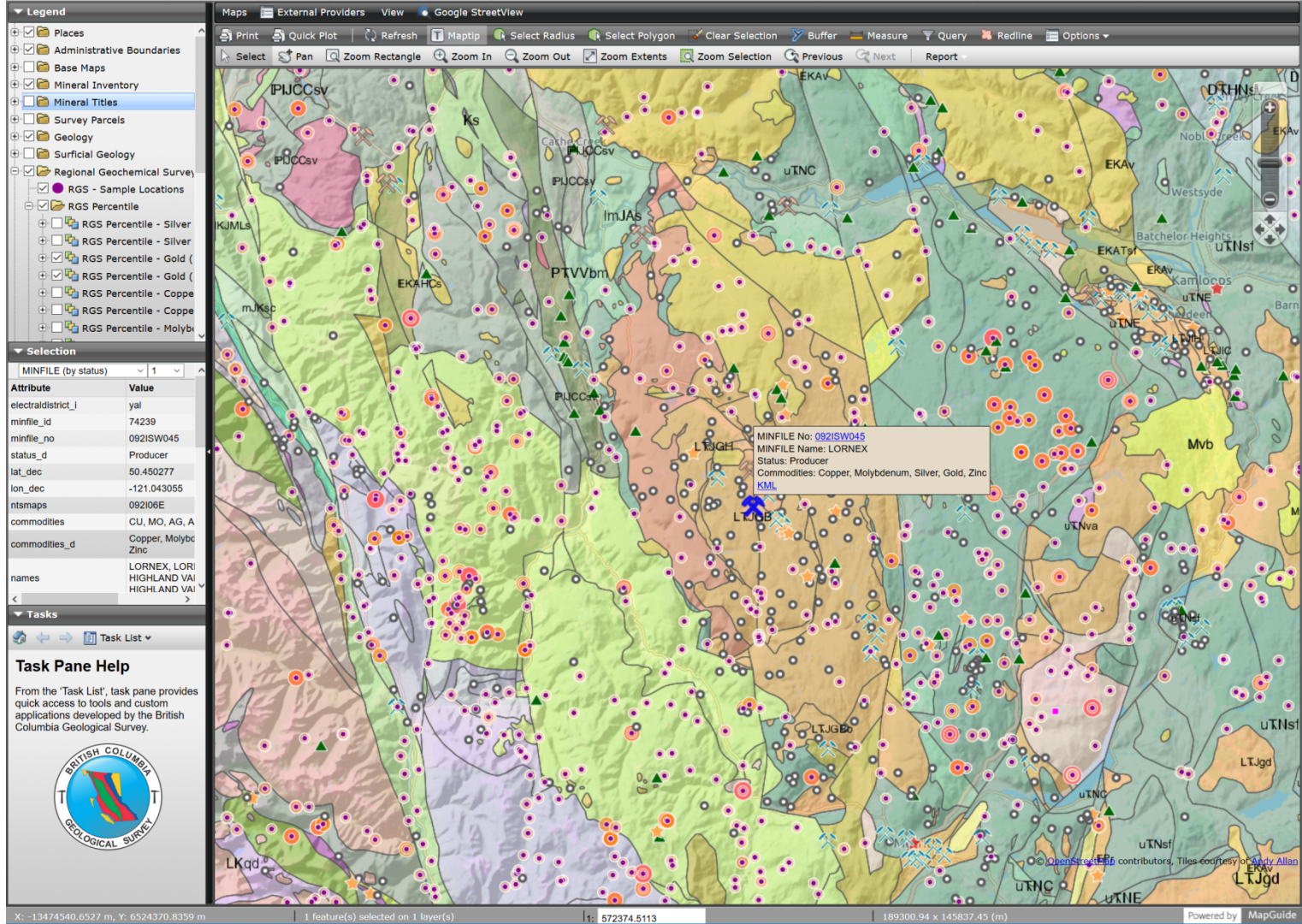
Task List

Task Pane Help

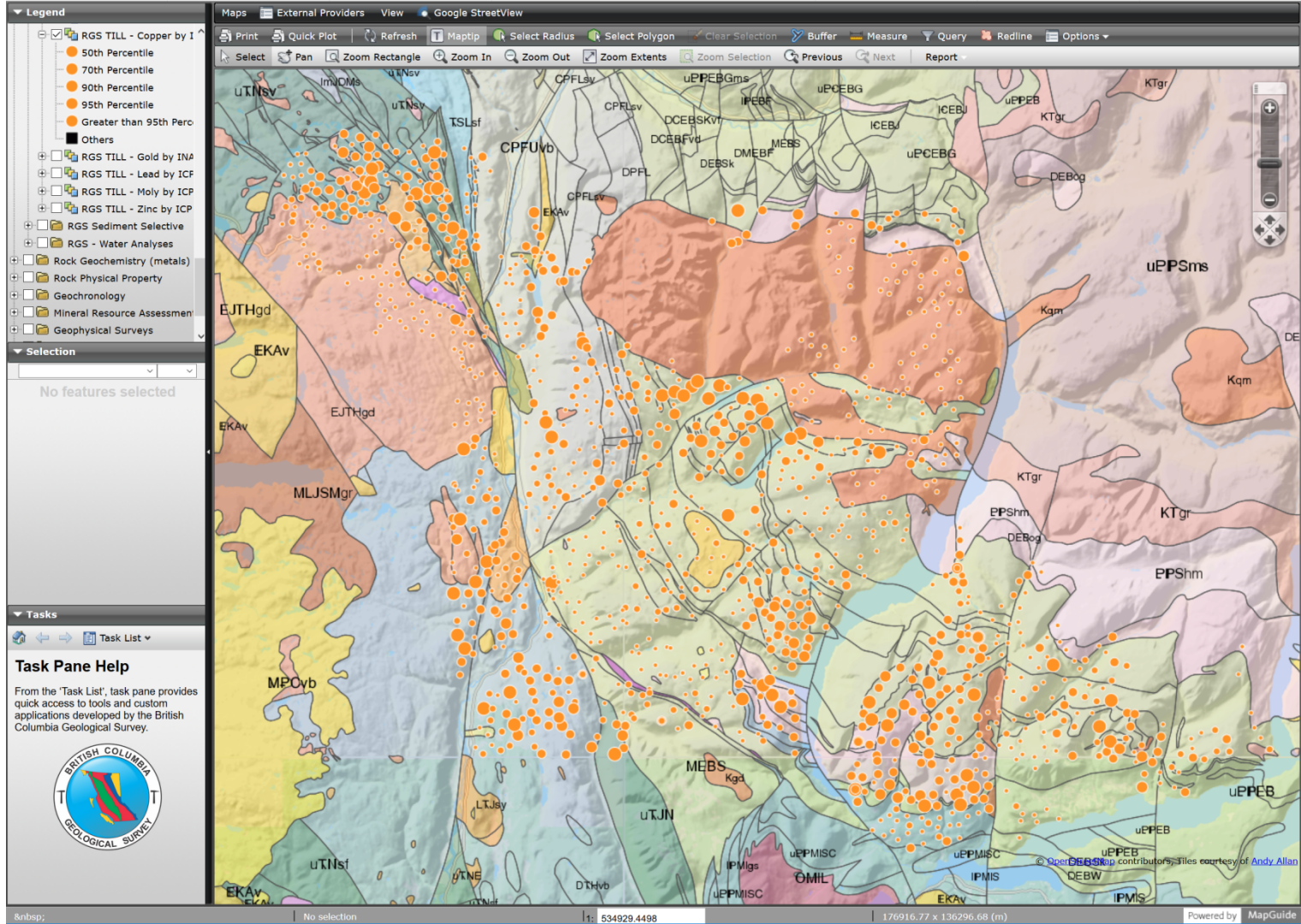
From the 'Task List', task pane provides quick access to tools for general analysis.



Bedrock geology
 Mineral occurrences
Geochemical data
 > 60,000 sites



Bedrock geology
Mineral occurrences
Geochemical data
Till geochem
focus areas



Bedrock geology
Mineral occurrences
Geochemical data
Till geochem
Ice flow indicators
> 130,000

Legend

- Surficial Geology
 - Ice-flow - Generalized Ind
 - Generalized unidirectional
 - Generalized bidirectional
 - Ice-Flow - Crag-and-Tail (I)
 - Ice-Flow - Drumlin (unidir)
 - Ice-Flow - Drumlinoid or F
 - Ice-Flow - Fluted Bedrock
 - Ice-Flow - Fluted Bedrock
 - Ice-Flow - Striation or Grc
 - Ice-Flow - Striation (unidir)
 - Surficial Geology (GSC)
 - Snowpacks (I)
 - Organic deposits - Undiffe
 - Colluvial - Veneer (Cv)
 - Colluvial - Undifferentiated
 - Alluvial sediments - Undiff
 - Marine - Offshore sedimer

Selection

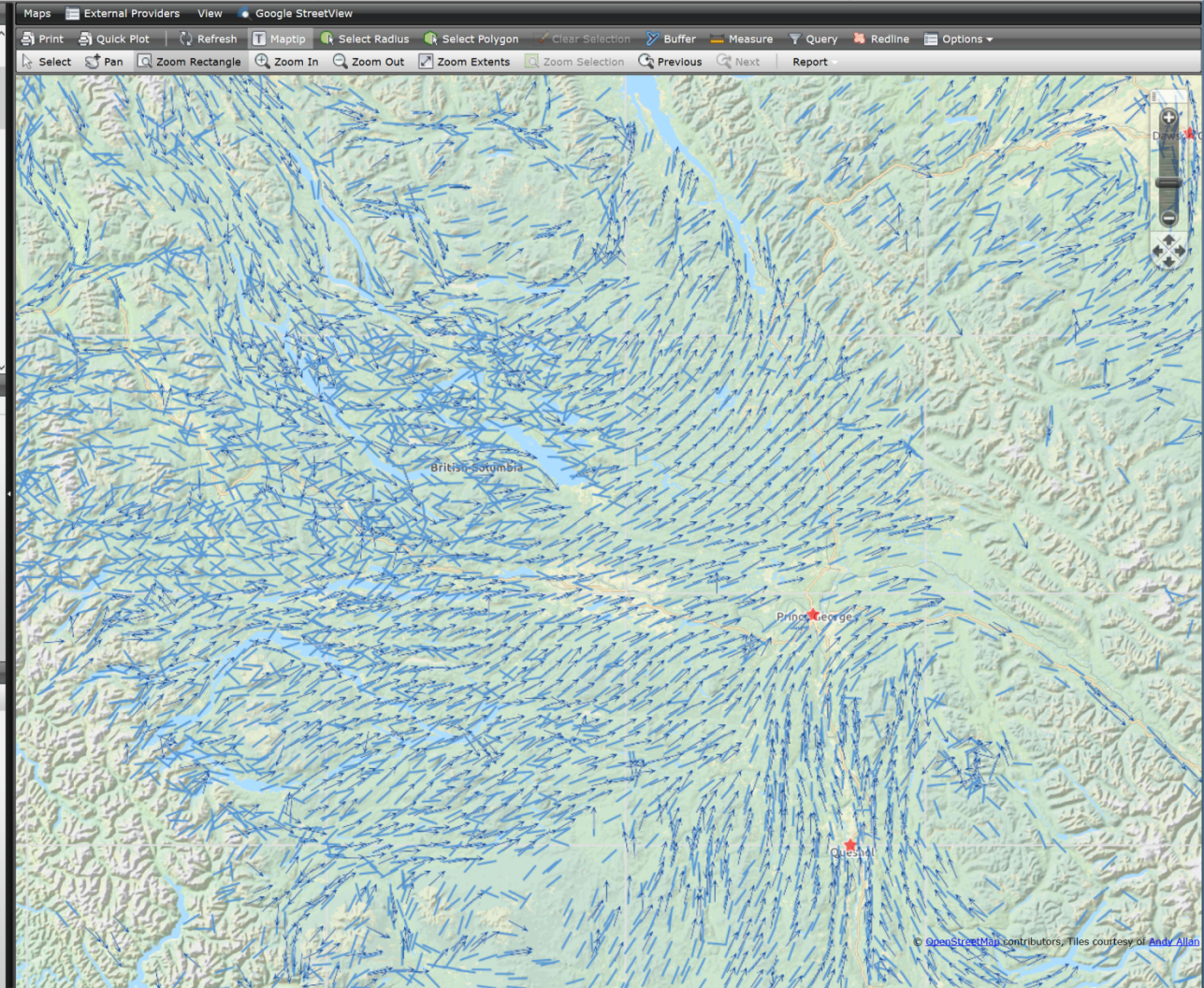

No features selected

Tasks

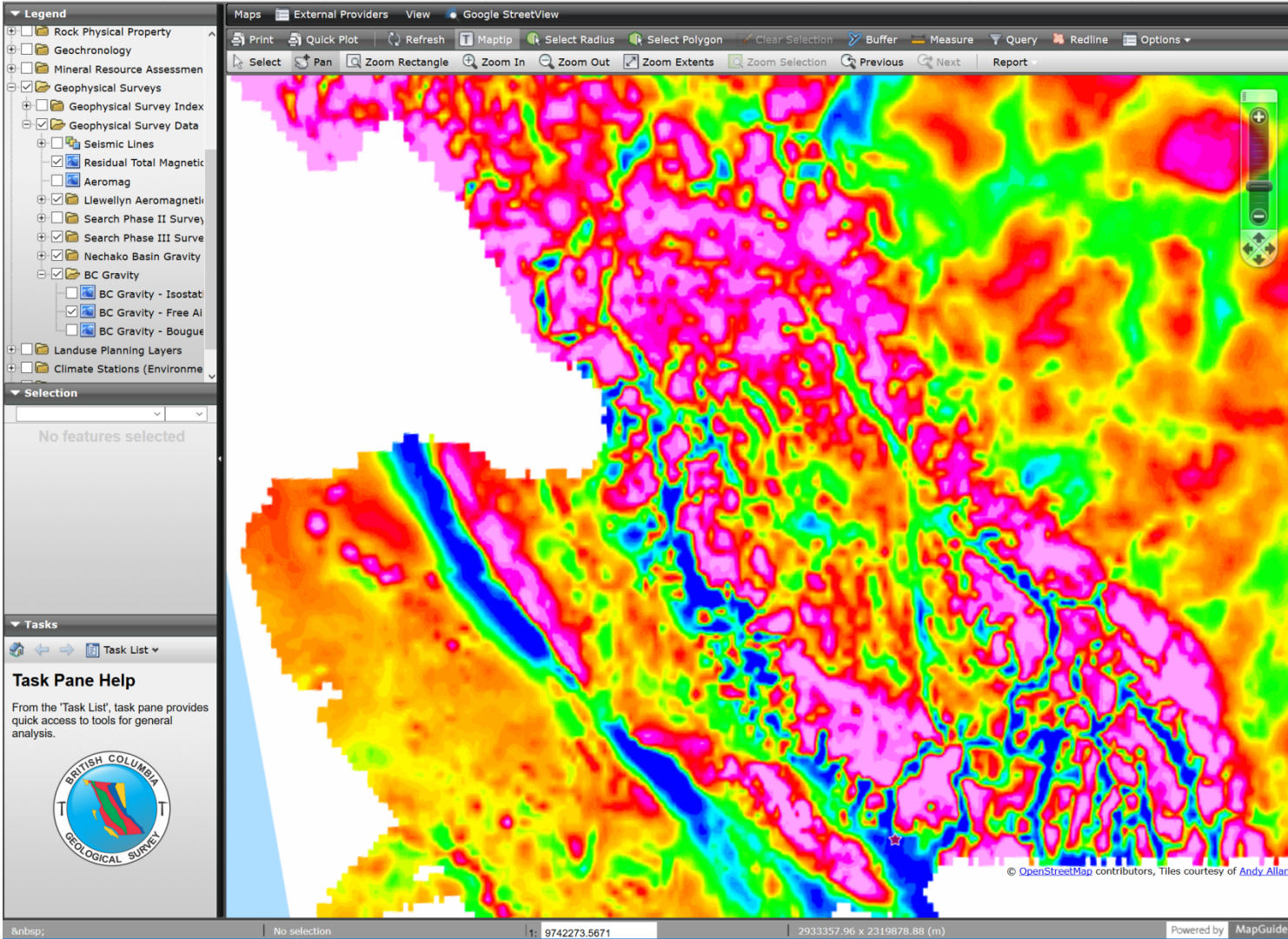
Task List

Task Pane Help

From the 'Task List', task pane provides quick access to tools and custom applications developed by the British Columbia Geological Survey.



Bedrock geology
Mineral occurrences
Geochemical data
Till geochem
Ice flow indicators
Geophysical surveys



Bedrock geology
Mineral occurrences
Geochemical data
Till geochem
Ice flow indicators
Geophysical surveys
Mineral titles

The screenshot shows a web-based map application interface. On the left is a sidebar with search filters, and on the right is a map of a mountainous region with overlaid mineral title boundaries. A tooltip is displayed over a red-shaded area on the map.

Legend
Selection
Tasks

MTO Title Search
Tenure expire date
Date format as yyyy-mm-dd (ex. 2020-11-22).
Within (day)
Tenure issue date
Date format as yyyy-mm-dd (ex. 2017-01-25).
Date
Claim name
Begin with
Owner name
Begin with
Tenure number
(One or more. For example: 222198,222491,592371)
Equal or WI
Tenure owner ID

Grid size (in hectare)
Equal

Maps External Providers View Google StreetView
Print Quick Plot Refresh Maptip Select Radius Select Polygon Clear Selection Buffer Measure Query Redline Options
Select Pan Zoom Rectangle Zoom In Zoom Out Zoom Extents Zoom Selection Previous Next Report

Task List

Tenure Number: 1036629
Title Type: Mineral
Title Sub Type: CLAIM
Claim Name: BOULDER#10
Good To Date: 2019-06-08
[KML](#)

© OpenStreetMap contributors, Tiles courtesy of Andy Allan

X: -14351666.3014 m, Y: 8049068.5673 m | No selection | 1: 301843.9797 | 96713.95 x 76907.96 (m) | Powered by MapGuide



Bedrock geology

Mineral occurrences

Geochemical data

Till geochem

Ice flow indicators

Geophysical surveys

Mineral titles

Land parcels

Tectonic assemblages

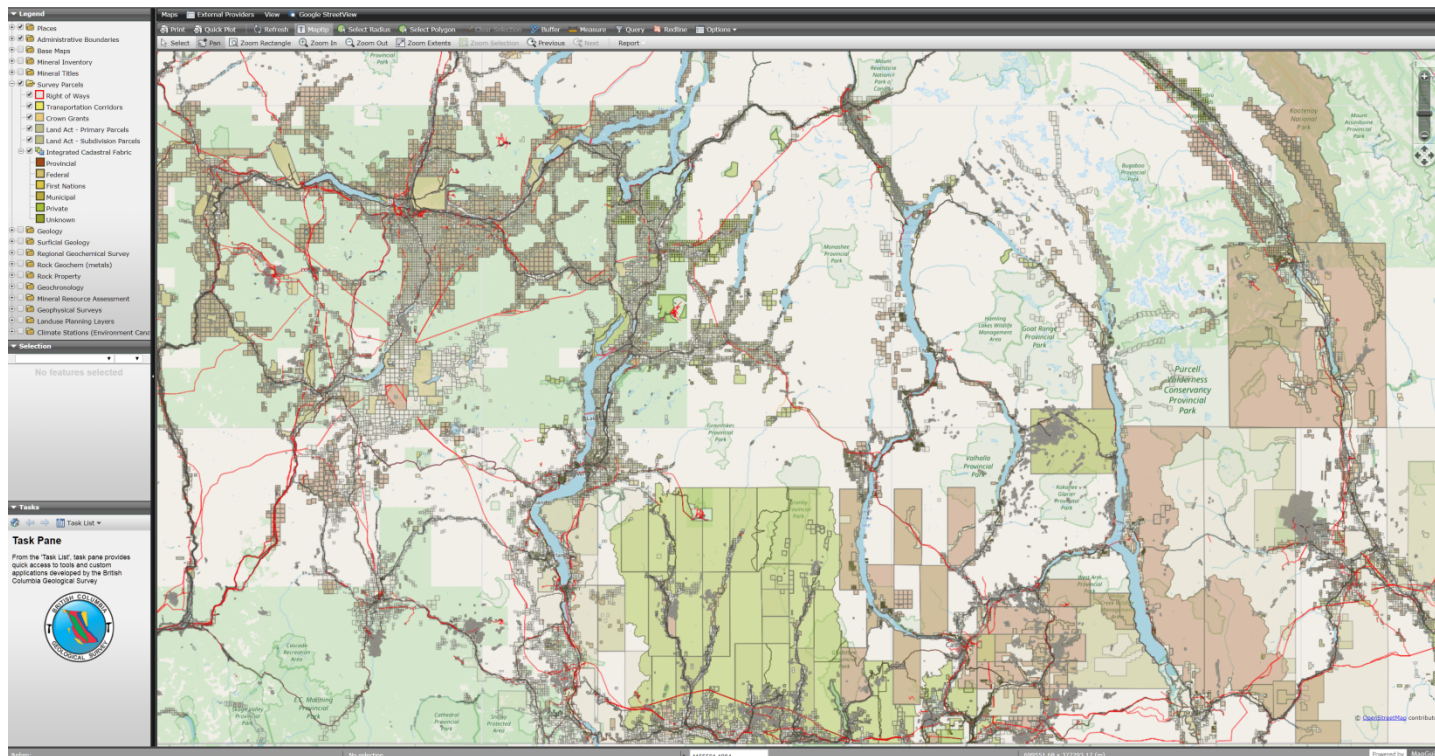
Lithogeochem

Rock physical property

Geomorphology

Publications

Mineral resource
assessment



Data mining tool

Search bedrock
Units by spatial or
non-spatial query

The screenshot displays a web-based geological data mining tool. The interface is divided into several sections:

- Legend:** Located at the top left, it shows a 'Selection' dropdown and a 'Tasks' section with a 'Task List' button.
- Geology Search Panel:** A central panel with four search categories:
 - Age:** Includes 'Phanerozoic', 'Cenozoic', 'Quaternary', and 'Neogene'. A 'Go!' button is present.
 - Lithology:** Includes 'Intrusive', 'undivided intrusives', 'syenite to monzonite', and 'high level quartz phyrrite, felsite'. A 'Go!' button is present.
 - Terrane:** Includes 'Alexander', 'Bridge River', 'Cache Creek', and 'Cadwallader'. A 'Go!' button is present.
 - Strat Name Keyword Search:** A search box containing the text 'Guichon', highlighted with a red border. A 'Find It' button is below it.
 - Strat Name List Search:** A dropdown menu with options like 'Abou Formation', 'Active Formation', 'Adamant Pluton', 'Aida Formation', and 'Aiken Lake Intrusive Complex'. A 'Go!' button is present.
- Map:** A geological map showing various rock units with labels such as PTCCMCh, EKAv, LTJGG, and IKSBPca. A tooltip is visible over the 'LTJGG' unit, providing details:
 - Strat Unit: LTJGG
 - Strat Name: Guichon Creek Batholith - Gump Lake Phase
 - Strat Age: Late Triassic to Early Jurassic
 - Rock Type: granodioritic intrusive rocks
 - UPID: 67d405a6
- Map Navigation:** A toolbar at the top right includes buttons for 'Print', 'Quick Plot', 'Refresh', 'Maptip', 'Select Radius', 'Select Polygon', 'Clear Selection', 'Buffer', 'Measure', 'Query', 'Redline', and 'Options'. Below the toolbar are navigation controls like 'Select', 'Pan', 'Zoom Rectangle', 'Zoom In', 'Zoom Out', 'Zoom Extents', 'Zoom Selection', 'Previous', 'Next', and 'Report'.
- Map Footer:** At the bottom, it shows '8mbps;', 'No selection', '1: 505753.2', '162583.85 x 128862.75 (m)', and 'Powered by MapGuide'.



Data mining tool

Getting mineral occurrences within a formation and reporting results.



A screenshot of a web-based GIS application. On the left is a legend titled "Legend" with a tree view of layers including "Geology Query Result", "Places", "Administrative Boundaries", "Base Maps", "Mineral Inventory", "Mineral Titles", "Survey Parcels", "Geology", "Geology - Faults", "Geology - Basins", "Geology - Basins (transparent)", "Geology - Terranes", "Geology - Terranes (transparent)", "Geology - Physiographic Boundary", "Geology - Physiographic Areas", "Geology - Physiographic Areas (transparent)", "Geology - Tectonic Assemblages", "Bedrock Geology", "Surficial Geology", "Regional Geochemical Survey", "Rock Geochemistry (metals)", "Rock Physical Property", "Geochronology", "Mineral Resource Assessment", "Geophysical Surveys", "Landuse Planning Layers", "Climate Stations (Environment Canada)", "Geothermal Layers", and "Oil and Gas". On the right is a map showing a geological area with labels like "PTCC", "EKAHCs", "EKAHCs", "EKAHCs", "KSBPca", "PTMMP", "PTMgd", "IKJ", and "LKPgd".

A screenshot of a web-based report page for a mineral file. The browser address bar shows "apps.empr.gov.bc.ca/pub/mapplace/mp2/report/minfile_report.asp". The page title is "MINFILE Record Summary" and "MINFILE No 092ISW014". There are buttons for "Print Preview", "PDF", and "-- SELECT REPORT --". The page is created by BC Geological Survey (BCGS) and last edited by Shielagh N. Banfield (SNB). A "SUMMARY" section is highlighted in orange, with a "Summary Help" link. The report content includes:

Name EMPIRE, BUTTLE LAKE, BL

Status Showing

Latitude [050° 27' 19"](#)

Longitude [121° 06' 44"](#)

Commodities Copper

Tectonic Belt Intermontane

Capsule Geology

The area is underlain by Early Jurassic-Late Triassic Guichon Creek batholith Bethsaida phase granodiorite to quartz monzonite. Ovoid quartz eyes and euhedral biotite "books" with minor hornblende are characteristic. Bethsaida rocks are intruded by quartz-feldspar porphyry dykes up to 30 metres wide and numerous aplite dykes up to 5 centimetres wide. Guichon variety quartz diorite outcrops to the southwest.

Intrusive contacts to the west and regional faulting define a prominent structural trend striking 010 degrees. A distinct second set of shearing strikes 045 to 065 degrees. Mineralization is localized along faulting and is of better grade and in larger bodies in the latter set. Jointing is well-developed and varies in density being more numerous close to faulting.

At the Empire showing an inclined and a vertical shaft are spaced 24 metres apart in the widest part (60 metres) of an altered shear zone. The altered shear zone pinches and swells along strike for about 185 metres. The shear strikes 050 degrees and dips very steeply to the southeast. Alteration associated with fracturing consists of intense sericitization with silicification and widespread malachite staining. Mineralization, primarily bornite with minor chalcocopyrite, is structurally controlled and occurs in thin quartz veins and as blebs, fracture-fillings and disseminations in silicified, sericitized rock. The grade of mineralization was considered uneconomic in the 1960's. Representative samples from the dumps assayed up to 1.13 per cent copper (Assessment Report 170).

Bibliography

EMPR AR 1924-139; 1930-203; 1956-45; 1963-127; 1964-85; 1965-147

EMPR ASS RPT *[170](#), [380](#), [381](#), *[490](#), [632](#), *[750](#)

EMPR BULL 56; 62

EMPR MAP *30

EMR MP CORPFILE (Laco Mines Ltd.)

GSC MAP 1010A; 1386A; 42-1989

GSC MEM 249; 262

GSC OF 980

GSC P 46-8; 47-10; 77-12

CIM Spec. Vol. 15 (1976), pp. 85-104

Northcote, K.E. (1968): Geology and Geochronology of the Guichon Creek Batholith, British Columbia, Unpublished Ph.D. Thesis, The University of British Columbia

Navigation buttons: Showing, CU, L04, and a "Powered by MapGuide" logo.

Data mining tool

Search bedrock units in the buffer, report results, download as KML, and generate legend.

Legend

- Bedrock Geology
 - Geology - Bedrock Geology (t)
 - Geology - Bedrock Geology (t)
 - Geology - Bedrock Geology
- Surficial Geology
- Regional Geochemical Survey
- Rock Geochemistry (metals)

Selection

Attribute	Value
upid	a218c4d4
strat_unit	LTrJGBe
strat_age	Late Triassic to Early Jurassic
strat_name	Gulchon Creek Batholith - Bethlehem Phase
terrane	Quesnellia
terr_code	QN

Tasks

Select Within

Select areas on the image.

Restrict results to selected layers:

- MTO - All Tiles
- MTO - History
- MTO - Reserves
- Industrial Mineral Potential (by rank)
- Metallic Mineral Potential (by rank)
- Geology - Bedrock Geology (transparent)
- Geology - Bedrock Geology (boundary)
- Geology - Bedrock Geology (transparent)
- Geology - Bedrock Geology**

Refresh

- If you continue to select areas on the image, click "Refresh" to update the layer list.
- To finish and select all features within the highlighted areas, click "Done".
- To start over, click "Clear".

Done Clear

Map Interface

75 feature(s) selected on 1 layer(s) | 1: 880537.3564 | 283065.24 x 224355.41 (m)

Powered by MapGuide

© OpenStreetMap contributors, data courtesy of Andy Allan


MapGuide

Options

- Refresh
- Pan
- Zoom Rectangle
- Zoom In
- Zoom Out
- Zoom
- Select
- Clear Selection
- Select More
- Buffer
- Measure
- Feature Info
- Query
- Redline
- Mineral Inventory Reports
 - MTO Reports
 - Geology
 - Bedrock Geology Report
 - RGS Reports
 - Bedrock Geology in KML (selected units)
 - Rock Geochem Reports
 - Bedrock Legend (selected units)
 - Rock Property Reports
 - Bedrock Legend (all units in BC)
 - BC Age Reports
 - MRA Reports
 - Geophysical Survey Reports
- Options
- Help
- About



apps.empr.gov.bc.ca/pub/mapplace/mp2/report/bedrock_report_legend_selected.asp 110%



Geology Legend

[Geology Legend \(all units in BC\)](#)
[Back to Main Table](#)

Miocene

- Mivb basaltic volcanic rocks

Eocene

Kamloops Group

- EKAv undivided volcanic rocks
- EKAs undivided sedimentary rocks
- EKAv undivided volcanic rocks
- EKAv undivided volcanic rocks

Princeton Group

- EPrb andesitic volcanic rocks
- Etp feldspar porphyritic intrusive rocks

Lower Cretaceous

Spences Bridge Group

- IKSBPca **Pimainus Formation:** calc-alkaline volcanic rocks
- IKSBPva **Pimainus Formation:** andesitic volcanic rocks
- IKSBsva **Spus Creek Formation:** andesitic volcanic rocks

Lower Jurassic to Middle Jurassic

- ImJas Ashcroft Formation: undivided sedimentary rocks
- ImJA Ashcroft Formation: mudstone, siltstone, shale fine clastic sedimentary rocks

Late Triassic


Gaichon suite

- LTrGCBgd **Gaichon Creek batholith - Border phase:** granodioritic intrusive rocks
- LTrGCSqm **Gaichon Creek batholith - Spatum quartz monzonite:** quartz monzonitic intrusive rocks


Late Triassic to Early Jurassic

Gaichon Creek Batholith

- LTrJGBe **Bethlehem Phase:** granodioritic intrusive rocks
- LTrJGG **Gamp Lake Phase:** granodioritic intrusive rocks
- LTrJGH **Highland Valley Phase:** granodioritic intrusive rocks
- LTrJGp high level quartz phyric, felsitic intrusive rocks
- LTrJGb **Border Phase:** quartz dioritic intrusive rocks



apps.empr.gov.bc.ca/pub/mapplace/mp2/report/bedrock_report.asp 110%



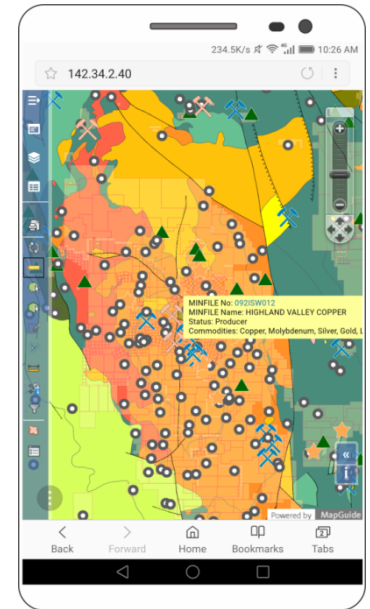
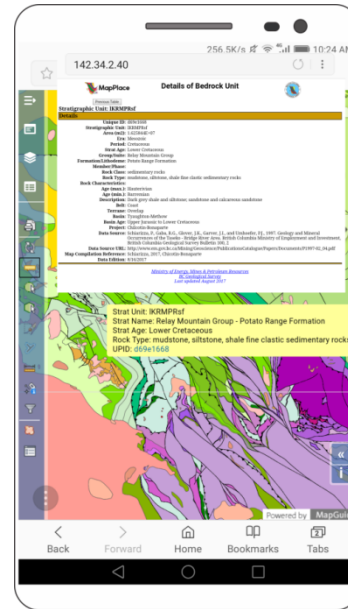
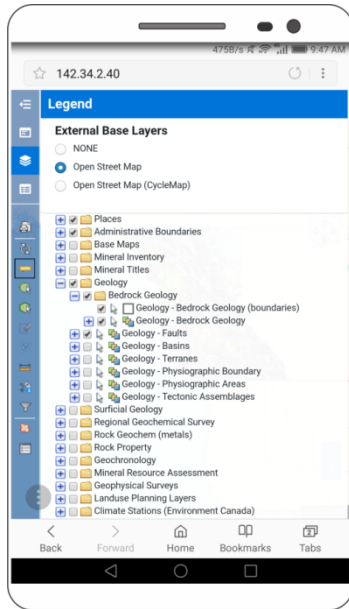
Summary of Bedrock Geology

[Download in KML](#)
[Bedrock legend \(selected units\)](#)
[Bedrock legend \(all units in BC\)](#)
 Click on [LTPD](#) for more information.
 Click column headings to sort results.

UPID	Strat Unit	Strat Name	Period	Strat Age	Rock Class	Rock Type	Age (maximum)	Age (minimum)	Terrane	Project	Google Earth	Bedrock Colour
0205a072	EKAv	Kamloops Group	Paleogene	Eocene	volcanic rocks	undivided volcanic rocks	Eocene	Eocene	Overlap	Okanagan		
05d21f2	LTrJGBo	Gaichon Creek Batholith - Border Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	quartz dioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
0811a952	EKAv	Kamloops Group	Paleogene	Eocene	volcanic rocks	undivided volcanic rocks	Eocene	Eocene	Overlap	Okanagan		
109a2904	EKAv	Kamloops Group	Paleogene	Eocene	volcanic rocks	undivided volcanic rocks	Eocene	Eocene	Overlap	Okanagan		
13613c04	LTrJGBe	Gaichon Creek Batholith - Bethlehem Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	granodioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
1647599a	EPrb	Princeton Group	Paleogene	Eocene	volcanic rocks	andesitic volcanic rocks	Eocene	Eocene	Overlap	Okanagan		
19b1a84b	LTrJGBe	Gaichon Creek Batholith - Bethlehem Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	granodioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
1d890063	KSBSva	Spences Bridge Group - Spus Creek Formation	Cretaceous	Lower Cretaceous	volcanic rocks	andesitic volcanic rocks	Albian	Albian	Overlap	Okanagan		
1f2c04f4	PTrVvbm	Vanables Valley assemblage	Permian to Triassic	Upper Permian to Middle Triassic	volcanic rocks	bimodal volcanic rocks	Upper Permian	Middle Triassic	Cache Creek	Chilcotin-Bonaparte		
17786021	ImJAs	Ashcroft Formation	Jurassic	Lower Jurassic to Middle Jurassic	sedimentary rocks	undivided sedimentary rocks	Lower Jurassic	Middle Jurassic	Quesnelia	Chilcotin-Bonaparte		
19a0e011	LTrJGBo	Gaichon Creek Batholith - Border Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	quartz dioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
2166e80b	LTrGCSpqm	Gaichon suite - Gaichon Creek batholith - Spatum quartz monzonite	Triassic	Late Triassic	intrusive rocks	quartz monzonitic intrusive rocks	Late Triassic	Late Triassic	Quesnelia	Chilcotin-Bonaparte		
23038955	EKAv	Kamloops Group	Paleogene	Eocene	volcanic rocks	undivided volcanic rocks	Eocene	Eocene	Overlap	Chilcotin-Bonaparte		
28b4a45b	Etp		Paleogene	Eocene	intrusive rocks	feldspar porphyritic intrusive rocks	Eocene	Eocene	Post Accretionary	Cariboo		
2b142298	EKAv	Kamloops Group	Paleogene	Eocene	volcanic rocks	undivided volcanic rocks	Eocene	Eocene	Overlap	Okanagan		
30a7e195	uTrN	Nicola Group	Triassic	Upper Triassic	volcanic rocks	undivided volcanic rocks	Upper Triassic	Upper Triassic	Quesnelia	Okanagan		
36010062	uTrNC	Nicola Group - Central Volcanic Facies	Triassic	Upper Triassic	volcanic rocks	andesitic volcanic rocks	Upper Triassic	Upper Triassic	Quesnelia	Okanagan		
38997422	EKAv	Kamloops Group	Paleogene	Eocene	volcanic rocks	undivided volcanic rocks	Eocene	Eocene	Overlap	Chilcotin-Bonaparte		
3d059633	uTrNW	Nicola Group - Western Volcanic Facies	Triassic	Upper Triassic	volcanic rocks	undivided volcanic rocks	Upper Triassic	Upper Triassic	Quesnelia	Chilcotin-Bonaparte		
3e176223	EPrb	Princeton Group	Paleogene	Eocene	volcanic rocks	andesitic volcanic rocks	Eocene	Eocene	Overlap	Okanagan		
42a18b03	LTrJGBo	Gaichon Creek Batholith - Bethesda Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	quartz monzonitic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
431472ba	LTrJgd		Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	granodioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
47d44459	EKAv	Kamloops Group	Paleogene	Eocene	volcanic rocks	undivided volcanic rocks	Eocene	Eocene	Overlap	Okanagan		
49749538	LTrGCBgd	Gaichon suite - Gaichon Creek batholith - Border phase	Triassic	Late Triassic	intrusive rocks	granodioritic intrusive rocks	Late Triassic	Late Triassic	Quesnelia	Chilcotin-Bonaparte		
4d42eaf4	LTrJGBo	Gaichon Creek Batholith - Border Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	quartz dioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
517c18ba	LTrJGH	Gaichon Creek Batholith - Highland Valley Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	granodioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
5d8b032	uTrNW	Nicola Group - Western Volcanic Facies	Triassic	Upper Triassic	volcanic rocks	undivided volcanic rocks	Upper Triassic	Upper Triassic	Quesnelia	Chilcotin-Bonaparte		
60726e95	LTrJGH	Gaichon Creek Batholith - Highland Valley Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	granodioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		
64c8599e	LTrJGBe	Gaichon Creek Batholith - Bethlehem Phase	Triassic to Jurassic	Late Triassic to Early Jurassic	intrusive rocks	granodioritic intrusive rocks	Late Triassic	Early Jurassic	Quesnelia	Okanagan		

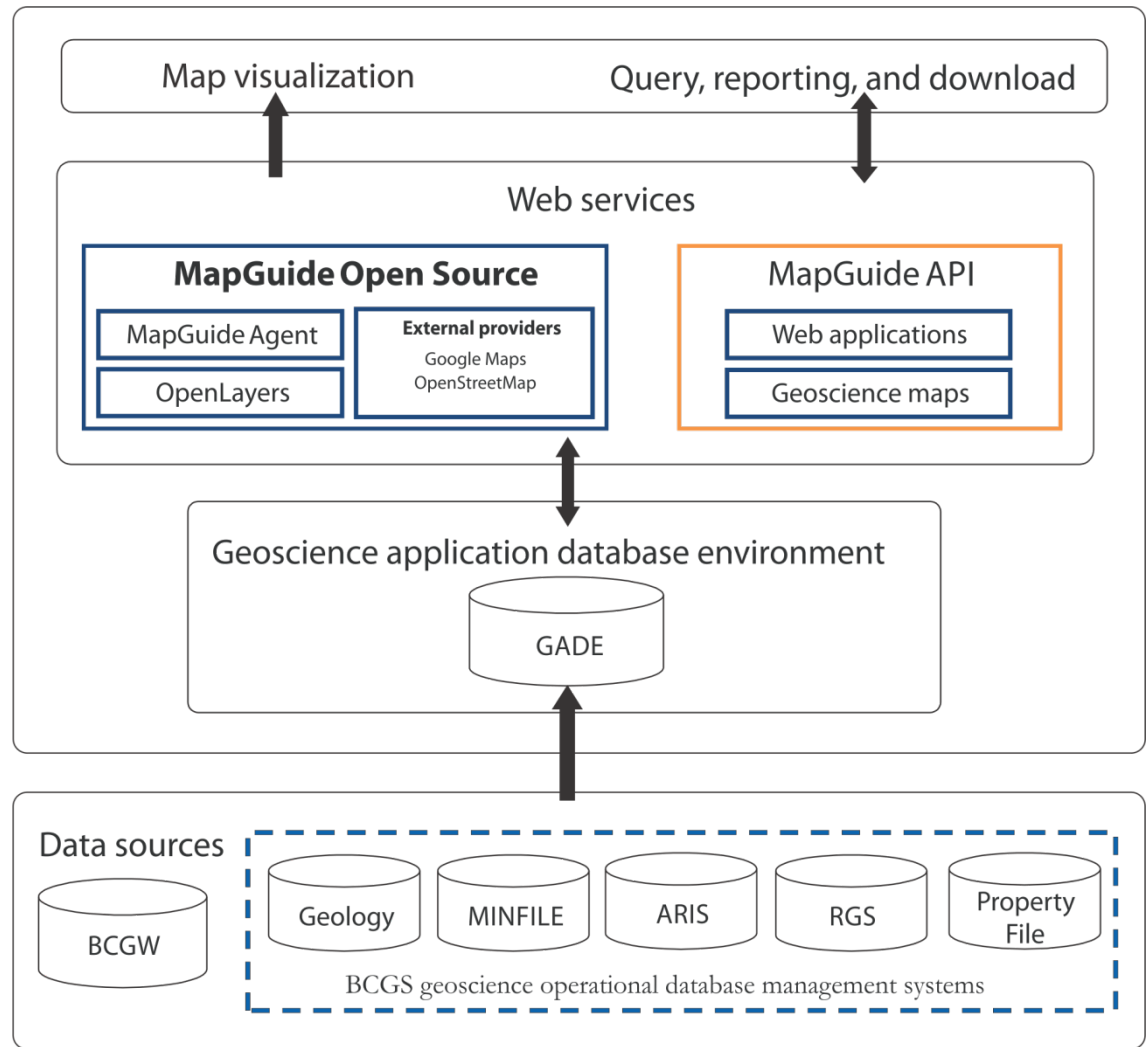
MapPlace 2 for mobile devices

- Simple queries
- API to details



MapPlace 2 system view

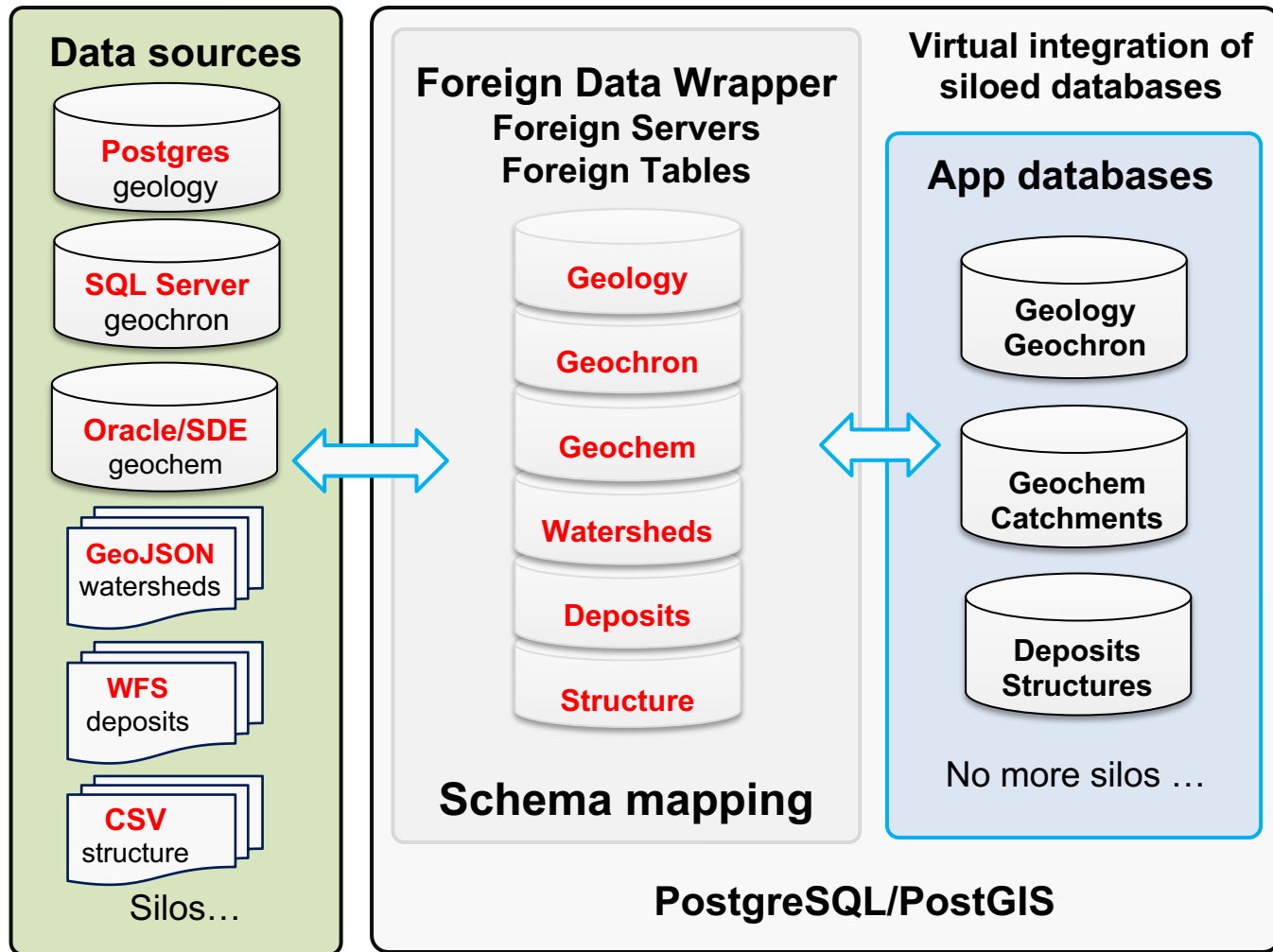
Build on open source software for geospatial



Foreign Data Wrapper

Extensively used to build the MapPlace 2 application databases to virtually integrated data from various data sources.

Database silo is a reality and not necessary a negative thing. It means data are maintained at the sources by the people who understand the data.



Foreign Data Wrapper

Added to SQL standard in 2003: SQL Management of External Data (SQL/MED)

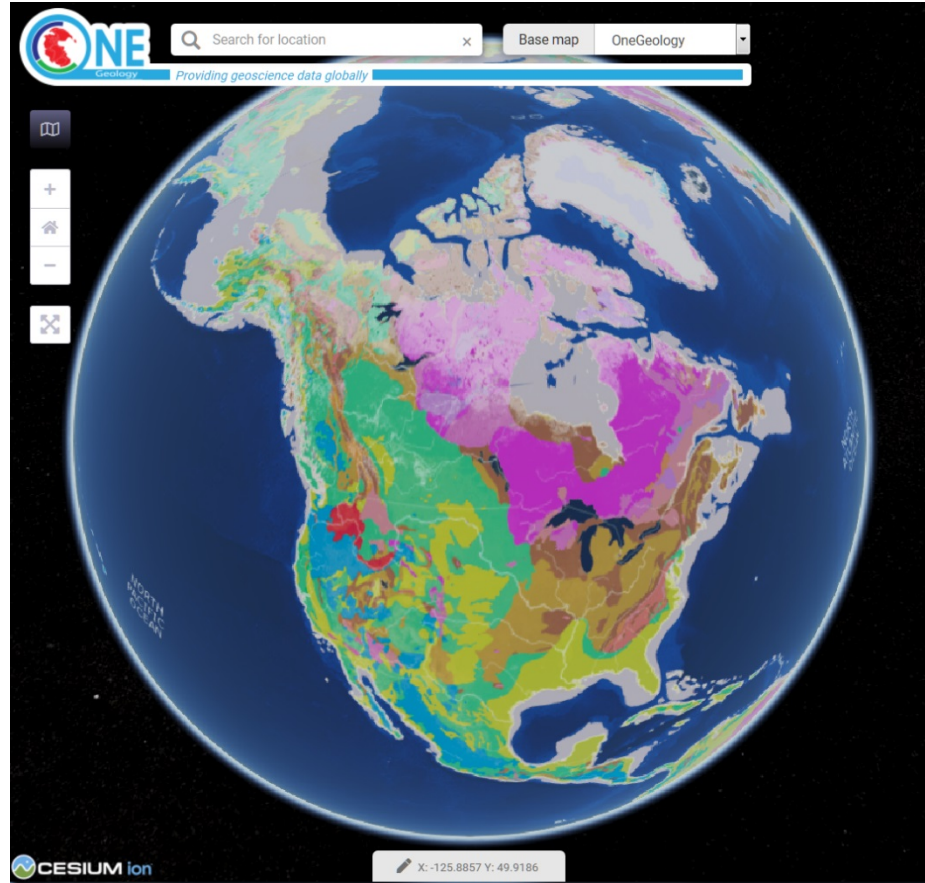
- **Geo wrappers:** GDAL/OGR, Geocode/GeoJSON, OSM PBF
- **Specific SQL database wrappers:** Oracle, MS SQL Server
- **Generic SQL database wrappers:** ODBC, JDBC
- **NoSQL database wrappers:** Cassandra2, CouchDB
- **File wrappers:** CSV, pg_dump, JSON, XML, TAR, ZIP files
- **LDAP wrappers:** LDAP
- **Generic web wrappers:** Git, ICAL, IMAP, RSS, www
- **Specific web wrappers:** Face, Google, Twitter, DynamoDB
- **Big data wrappers:** Elastic Search, Hadoop, Hive, HDFS, Impala
- **Column-oriented wrappers:** Columnar Store, MonetDB
- **Scientific wrappers:** Ambry, ROOT files, VCF files
- **Operating system wrappers:** Dockers, Log file, OS Query, Passwd
- **Exotic wrapper:** fdw_fdw, PPG, Open Civic Data, Random Number



International Geoscience Standard

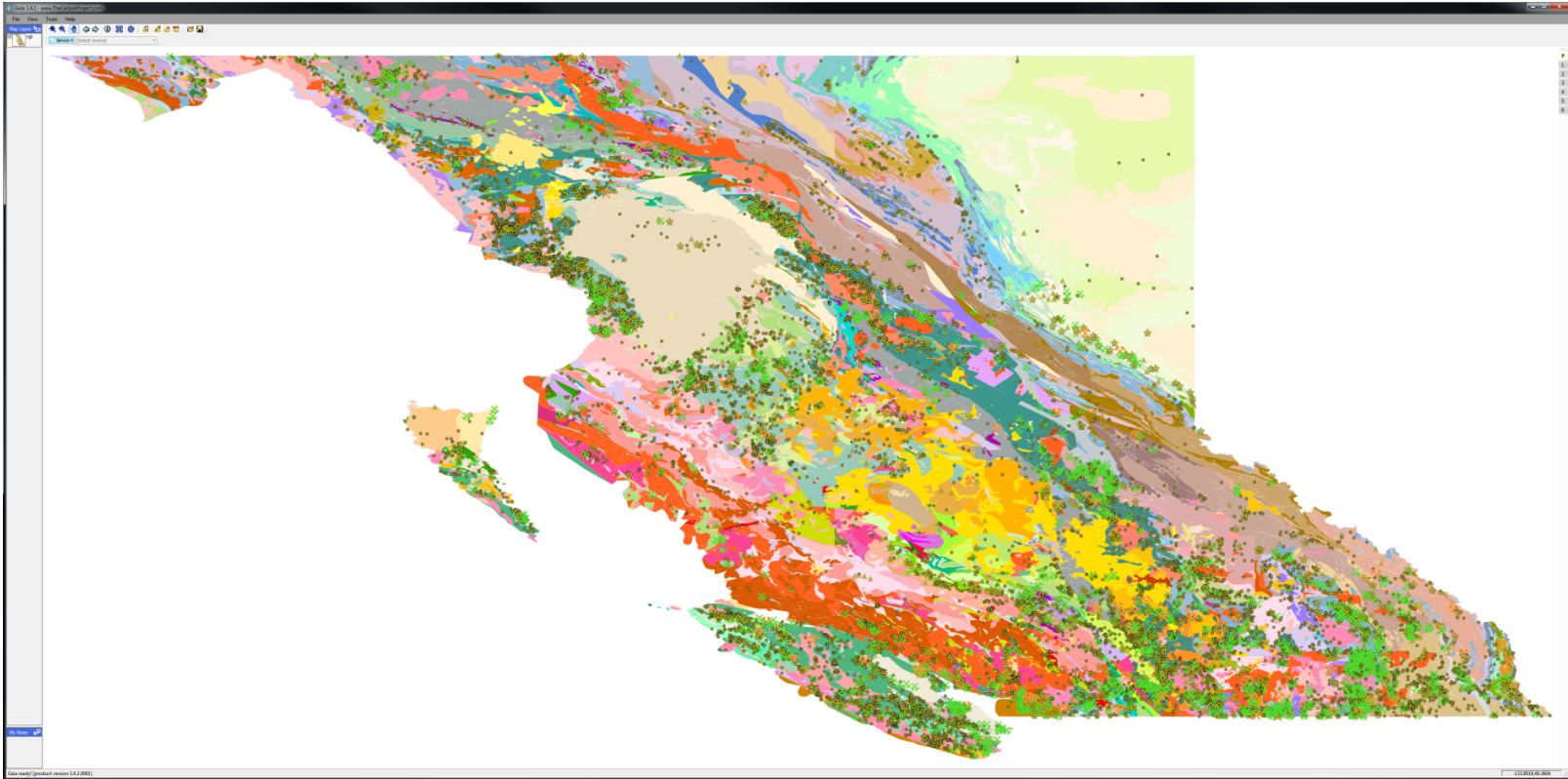
IUGS / OGC standards

- GeoSciML
- EarthResourceML

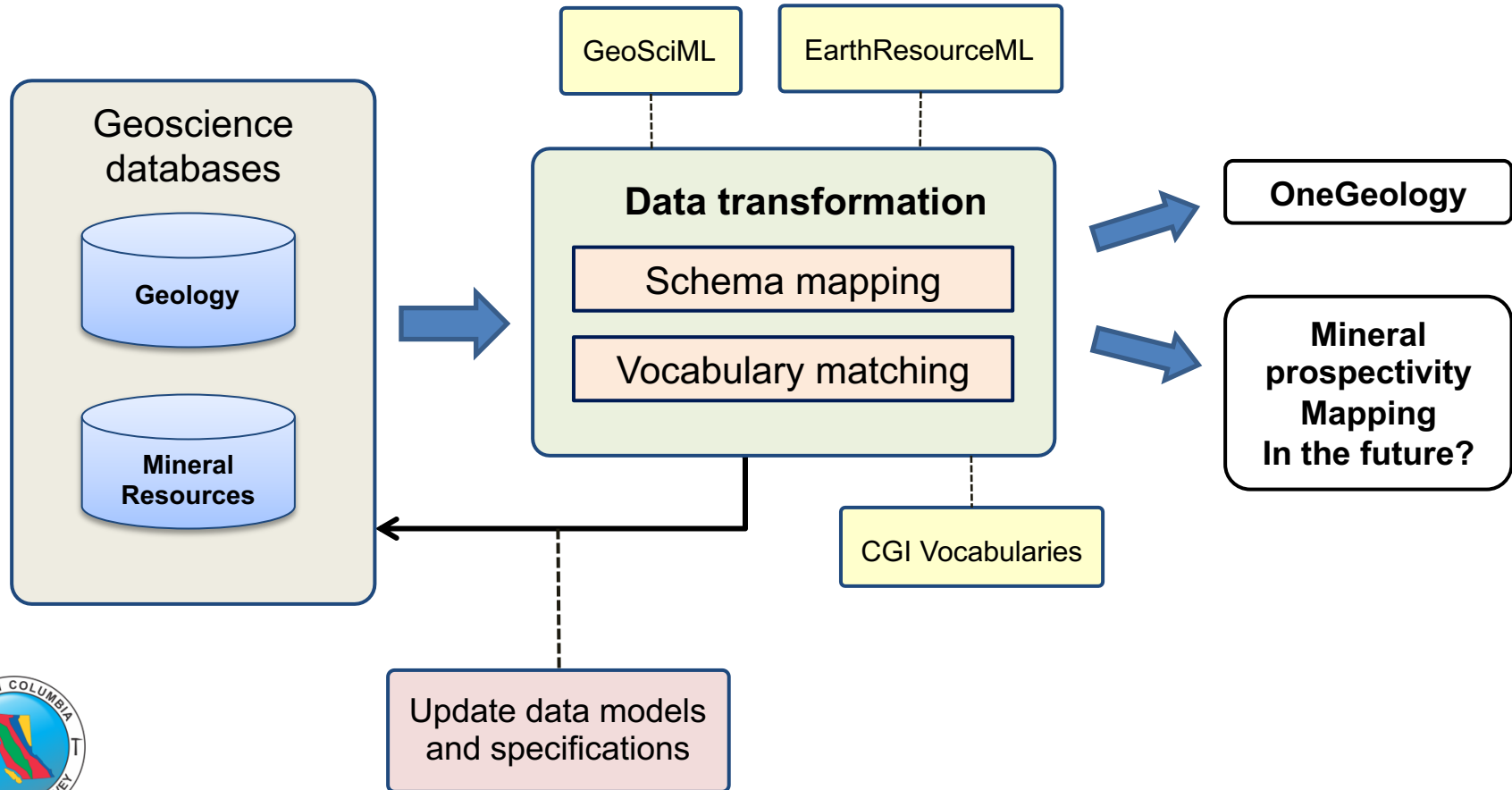


BCGS bedrock geology and mineral resources

at scale of 1:250,000, as WMS and WFS, posted to OneGeology



Towards GeoSciML and EarthResourceML



Solutions originated from Victoria

PostGIS, spatial extension to PostgreSQL

- Originated from Victoria
- Spatial library GEOS, ported from JTS Topology Suite
- JTS was developed by Martin Davis (2011 Sol Katz Award Winner), teamed up with and specified by staff from the Province of British Columbia, and partially funded by Natural Resource Canada.

JEQL Query Language

- Developed by Dr. JTS, Martin Davis from Victoria, BC
- a scripting language engine for spatial ETL and manipulation of spatial and non-spatial data, implemented on the Java platform
- table-oriented programming
- access to JTS spatial library



Summary

Streamlined from field to web services

- Driven by mineral prospectivity mapping, land use management and interoperable web services
- System architecture centres on geospatial frame data (digital geology), not maps
- Operation follows lifecycle of geospatial data:
 - observation, compilation, integration, production



Thank you!



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