

## Annual review by E.C. Syme

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In 2011, the Manitoba Geological Survey (MGS) continued major field projects in Manitoba's far north, as part of our Far North Geomapping Initiative and supported in part by the Geological Survey of Canada (GSC) Geo-mapping for Energy and Minerals (GEM) program. The northern projects included bedrock and surficial mapping in the Snyder Lake region of northwestern Manitoba, surficial studies at Churchill and Phanerozoic studies in the Hudson Bay Basin. Fieldwork continued in the Snow Lake area and the Thompson Nickel Belt (TNB), building on work in 2008–2010. New work was undertaken to better define the setting of a number of commodities, including gold (in the Rice Lake Belt), rare earth elements (at Burntwood Lake) and nickel (in the Mayville area of southeastern Manitoba).

Phanerozoic investigations focused on evaluation of the potential for shallow unconventional Cretaceous shale gas in southwestern Manitoba, three-dimensional geological modelling in southern Manitoba and collaborative work with the GSC in the Hudson Bay Basin.

Academic and industry colleagues present the results of new or continuing thematic studies in Flin Flon, Snow Lake, The Pas and southeastern Manitoba.

### **Collaborative programming with the Geological Survey of Canada**

The Geo-mapping for Energy and Minerals (GEM) initiative, announced by the Government of Canada in 2008, is a five-year program designed to provide the geoscience information necessary to guide investment decisions leading to the discovery and development of new energy and mineral resources. The GEM-Minerals initiative in Manitoba is represented by a 2008 GSC-funded airborne radiometric and magnetic survey in the Great Island area; these data were used to support the subsequent geological mapping at Great Island by the MGS in 2009. The GEM initiative also provides support for surficial mapping and geochronology in projects of Manitoba's Far North Geomapping Initiative. A GEM-Energy project is focused on the Phanerozoic stratigraphy of the Hudson Bay and Foxe basins.

The Targeted Geoscience Initiative (TGI) is a federally funded program that is co-planned and jointly delivered with provinces and territories, which provide their own funding for their activities under the program. The TGI-4, announced in the February 2010 federal budget, is the fourth such initiative since 2000 and focuses on deep exploration. Projects to be conducted under the five-year TGI-4 are in the first year of field study.

### **Precambrian mapping and mineral deposit studies**

#### ***Far north***

The Manitoba Geological Survey's Far North Geo-mapping Initiative continued in the summer of 2011 with bedrock and surficial geological mapping in the Snyder Lake area (Kremer et al., GS-1; Trommelen, GS-2), in the northwestern corner of the province. The Snyder Lake area is underlain by medium- to upper-amphibolite grade metasedimentary rocks of the Wollaston Supergroup, flanked by high-grade intrusive rocks of possible Archean age. Calcsilicate gneiss and marble in the Snyder Lake area locally host uranium and/or rare earth element (REE) occurrences, both in outcrop and in glacial deposits. The mineralization appears to occur in silicified, albitized and hematized zones, which presents a different mineralization environment and process compared to the unconformity-type uranium deposits at or near the top of the Wollaston Supergroup rocks in Saskatchewan.

Quaternary geological investigations were undertaken in the Snyder Lake area in conjunction with the detailed bedrock mapping (Trommelen, GS-2). This surficial mapping provides a modern geoscience knowledge base tailored towards current and future mineral exploration and/or infrastructure development. These studies aim to provide a detailed framework for the directions, timing and nature of major and minor ice-flow events in the region. The Snyder–Grevstad lakes area hosts several known showings and boulder trains with enriched uranium and/or REE. Local, detailed boulder and till surveys based on known mineralized outcrops can provide dispersal-train patterns, which can be used to measure ice-transport distances and directions that can be applied to drift exploration in this challenging region.

A 30 km stretch of well-exposed bedrock on the southwestern coast of Hudson Bay, near Churchill, Manitoba, was thoroughly examined for erosional ice-flow indicators (Trommelen and Ross, GS-3). Churchill quartzite outcrops preserve a complex record of ice-flow indicators that likely record a mix of Keewatin and Quebec-Labrador ice sources. In combination with clast-dispersal and stratigraphic data, this information will help determine up-ice source areas and possible dispersal vectors for drift prospecting in northeastern Manitoba.

#### ***Flin Flon–Snow Lake greenstone belt***

Remapping of the portion of the Flin Flon Belt lying under Phanerozoic cover was initiated in 2009 by the

Manitoba Geological Survey to produce revised geological maps of an area that is the focus of significant new mineral exploration. A key portion of the remapping effort consists of building a comprehensive database of historical data (drillcore logs, geochemistry, etc.) for the sub-Phanerozoic Flin Flon Belt, using a Microsoft® Access® database (Lee et al., GS-4). The development of a comprehensive database of all existing geoscientific data in the sub-Phanerozoic Flin Flon Belt will be of great assistance in revising the geological maps of the area, as well as in producing three-dimensional (3-D) models of areas of interest. The newly acquired ability to bring such historical data into a geographic information system (GIS) environment will also help achieve a better understanding of the regional distribution of geological domains and prospective assemblages, providing valuable guidance for current and future mineral exploration programs.

Detailed mapping (1:2000 scale) in the vicinity of the Schist Lake and Mandy deposits was undertaken by a researcher from Mount Royal University to determine whether the ore horizon for the deposits may be the time-stratigraphic equivalent to the main ore-hosting stratigraphy in Flin Flon, or unrelated and simply juxtaposed by a fault (DeWolfe, GS-5). Although the stratigraphic relationship with the ore-hosting stratigraphy in Flin Flon remains unresolved, this work did result in the potential recognition of synvolcanic structures, and associated synvolcanic depositional basins, in the Schist Lake–Mandy area. Such structures provide more evidence that key conditions required to form a volcanogenic massive sulphide (VMS) deposit are observed in the rocks overlying the Schist Lake and Mandy deposits.

In 2011, MGS fieldwork in the Snow Lake area was completed along the western side of Squall Creek and north of Lalor Lake (Gagné, GS-6). The resulting data have been combined with the detailed geology acquired by earlier investigations to update the geological map of the area. Snow Lake arc assemblage volcanic rocks of the map area share geochemical characteristics with the upper Chisel sequence at Snow Lake. Despite the apparent absence of intense synvolcanic alteration and the historical lack of base-metal mineralization associated with the upper Chisel sequence, the Squall–Varson lakes area is considered to represent a prospective area for fertile VMS systems at depth.

During the 2011 field season, lithostratigraphic mapping was undertaken within the McLeod Road–Birch Lake thrust panel in the Snow Lake area as part of a Ph.D. study at Laurentian University (Rubingh, GS-7). The aim of this new study is to outline and define early regional structure, which will have implications for the understanding of gold mineralization at the New Britannia mine. Preliminary work suggests that the upper portion of the McLeod Road–Birch Lake thrust panel represents a homoclinal sequence that consistently youngs to the

north. In the subsequent field seasons, the lower portion of the McLeod Road–Birch Lake thrust panel will be tested.

### ***Kisseynew Domain***

A reconnaissance geological investigation of the Burntwood Lake syenite was conducted to evaluate the potential for REE mineralization (Martins et al., GS-8). The rocks of the Burntwood Lake syenite are enriched in light rare earth elements and large-ion lithophile elements, and depleted in high-field-strength elements. The Burntwood Lake syenite bears many similarities to the Eden Lake Complex, which has been an exploration target for REE mineralization. As with the Eden Lake syenite, at least some of the heterogeneity of the Burntwood Lake syenite appears to be the result of alkali metasomatism.

### ***Thompson Nickel Belt–Superior Boundary Zone***

Mapping in the Manasan Falls area has revealed the presence of a supracrustal sequence that is likely Archean in age (Couëslan, GS-9). The new findings at Manasan Falls, together with recent discoveries of Archean supracrustal rocks elsewhere in the Thompson Nickel Belt, suggest that some occurrences of supracrustal rocks in the TNB have been misinterpreted as Paleoproterozoic Grass River Group or Ospwagan Group rocks, and that Archean supracrustal rocks may be considerably more widespread than previously recognized. It is important that the nature of the typically barren Archean supracrustal rock sequence(s) be documented so that they can be differentiated from the nickel-hosting Ospwagan Group supracrustal rocks.

### ***Superior Province in southeastern Manitoba***

Detailed (1:5000 scale) geological and structural mapping of the Rice Lake mine trend was conducted in 2011 to address the need for a single, comprehensive and up-to-date geological map of the mine trend at a scale suitable for modelling the distribution and geometry of the contained gold deposits and the controls on mineralization (Anderson, GS-10). This work represents a significant upgrade to the existing geological map and serves to emphasize the important role of hostrock composition, competency and primary strength-anisotropy in the localization of vein-hosted gold mineralization in the Rice Lake mine trend. Related work (Anderson, GS-11) presents new information on the structural geology of the hostrocks and quartz-vein systems in the Rice Lake mine trend, with emphasis on small-scale examples of shear-associated vein systems exposed on surface.

A new project was initiated in the Mayville mafic–ultramafic intrusion (Yang et al., GS-12), located in the Neoproterozoic Bird River greenstone belt of southeastern Manitoba. The objective of the project is to address fundamental questions relating to the economic potential of the Mayville intrusion, which contains numerous

platinum group element (PGE), copper, nickel and local chromium occurrences. Preliminary investigations involving core logging and re-examination of analytical data have identified the stratigraphic location of the sulphide-rich mineralization, and have shown that the disseminated sulphide minerals are widespread and transition zones between major rock units may carry significant amounts of PGE.

### ***Community liaison***

The MGS community liaison program (Murphy, GS-19) provides a geological contact person for Manitoba First Nation communities and the mineral-resource sector. The purpose of this program is to acknowledge and respect the First Nation land-use perspective, allow for an open exchange of information and encourage the integration of geology and mineral-resource potential into the land-use-planning process. Schools, communities and mineral-industry stakeholders throughout Manitoba can access the program, encouraging a balanced approach to economic development in traditional land-use areas.

### **Phanerozoic investigations**

#### ***Shallow Unconventional Shale Gas Project***

The Shallow Unconventional Shale Gas Project is a multiyear investigation of the shale gas potential of the Late Cretaceous shale strata of southwestern Manitoba (Nicolas and Bamburak, GS-13). The geochemical and mineralogical information that has been gathered for these rocks is important in providing a geoscientific knowledge base for further study and exploration. Information assists in identifying units in the Late Cretaceous shale sequences that have promising characteristics for expanding the potential pay-zone thickness at any given location, making exploratory drilling more attractive. Based on the geochemical and mineralogical information, the Favel and Carlile formations are identified as the best shale gas targets, with some potential in the Gammon Ferruginous Member of the Pierre Shale.

#### ***Hudson Bay Basin***

The Hudson Bay and Foxe basins project of the GEM program is in its third year (Nicolas, GS-16). The aim of this project is to understand the sedimentological framework in this part of the Hudson Bay Basin, to help promote hydrocarbon exploration in this underexplored region. Work in 2011 focused on completing the logging of all available drillcore in the Hudson Bay Lowland of Manitoba, and sampling for geochemical and biostratigraphic analyses. Work to date suggests that the Hudson Bay Basin has undergone sufficient burial and heating for source rocks to pass through the oil window, leading to a potential active hydrocarbon system in this basin.

### ***Three-dimensional geological mapping***

The MGS has been generating 3-D geological maps since early 2000 (Matile et al., GS-17), using data from Manitoba's water well, oil well and stratigraphic drill-hole databases; large lake bathymetry; Lake Winnipeg seismic survey; and surface datasets, such as the provincial surficial geology compilation map series. The modelling methodology that the MGS employs uses a series of cross-sections, each of which represents a 5 km wide, east-west transect across the province. These cross-sections include all data available within 2.5 km from the line of the section. The vertical sections have been posted to the MGS website and have proven useful for educational purposes, to resolve complex aquifer issues and to define 'base of groundwater protection' (the depth to which oil wells are cased) on behalf of Manitoba Conservation's Water Branch.

### ***Coal***

The MGS is collaborating with Westcore Energy Ltd. on the stratigraphic setting of Westcore's 2011 discovery of nine Cretaceous coal basins located southwest of The Pas (MacNeill et al., GS-15). The coal is interbedded with carbonaceous sedimentary rocks and sandstone within the Swan River Formation. Individual layers of coal range in thickness from less than 1 m up to 63 m; in one instance, the composite thickness of several layers is more than 95 m. Basin morphology is interpreted to be that of bowl-shaped depressions that formed in the underlying Devonian paleosurface.

### ***Bentonite***

Bentonite, an altered volcanic ash, is unique compared to other rock-forming components in that it can catalyze the oligomerization of activated nucleotides to form RNA (Aldersley et al., GS-14). It is proposed that the origins of life on Earth (and possibly on Mars) were facilitated by the storage of the genetic code within RNA, thus catalyzing first life on Earth. In southern Manitoba, one excellent catalyst and one good catalyst have been recognized from the Odanah Member of the Pierre Shale. Additional testing will be done in an attempt to recognize if the Odanah Member bentonite consistently provides good to excellent catalytic properties and to determine if these properties may be attributed, in part, to the underlying Paleozoic basement rock.

### ***Minesite remediation***

Manitoba has approximately 20 abandoned or orphaned mines, one of which is the Gunnar gold mine, located within the Archean Rice Lake greenstone belt in southeastern Manitoba. This site was chosen by researchers at the University of Manitoba to study how common plant species interact with remnant soil contaminants (Naguit et al., GS-18). The objective is to more confidently

select native plant species compatible with the given soil situation, ultimately increasing the likelihood of successful reclamation.

### **Compilation and partnerships**

The MGS is engaged in many partnered initiatives, including contributions from the federal government, the mineral industry and several Canadian universities. These partnerships provide the MGS access to expertise and technologies that enhance our ability to provide a state-of-the-art geoscience database for Manitoba. These programs facilitate the training of future geoscience professionals, which in 2010–2011 included one Post-Doctoral Fellow, two Ph.D. candidates, two M.Sc. candidates and one B.Sc. Honours thesis project.

A number of new partnered projects have been initiated or are in advanced planning stages for 2011–2012. Some, such as a shale gas initiative with Manitoba Hydro and the University of Calgary, branch into new and important fields of research. Two new collaborative research projects between industry, universities and the MGS are in the planning stages. The first, a Ph.D. study at Laurentian University with financial support from Alexis Minerals Corporation, will involve a structural and stratigraphic study in the Snow Lake area. The second, with industry support by Hudson Bay Exploration and Development Company Limited, will include at least one Ph.D. study on the Lalor deposit and hostrocks.

### ***Mineral deposits database***

The digital mineral deposits and occurrence database for Manitoba has been available on the MGS GIS Map Gallery website since November 2008. The database summarizes all of the information contained in the reports of the Mineral Deposit Series. Work will continue on new data entry to incorporate recently released work described in assessment files. The updates from the past year will be added to the GIS Map Gallery in a November 2011 release. Addition of new occurrences and updating of existing occurrences with files that become nonconfidential are continuing processes.

### **Geoscience Information Services**

The Mineral Resources Division is in the process of redesigning the Map Gallery Internet mapping tool to use newer and more versatile software, increase the quality of the presentation and improve the stability of the service. Geoscience Information Services has devoted considerable time and effort to convert from the old technology to the new system.

In 2010–2011, Geoscience Information Services continued support for the compilation of sub-Phanerozoic Precambrian geology. Geographic information system

support is a critical component of this project because of the large number of drillhole descriptions and chemical analyses available for the compilation (Lee et al., GS-4).

The geophysical dataset compilation project involves a collection of the nonconfidential geophysical datasets that were filed for assessment purposes. This ongoing project focuses on expanding the number of datasets and converting the data presentations to standard format, with particular emphasis on converting data to a standard map projection and datum. The compilation will include more than 200 geophysical datasets when the new Map Gallery is made available in late 2011. These data presentations are available for free download.

### **Client Services and Outreach**

In 2010–2011, the MGS published the annual *Report of Activities*, two open file reports, one geoscientific report, three preliminary maps and six data repository items. Most of the publications continue to be offered in hard copy and on CD-ROM or DVD for purchase through Publication Sales, and in electronic format for free download from the Mineral Resources Division website.

The MGS contributed to the development of the new CanGeoRef database by facilitating the population of the Manitoba portion. Lori Janower, the MGS Library Services Co-ordinator, participated as a member of the Steering Committee, provided publication data for the database and is helping promote the release of the new Canadian geoscience literature database at the 2011 Manitoba Mining and Minerals Convention in November.

Manitoba Geological Survey mineral-education outreach initiatives included the ‘Manitoba Rocks!’ program, which was delivered at the Manitoba Mining and Minerals Convention, at the Children’s Hospital and during Provincial Mining Week, the latter event drawing 2700 visitors. ‘Manitoba Rocks!’ offers free hands-on activities developed to complement the Earth-sciences curriculum and increase public awareness of the importance of Manitoba’s mineral resources and mining industry.

Other MGS outreach programs included the following:

- **Provincial Engineering and Geoscience Week:** Staff of the MGS co-ordinated interactive mineral-education displays for this annual event.
- **Canadian Aboriginal Minerals Association 18th Annual Conference:** The MGS outreach co-ordinator assisted the organizers of the 18th Annual Canadian Aboriginal Minerals Association Conference (CAMA), which was held in Winnipeg for the first time on November 7–9, 2010. With 550 delegates attending, it was the largest CAMA conference in the association’s 18-year history.

## **Acknowledgments**

Two long-term staff of the Manitoba Geological Survey retired since November 2010. Dorne Lindal (compilations geologist) and Elaine Stevenson (outreach co-ordinator) both made significant contributions to the MGS and the Mineral Resources Division.

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