Development of MapPlace 2 geospatial web service to disseminate geoscience in British Columbia

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Abstract

MapPlace 2 is a geospatial web service developed in-house by the British Columbia Geological Survey. Based on user requirements determined from operating the original MapPlace for more than 20 years, MapPlace 2 has a modernized interface for visualization, and has improved performance. Through this interface, MapPlace 2 enables efficient browsing, displaying, searching, reporting, and analyzing data from multiple geoscience, mineral resource and tenure databases. It works on any web browser, requires no plug-ins, and can rapidly retrieve and display large volumes of data and third-party topographic maps and imagery, thus facilitating data mining by anyone interested in British Columbia geoscience. Built on open-source geospatial software, MapPlace 2 uses MapGuide Open Source as the web service platform, OpenLayers for rendering, and PostgreSQL/PostGIS for the application database. BCGS continues to add new data and databases and is developing a light version for mobile devices.

Keywords: MapPlace, geospatial web service, spatial database, geoscience

1. Introduction

MapPlace 2 (Fig. 1) is the geospatial web service developed by the British Columbia Geological Survey (BCGS) to serve the needs of the mineral exploration industry, environmental organizations, resource planners, public safety agencies, communities, First Nations, government, research organizations, and the general public. Developed entirely in-house, it builds on the success of MapPlace, which has been online since 1997 and has a proven record of helping decision makers reduce the costs of accessing and analyzing geoscience data. In contrast to the original, MapPlace 2 is easier to use and has much improved functionality and performance. It can be used on either a Mac or a PC, does not require plug-ins, and works on all web browsers. In addition, it allows visualizing and querying province-wide geoscience data at exceptional speed and provides applications to search, analyze, report, and download these data.

This paper provides a brief tour of MapPlace 2, highlighting how it has evolved, how it functions, what users can expect, key elements of its architecture and the development process, and plans for the future. For more detailed information how to use MapPlace 2, please refer to the workbook by Cui et al. (2017a).

2. History: from MapPlace to MapPlace 2

In 1995, BCGS geologist Ward Kilby started building MapPlace to make geoscience data from across the province accessible online. The initial version was based on Argus Technologies MapGuide, which was acquired by Autodesk in

Fig. 1. MapPlace 2 logo.

1996 and later released as Autodesk MapGuide (Bray, 2008). MapPlace was released to public in 1997, and has since evolved to include not only a comprehensive suite of geoscience and related data, maps, and satellite imagery, but also advanced web applications (Kilby, 1999; Tupper et al., 2001; Jones et al., 2002; Kilby et al., 2004). By 2003, an image analysis toolbox and enhanced satellite imagery were integrated into MapPlace, with online image processing capacity on multispectral and hyperspectral images (Kilby et al., 2004), an analytical technique typically only available through specialized software. Although MapPlace served the province well for more than 20 years, advances in technology made maintaining the service difficult.

MapPlace was built on a version of Autodesk MapGuide (6.5) that is now obsolete. Autodesk MapGuide required that users install a viewer plug-in that was built for early versions of the Microsoft Internet Explorer web browser and MapPlace could not work on other operating systems or browsers. Moreover, this version was last released in 2004 and vendor support ended in 2010, effectively ending upgrades to MapPlace. Keeping

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MapPlace operational was also problematic. During its lifetime, most of the data products and applications in MapPlace were added as either ad hoc solutions or in response to requests from clients. Although this approach enabled MapPlace to be highly adaptable, it resulted in a difficult to maintain patchwork of inconsistent data models, multiple scripting languages, and obsolete database technologies, some of which needed to comply with government security policies. These challenges prompted BCGS to conduct a complete overhaul.

In 2012, after testing several platforms, we selected MapGuide Open Source to build a prototype. MapGuide Open Source gained a significant performance boost after incorporating a new version of OpenLayers (OpenLayers, 2017) as the rendering engine. By 2014, the first working prototype of MapPlace 2 was completed and made available to the public. We invited clients to test its performance and usability, and held a workshop to gather further feedback. Encouraged by early results, we continued to improve the functionality, culminating in a beta release as MapPlace 2 in 2016 (Cui et al., 2017a).

3. MapPlace 2 functional components and their applications

MapPlace 2 has two major functional components: 1) an application database for BCGS geoscience and related data from other government agencies; and 2) a web interface with tools and custom applications.

3.1. Geoscience and related data

MapPlace 2 disseminates geoscience data through a web interface that also provides other, land-related data such as mineral tenures, survey parcels, and topographic base maps and imagery. The geoscience data are organized in folders (Fig. 2) for easy discovery and browsing, and themed as map layers with styles, symbols, and legends (Fig. 3). Many of the data displayed in the map window are linked to databases and can be retrieved and downloaded.

The bedrock layer includes the current province-wide bedrock geology, with more than 33,000 units mapped at scales from 1:50,000 to 1:250,000 (Cui et al., 2017b). Other geological information, such as terranes, basins, physiographic areas, and tectonic assemblages are also available. MINFILE is British Columbia's mineral inventory of more than 14,600 metallic, industrial mineral, and coal occurrences. The Assessment Report Indexing System (ARIS) is a collection of more than 36,600 reports submitted to the Ministry summarizing exploration work on mineral claims. Similar to ARIS, COALFILE is a collection of close to 1000 coal assessment reports. Property File is a collection of more than 65,000 scanned and georeferenced documents donated to BCGS by government, university, industry, and individuals in the last 150 years.

MapPlace 2 hosts several geochemical and geophysical data sets. Geochemical data have been updated recently. The Regional Geochemical Survey (RGS) data contain multi-element analyses from stream, moss, and water samples collected from across the province since the 1970s (Han and Rukhlov, 2017). The till geochemical data include analyses of nearly 10,500 samples from 39 till surveys (Bustard et al., 2017). Geophysical data include multisensor, airborne geophysical surveys of the entire province and targeted areas.

Several surficial geology layers are available. For example, one layer provides an index of available maps, with URLs to publication and data sources. Another layer includes ice-flow indicators (Arnold et al., 2016), themed by landforms that provide information on the flow directions of the Cordilleran Ice Sheet during the last glaciation.

The BCGS publication catalogue includes Papers, Open Files, GeoFiles, Geoscience Maps, Information Circulars, Mineral Deposit Profiles, and Bulletins published since 1874. These publications present the results of field-based projects conducted by the BCGS and the Geological Survey of Canada. MapPlace 2 offers footprints for many of these products allowing for rapid and efficient research.

Data sourced directly from the British Columbia Geographic Warehouse, include administrative boundaries, place names, topographic base maps, map grids, and public records of mineral, placer, and coal tenures from the Mineral Titles Office. Land use planning data include details such as community watersheds, habitat/wildlife management areas, protected areas, recreation and tourism areas, and settlements. Locations for climate, hydrometric and water quality stations are from Environment Canada. MapPlace 2 embeds access to a number of third party topographic base maps and imagery from external providers (Fig. 4), including Google Maps (transportation networks, imagery, and shaded relief), and OpenStreetMap (with transportation networks themed with topographic features).

3.2. MapPlace 2 functions and application highlights

MapPlace 2 provides tools very similar to typical desktop GIS software. It retains much of the functionality of the original MapPlace, but with improved performance, more advanced applications, and additional features.

3.2.1. Visualization

MapPlace 2 has a modernized user interface for visualization, and has improved performance in retrieving and displaying large volumes of province-wide data. In typical use, it takes less than one second to display maps of the entire province, which is significantly faster than similar services that handle this level of data. In addition, the new platform takes advantage of third-party developments. For example, Google StreetView has been embedded and can be used to view bedrock outcrops (Fig. 5), mineralization, mine sites, and even underground mines.

3.2.2. Basic functions and tools

MapPlace 2 has a set of basic tools to interact with the maps. A user can zoom and pan the maps by using the navigation control, the buttons on the menu bar, or a combination of click and drag (Fig. 2). Features on many of the map layers can be selected and descriptions viewed or reports generated by
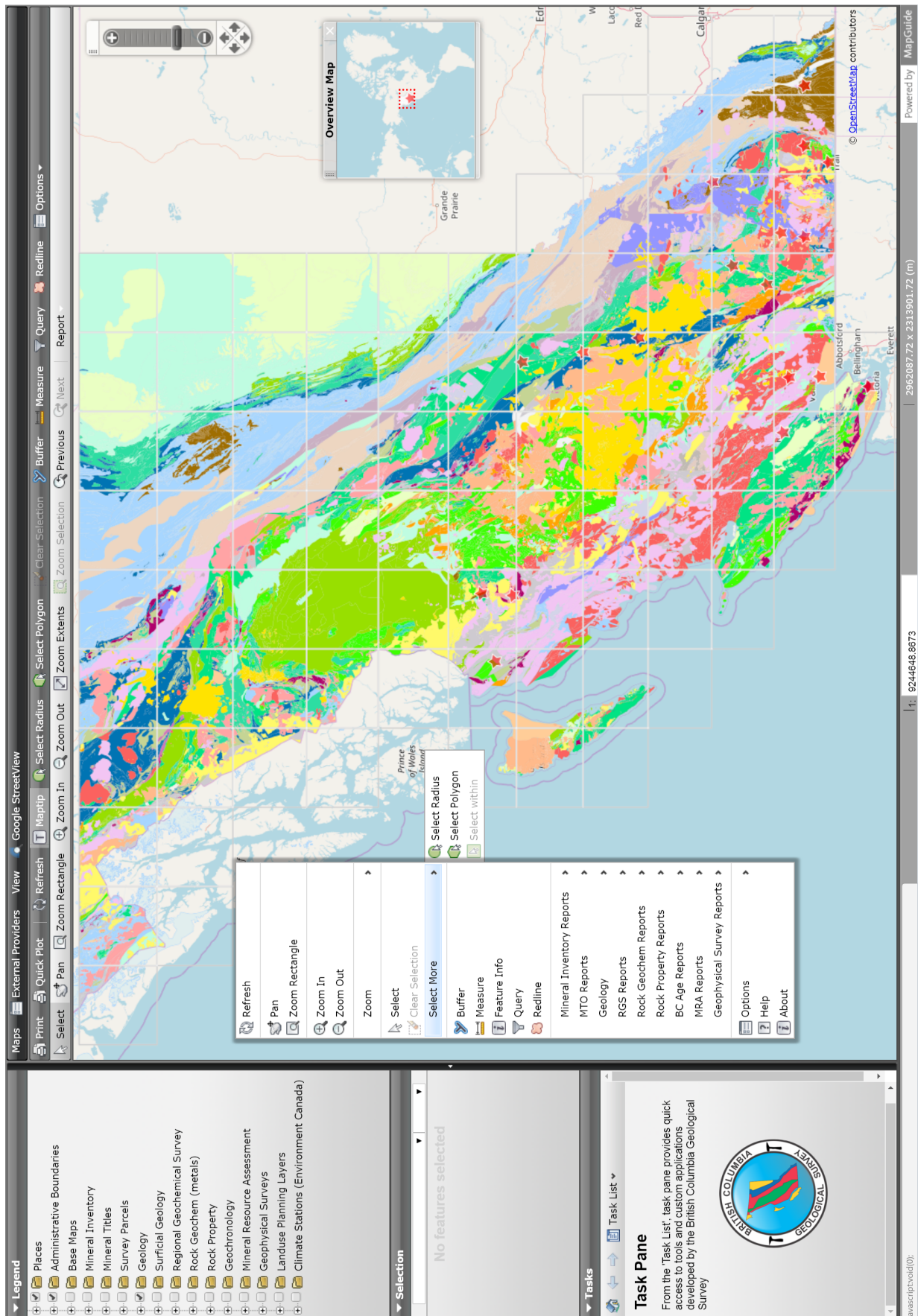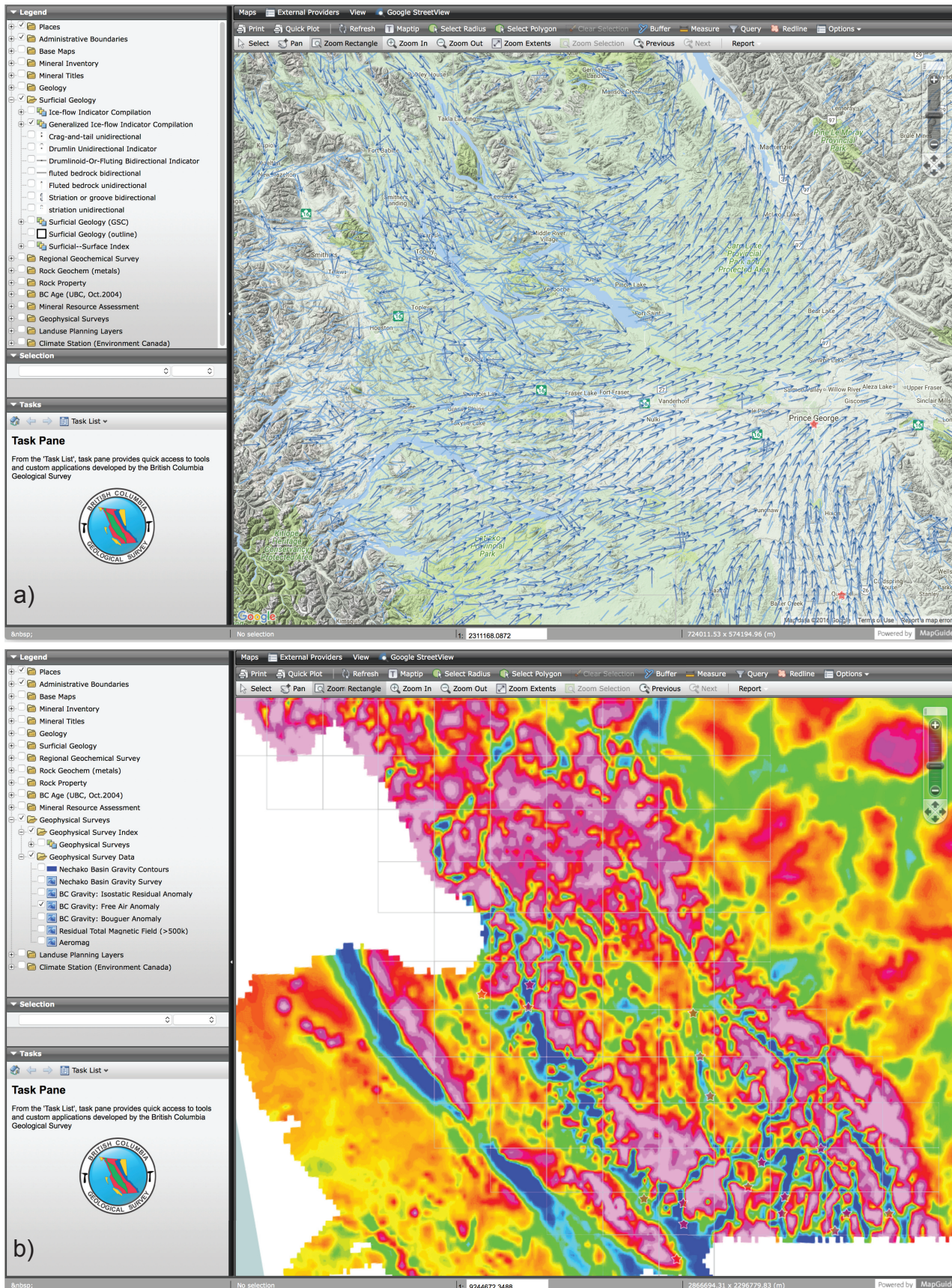
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Fig. 2. MapPlace 2 interface.

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Fig. 3. Examples of geoscience data shown on MapPlace 2. **a)** Ice-flow indicators. **b)** Total residual magnetic field.

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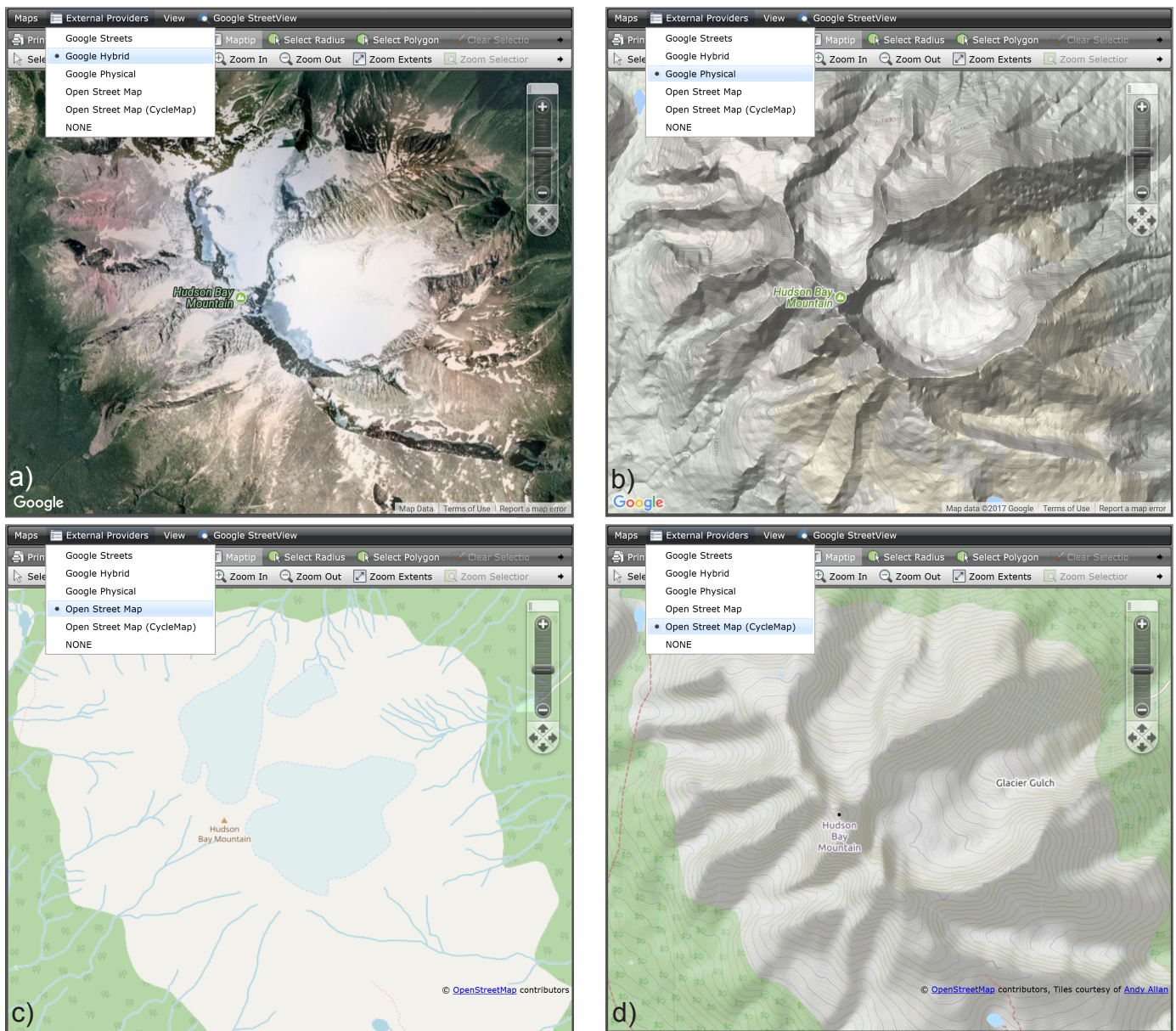
Fig. 4. Choices of different third-party basemaps and imagery. **a)** Google Hybrid, satellite imagery. **b)** Google Physical: shaded relief with contours. **c)** OpenStreetMap. **d)** OpenStreetMap-CycleMap.

mouse clicking or by outlining multiple features by drawing a selection rectangle, circle, or polygon. 'Maptips' is a tool that displays basic information about a feature when the cursor hovers over it, commonly with a hyperlink to pages with further details. The measurement tool gives the total length of continuous line segments and the total area the line segments enclose. The basic query tool allows selecting and interrogating many of the map features.

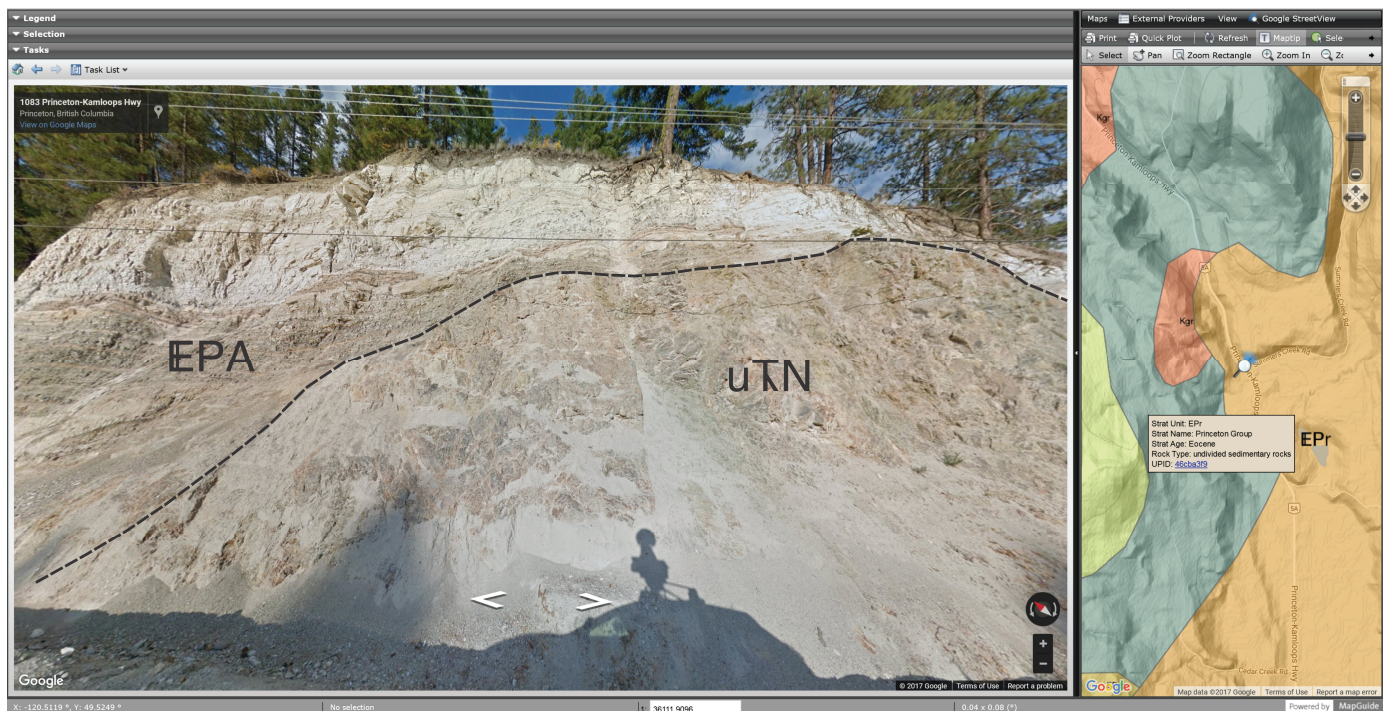### 3.2.3. Custom query and report tools

We developed a suite of applications to conduct more advanced spatial and non-spatial queries and generate summary reports. These custom query tools are listed in the Tasks pane (Fig. 6a). Each of the custom query tools allows a user to

enter search criteria (Fig. 6b). Retrieved summary results are displayed in the Tasks pane (Fig. 6c). The summary can be saved as a Microsoft Excel spreadsheet. A general search tool is available to find named places, streets, rivers, lakes, and points of interest anywhere in the province.

Custom reporting tools are accessed using the 'Report' button on the top menu or by right-clicking in the map window (Fig. 7a). These tools retrieve data and generate summary reports of the selected features, and results are displayed in a webpage (Fig. 7b). The ID for each of the records has a link to full details in other BCGS geoscience databases. Most of the summary reports have a link to download a KML file that can display features on Google Earth.

MapPlace 2 allows users to combine these custom tools

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Fig. 5. Google StreetView showing sedimentary rocks of the Allenby Formation (Princeton Group; Eocene), unconformably overlying volcanic rocks of the Nicola Group (Upper Triassic).

with a buffer and spatial overlay to carry out more complex spatial queries. Illustrated in Figure 8 is an example of a buffer being used as a spatial filter. Bedrock units with the potential for porphyry deposits are selected using the 'Bedrock Geology Search' tool (Figs. 6b and 6c), and all the mineral occurrences within the buffer are reported.

3.2.4. Custom map making: the 'Redline' tool

With the 'Redline' tool users can add text, points, lines, and polygons to a map (Fig. 9a) and generate cartographic features such as titles, legends, scale bars, north arrows, and coordinates (Fig. 9b). We have designed the map output to meet the requirements for submitting assessment reports. The final map can be printed or saved as a PDF file. The Redline tool also allows saving user-added data in Esri shapefile or Google KML format.

4. MapPlace 2 system components and their development

Hidden from the user interface are system components that make MapPlace 2 work. Our feasibility studies and prototyping led to a conceptual system design using available technical solutions specifically for the purpose of disseminating geoscience data. Below we provide a high-level overview of the system components and how we developed them.

4.1. System architecture

MapPlace 2 is built with a new system architecture (Fig. 10) based on 'real-world' cases and requirements gathered from operating the original MapPlace for more than two decades.

In other words, our system architecture has been developed through iterations that reflect requests, recommendations, and demands from clients that have long-used MapPlace. A system architecture is important to define the structure and behaviour of system components (e.g., geoscience databases and custom applications), their relationships, and dependency to external resources (e.g., external data sources and other web services).

MapPlace 2 depends on data sources that are external to the MapPlace 2 web server. These sources include the BCGS geoscience data that are maintained by a number of database management systems (loosely identified as part of the geoscience operational database environment), including digital geology in PostgreSQL/PostGIS, MINFILE and Property File in Microsoft SQL Server, ARIS in Microsoft FoxPro, and RGS in Microsoft Access. Other data products are available as Esri shapefile, Microsoft Access, and raster imagery format, including mineral resource assessment, ice flow indicators, and geophysical survey data. Mineral tenures, administrative boundaries, and topographic data are from the Oracle databases in the British Columbia Geographic Warehouse.

The core system components of MapPlace 2 are the geoscience application database environment (GADE), and the web services with custom applications.

4.2. Application database architecture and applications

MapPlace 2 requires an application database optimized to display maps quickly and support rapid spatial and non-spatial queries across all datasets. This application database must be built on a database architecture with consistent data models,

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Fig. 6. MapPlace 2 custom search tools. **a)** List of tools. **b)** Bedrock geology search interface. **c)** Bedrock search results.

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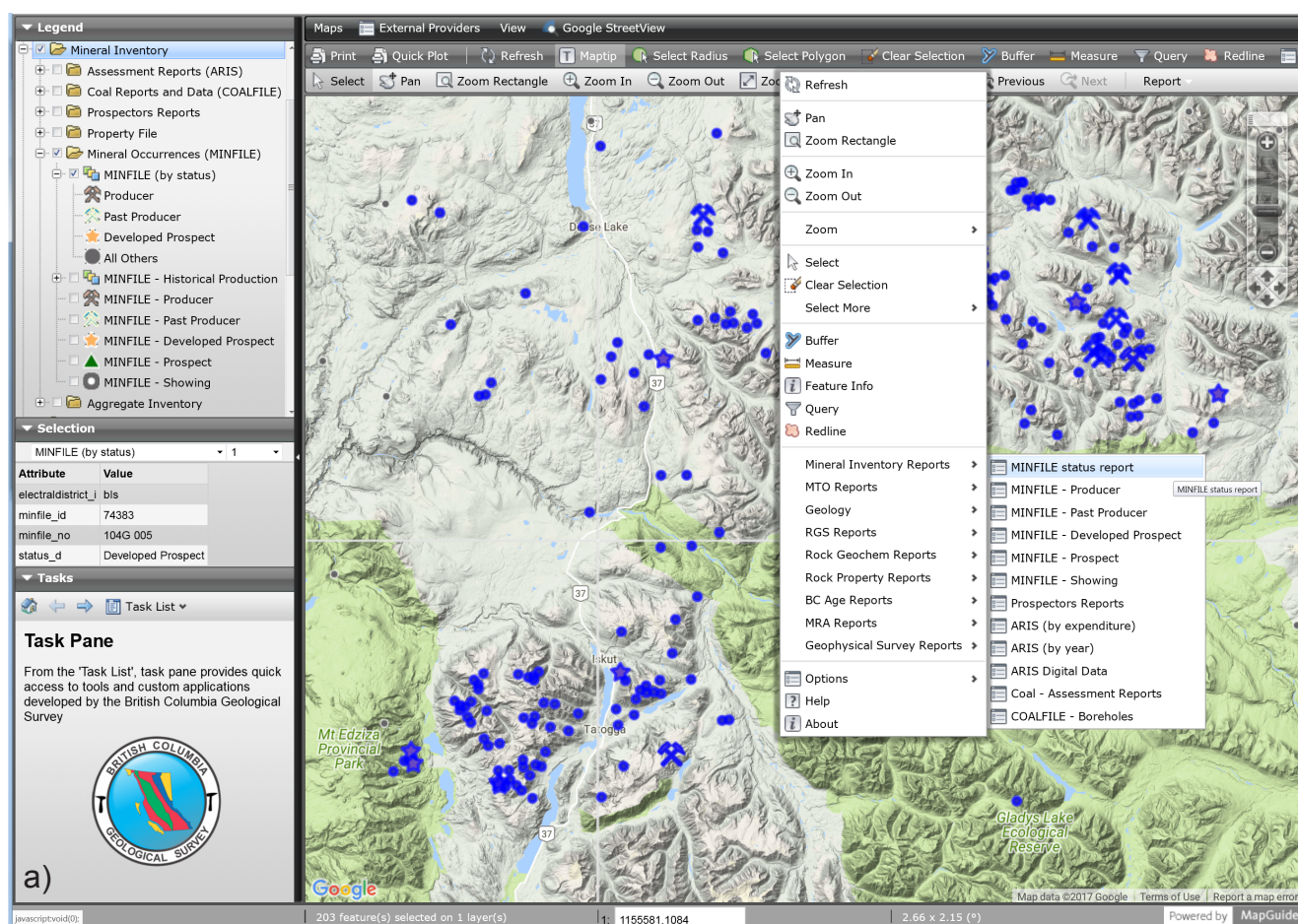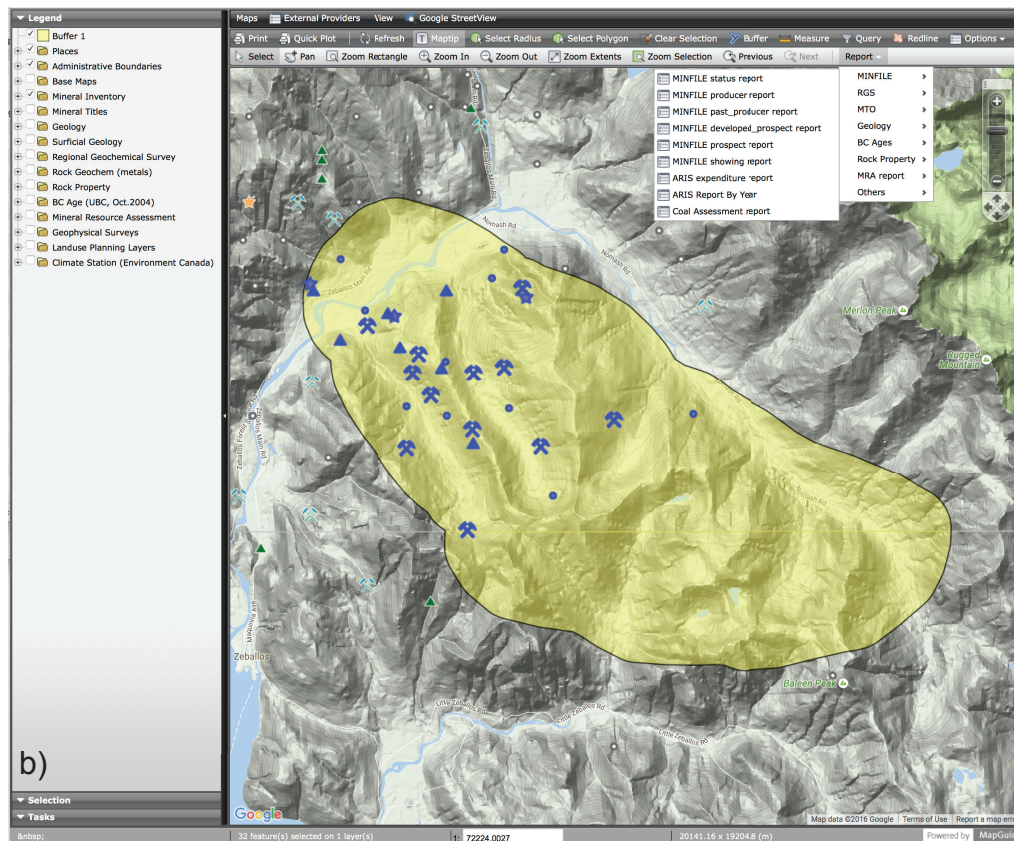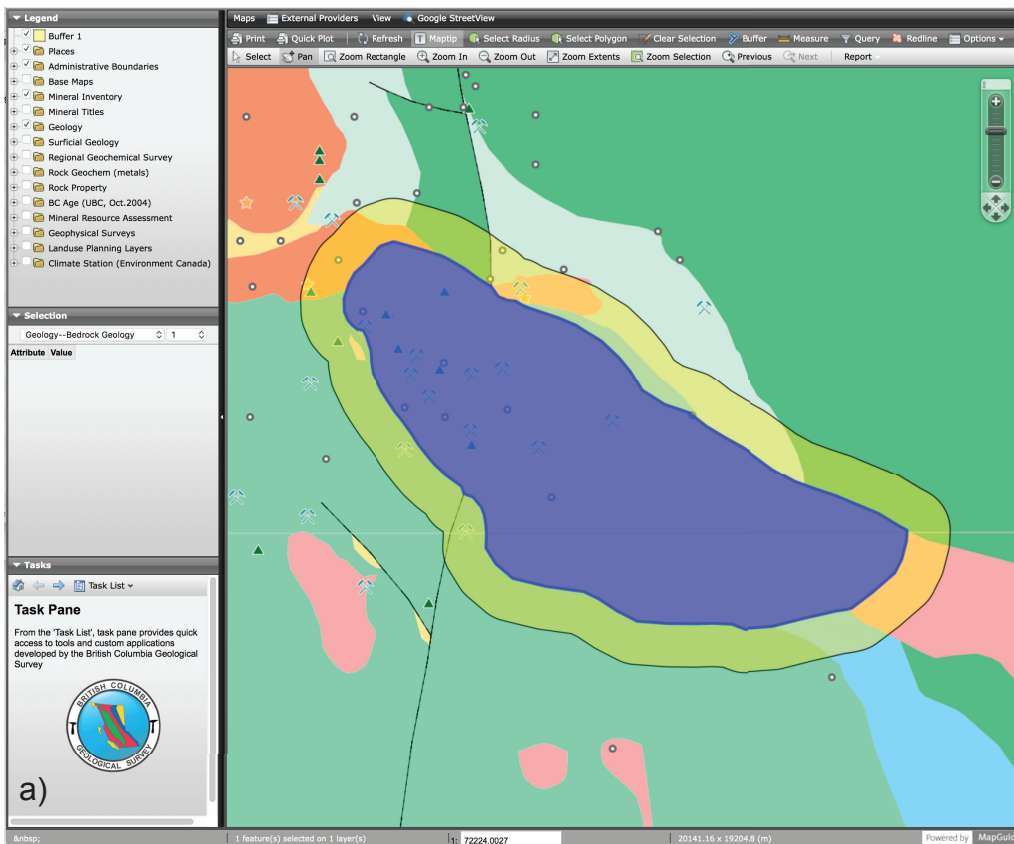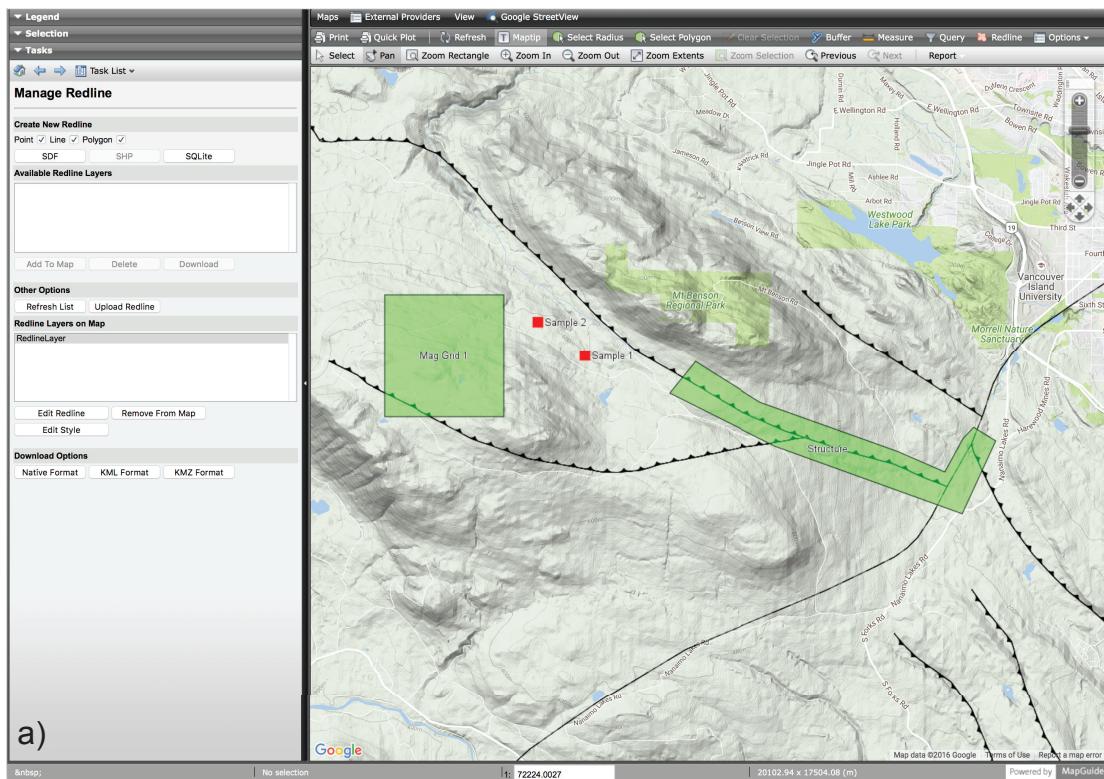Geological Fieldwork 2017, British Columbia Ministry of Energy, Mines and Petroleum Resources, British Columbia Geological Survey Paper 2018-1

Fig. 7. MapPlace 2 custom report tools. **a)** List of tools and choices of mineral inventory reports. **b)** Report example for MINFILE.

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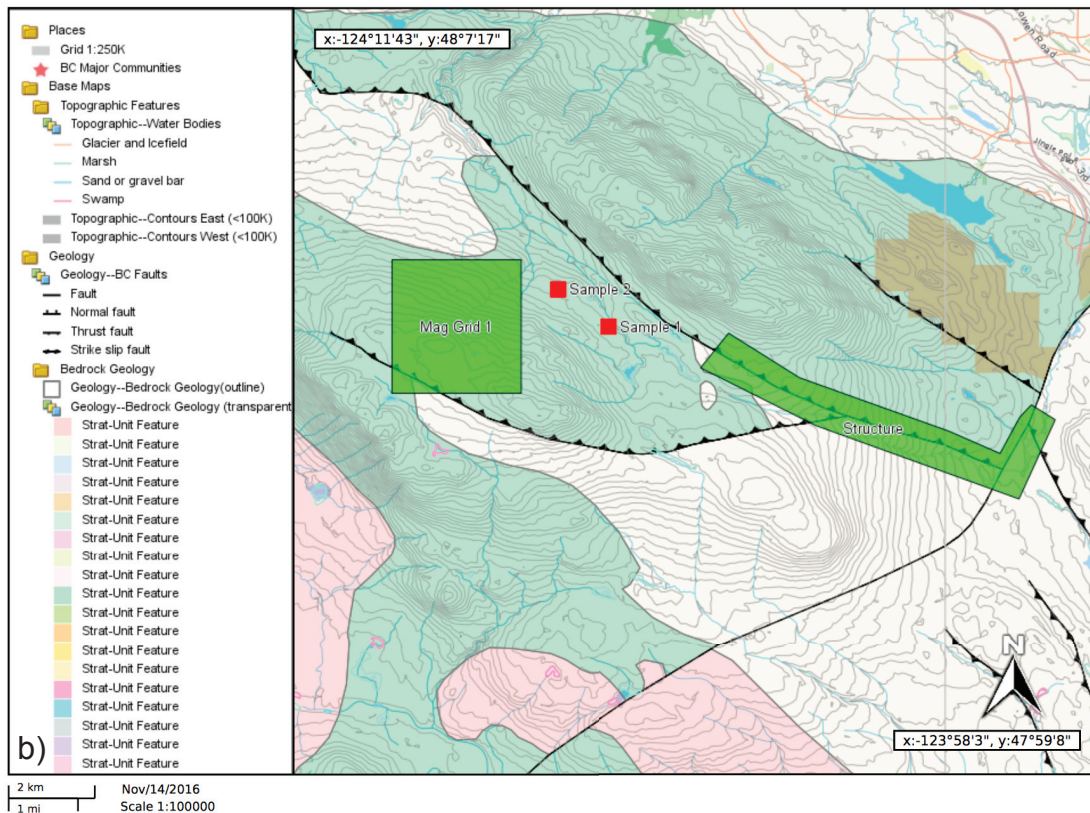
Fig. 8. Example of spatial overlay. **a)** A buffer (in yellow) is created on selected bedrock units (highlighted in blue). **b)** The buffer is used to select mineral occurrences (highlighted in blue) within the area (using Select within).

Property Map
Work and Samples Locations

Fig. 9. Custom map making. **a)** Adding sample locations as points, survey areas as polygons, and text as labels using the Redline tool. **b)** Generating a map and saving it as PDF by the Quick Plot tool.
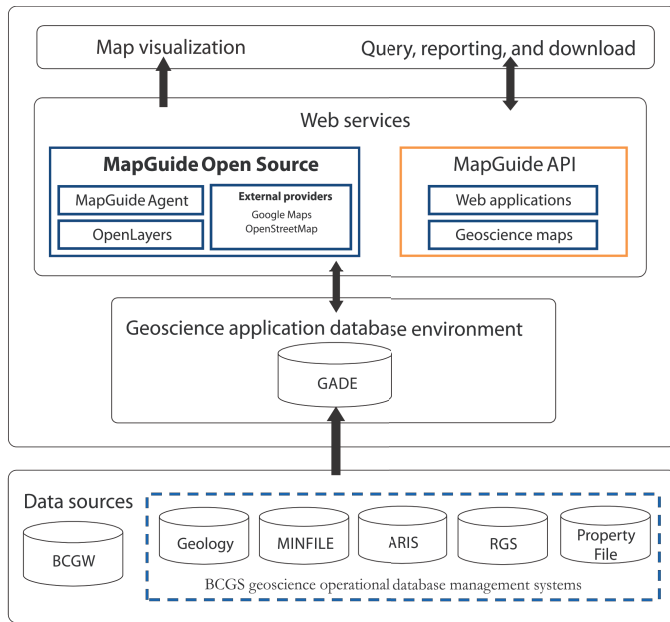
Fig. 10. MapPlace 2 system overview.

rules, and applications to streamline extracting, transforming, and loading (ETL) large volumes of province-wide geoscience and supporting data from different sources and in different formats, map projections, and database management systems (data silos). The new MapPlace 2 data models are designed to ensure consistency in data types, proper level of normalization, integrity of relationships, and naming conventions.

The application database architecture is deployed as a geoscience application database environment (GADE) in PostgreSQL/PostGIS that consists of a spatial database for geoscience data, rules, processes, and applications to manage the processes of ETL (Fig. 11). To break down the data silos, Foreign Data Wrapper is used to access remote data sources and

virtually integrate data through schema mapping. The result is the ability to execute queries on data from different remote sources, such as locating mineral occurrences (sourced from MINFILE in Microsoft SQL Server) within selected mineral tenures (sourced from BCGW in Oracle). The MapPlace 2 application database achieves further efficiency with a consistent query language, functions, triggers, and constraints by using a single spatial database in PostgreSQL/PostGIS.

4.3. Web services: custom applications

We developed MapPlace 2 web applications using MapGuide Open Source as the geospatial web service platform. We selected MapGuide Open Source because it is one of the most advanced open source geospatial web service platforms available, with great community support and the potential to extend and develop custom applications required for MapPlace 2. MapGuide Open Source has an open architecture in system configuration, data connections, and Application Programming Interface (API), and is independent of vendor-specific technology. Our decision to choose MapGuide Open Source was heavily based on the significant performance boost that resulted when a new version of OpenLayers was adopted as the rendering engine. OpenLayers is one of the most advanced rendering technologies in terms of performance, features, and installations.

We built most MapPlace 2 core web applications (custom query and reporting tools) in JavaScript, some with PHP code, to access the MapGuide Open Source API. MapPlace 2 extends to RESTful (Representational State Transfer) web services (Fielding, 2000; Richardson and Ruby, 2008) by forwarding selected features to 'get' and generate summary reports through scripts developed in Microsoft ASP.NET. An example of this RESTful extension is to view full details for a selected MINFILE record.

5. Future development

We are working on a light version of MapPlace 2 to support use on mobile devices (Fig. 12). This mobile version displays the same data as the desktop version, with similar appearance and performance. It is designed to work on small but high-resolution touch screens. Basic tools are available for navigation, selection, buffer creation, length and area measurement, querying, and Redline map customization. Users can retrieve further details by selecting and querying or through the hyperlinks in Maptips. We are soliciting feedback on an alpha version and are making it available upon request for user testing.

MapPlace 2 is slated to move to a better-configured web server in early 2018, which will provide a smoother user experience. The MapPlace 2 system architecture has evolved and been refined progressively and we continue adding to, and improving, the system components. As new data and databases become available, these are being added to MapPlace 2.
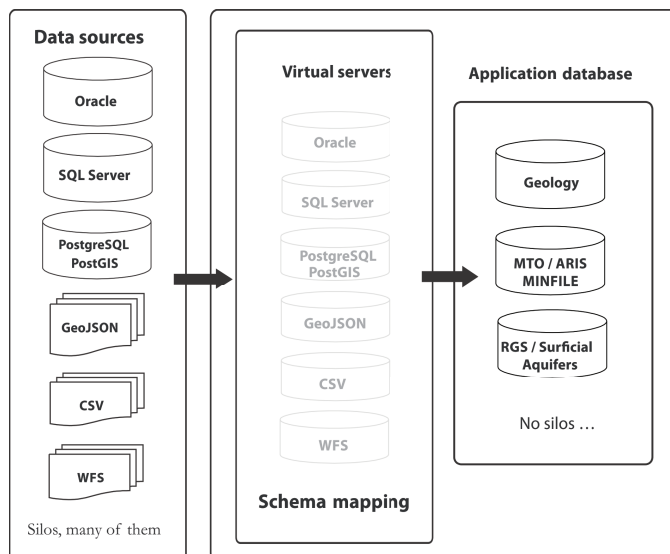

Fig. 11. MapPlace 2 application database architecture.

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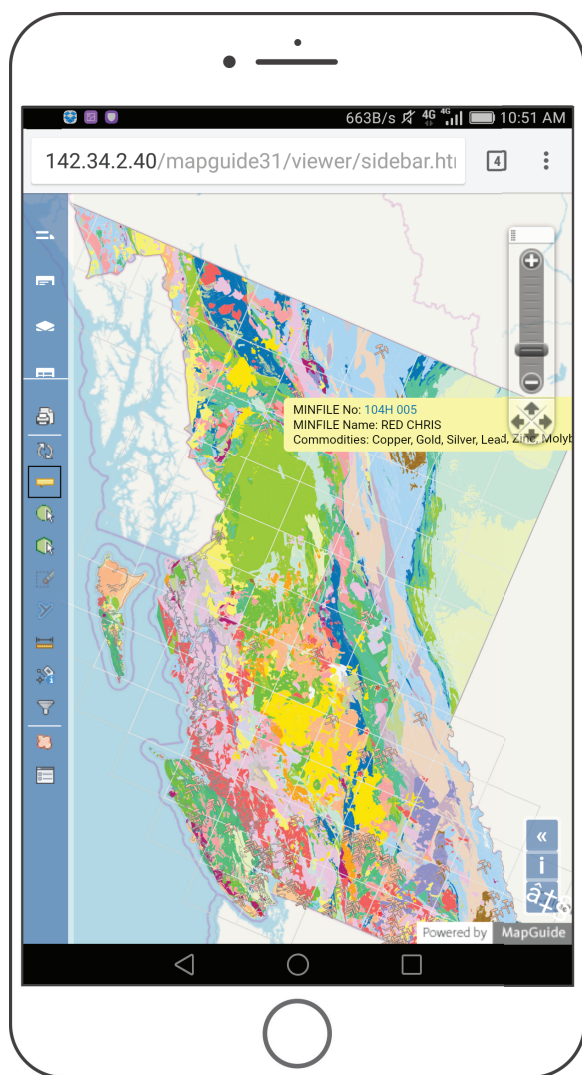
Fig. 12. MapPlace 2 mobile is available for alpha testing.

6. Conclusions

The British Columbia Geological Survey developed the MapPlace 2 geospatial web service to modernize disseminating public geoscience. With a completely new system architecture and interface, MapPlace 2 has improved performance and functionality and works in any web browser. It is of use to anyone interested in British Columbia geoscience, including the mineral industry, environmental organizations, resource planners, public safety agencies, communities, First Nations groups, government, research organizations, and the general public.

MapPlace 2 embraces the most appropriate free and open source software for rendering, integrating application databases, and developing new web applications. It differs from other geospatial web services in its ability to carry out advanced spatial and non-spatial queries and generate summary reports. The power of MapPlace 2 derives from an application database that integrates data from diverse external sources, enabling users to conduct queries and generate custom results across all

datasets. The British Columbia Geological Survey continues to improve MapPlace 2 with advanced applications and access to more geoscience data.

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