

# The Geological Map Flow Process – How the Geological Survey of Canada is Streamlining Map Compilation and Delivery

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## Transitioning Geological Mapping

The Geological Survey of Canada, Natural Resources Canada, has been producing geological maps since Sir William Logan was designated as the first Director of the Geological Survey of Canada (GSC) in April 1842. The compilation of a geological map has always involved considerably more than the cartographic work. Just as a topographic map compilation requires the surveying of the topographic features, a geological map requires the collection of remote and ground-based data from which the geologists will compile the map. But this work is not based completely on observational information; rather, the geologist takes on the role of a detective who, using vast knowledge and skills of interpretation, must piece together the most likely scenario of the geological history based on limited information that can be collected because most of the 'facts' are hidden by vegetation, water, sediment, and other rocks. Add to this the fact that the last glaciation of North America (about 20,000 years ago) smeared many of the clues across the landscape, and that in a geological context, this glaciation was a very recent event. You can get an idea of how difficult it is for these 'rock sleuths' to practise their trade.

Over time, the GSC developed an international reputation for the quality of its geoscience maps, from both a scientific and technical point of view. Much of the supporting information used for the compilation of the maps was then discarded or lost after the maps were published. However, times have changed and the GSC has had to adapt to the demands of users and technology. With the advent of Geographic Information Systems (GIS) and digital cartography, many enhancements in the way geological maps are produced have been made, but this has mainly focused on the cartographic component, and

less so on the scientific components. Although technology has been applied to many of the scientific areas, it generally has been on an individual basis and (or) in support of scientific analysis, and not in the context of data management or as part of a standard methodology for making maps. Increasingly, the demand not only for the interpretation (published map) but also for the supporting data has compelled a rethinking of how the data are managed and used. The inherent value of this information, for example, the cost of collecting a rock sample on Ellef Ringes Island in Nunavut, includes not just the potential geological knowledge but also the cost of reacquiring that sample. The collected data, therefore, have a significant value and have become a government asset that needs to be properly managed and made available to Canadians.

## New Requirements For Geological Mapping

Clearly, a more efficient and streamlined method to collect, manage, interpret, and disseminate these data, information, and knowledge was needed. A catalyst was necessary to effect this change. The Geo-mapping for Energy and Minerals (GEM) Program was announced in 2008 to provide the geoscience knowledge necessary for private sector exploration companies to guide investment decisions, as well as for local governments to make informed land-use decisions such as the creation of parks and other protected areas. GEM's focus is mainly on mapping the Arctic using modern geological methods and standards to identify the potential for energy and mineral resources. GEM has become the catalyst needed for the improved management of scientific information.

Additionally, GEM was mandated to deliver geoscience data and knowledge. The Geological Map Flow (GMF) project was initiated under GEM to address the need for a more consistent and efficient approach to geological mapping and managing the geological map data.

## Approach

The approach taken by the GMF team was to define a complete process from project initiation to final output (publication), so that the data were controlled from the outset. It was also understood that this would be a significant cultural change for many geologists and so, without adequate preparation and training through a transitional period, this initiative would be painful. In order to mitigate this 'culture shock,' the team:

- identified and reviewed existing best practices and selected those methods that could be adapted to the GMF;
- developed new tools that mimicked 'traditional' methods where needed, so that the adoption of new technology followed conventional practices;
- defined roles and responsibilities so that the scientist can continue to focus on science;
- provided specific training for the different roles in a timely manner; and
- consulted continuously with geological staff throughout this process, in order to address challenges and to enhance the process when and where necessary.

The project was divided into four components, each addressing a key area in the GMF process: field preparation and collection, information management and compilation, map information dissemination, and training and delivery.

## Field Preparation and Collection

The field preparation and collection component defines sources of information (for example, topographic data, geophysical information) for project planning and preparation and provides tools to extract this information from the sources where necessary. An enhanced version of GanFeld (Buller, 2004) was developed from an existing field data collection system for geoscience data, providing a seamless data flow into the project data management process while continuing to provide field projects with a level of scientific flexibility (figs. 1 and 2). By properly managing the data during the collection phase, we can also support and feed other corporate systems such as the Sample Management System, which catalogs all samples collected in the field including key information such as location and sample method.

## Information Management and Compilation

This component supports the integration of data and information, both existing and new, and the interpreted geological map model within a structured project-level geodatabase. To support this, the following were developed:

- standard bedrock and surficial geology geodatabases using consistent fields and terminology while allowing for 'free text' descriptions at more detailed levels of the geologic model,
- tools and services to streamline the digital compilation of interpreted geologic map information (polygons, contacts, and so on),
- a legend compilation tool to facilitate the symbolization of preliminary maps,
- an intuitive interface for the geologist to view multiple layers of collected field and other information, facilitating the digital compilation of interpretations, and
- a service for the streamlined compilation of interpretations compiled on stereo-pair images.

The use of consistent geodatabase design and science language enables the integration of published project-level geodatabases into a corporate geological map database. This in turn provides the foundation for the dissemination of geological map information.

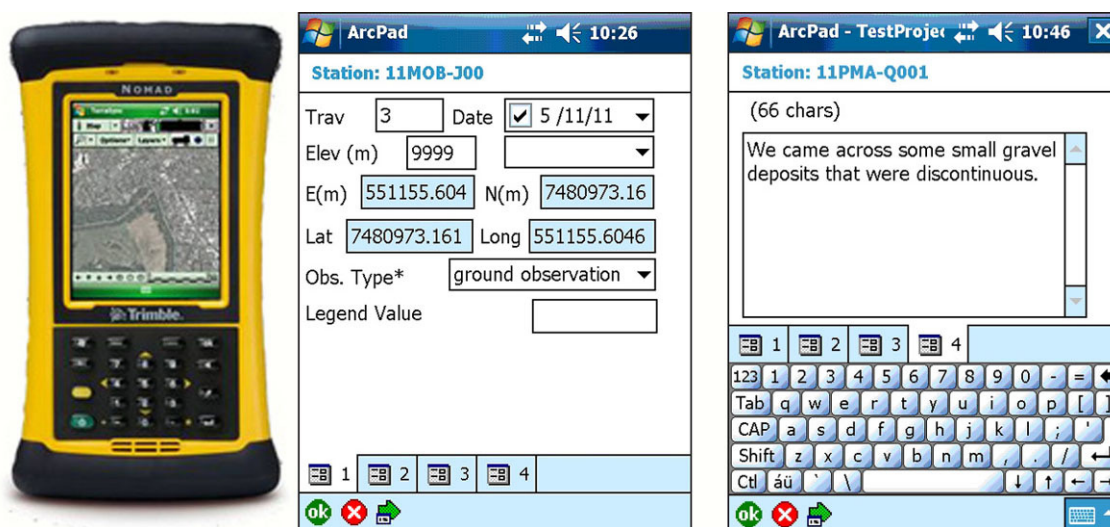
## Map Information Dissemination

This component has a product preparation process that streamlines the delivery of print-ready and geographic information system (GIS) products directly from the geological databases. This process includes providing geomatics (that is, GIS-cartographic) support during the compilation steps and a more automated process for print-ready product preparation. The GIS-ready product is designed to facilitate immediate use in common GIS software and is released at the same time as the print-ready product. The GMF project team is working with GSC scientists and international agencies (U.S. Geological Survey, Federal Geographic Data Committee) to define a North American standard for the cartographic representation of geological information.

A key deliverable of GMF is a revised geoscience map output (print-ready and GIS-ready). The current Open File and A-Series map publications will be replaced by the new Canadian Geoscience Map (CGM) Series. The CGM can clearly show users that they are using a "preliminary map" and that a final version is pending. The final version will simply be a later edition of the same map in the CGM series. In addition, the geoscience map outputs (print-ready and GIS-ready) are derived from the same project geodatabase through a



**Figure 1.** Field geologists at a sample site (left) and digitally collecting information in the field (right).



**Figure 2.** GPS/GIS-enabled field device (left) and data collection interface (right), which uses the GanFeld software (Buller, 2004).

semi-automated process (with defined procedures and tools), ensuring that both are delivered quickly and in a coordinated fashion (fig. 3).

## Training and Delivery

In order to support and coordinate a sustainable implementation of GMF, clear and consistent documentation, appropriate and timely training for field parties, and clearly defined roles and responsibilities have been prepared. This component also provides support to key field geologists who will validate the work and direction of this project.

In summary, the Geological Map Flow process has gone from a purely cartographic and less standardized (not so GIS-ready) digital product to a coordinated and consistent collection of geoscience information. The former was characterized by nonstandard, inconsistent data collection, pen and ink compilation, and digital cartographic representation focused on a paper product. The new system offers data that are now fully managed in a central project database from project initiation, through the scientific compilation, to the delivery of print-ready and GIS-ready products.



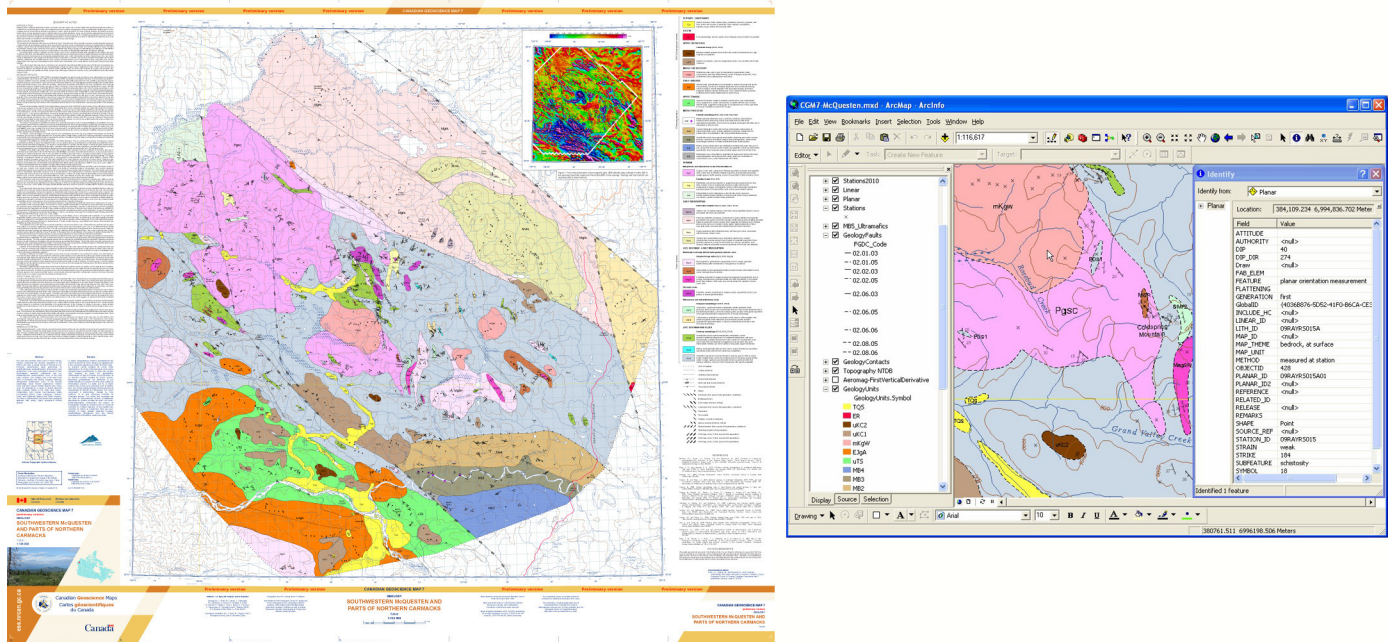


Figure 3. Canadian Geoscience Map Series (left) and corresponding GIS-ready data (right).

## Results

As the GEM program nears completion and we look forward to GEM 2, the GMF system has evolved and has been adapted to overcome specific operational challenges and to mitigate the ‘culture shock’ effect associated with implementation of a new way of doing geological field work. To date, GEM has released new maps through this process and more are expected over the next 2 years. Not only has this process shown that it can accelerate the delivery of geological map information by providing more efficient and effective data management processes and tools but also it has shown GSC scientists and our key users alike the potential of this process in delivering supporting data in addition to the interpreted map.

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