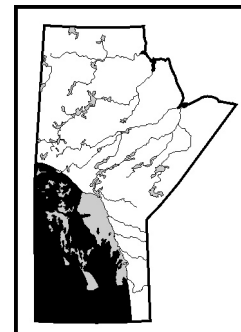


GS-25 Targeted Geoscience Initiative II – Williston Basin architecture and hydrocarbon potential in southwestern Manitoba and southeastern Saskatchewan: an update
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Summary

This project proposes to undertake a new multidisciplinary, coordinated geoscientific study aimed at characterizing and understanding basin architecture and hydrocarbon potential in the Williston Basin. The second year of this two-year Targeted Geoscience Initiative will involve new work that builds on established scientific leadership, cooperation and expertise among federal and provincial government agencies and universities. The result will be a seamless, three-dimensional (3-D) geological model of Paleozoic- and Mesozoic-age rocks, from basement to outcrop, in Manitoba and Saskatchewan, in a geographic area extending from the northern and eastern outcrop edge of the Williston Basin to the international border and west to longitude 106°W. A major objective is to enhance understanding of the basin's hydrocarbon and mineral potential.

Introduction

An increasing demand for hydrocarbons by the North American economy is widening the gap between supply and demand. Geoscience knowledge is an essential component of hydrocarbon- and mineral-exploration strategies. Over the past several decades, however, both industry and governments in Canada have generally reduced funding for geoscience investigations. As a result, Manitoba Industry, Economic Development and Mines (IEDM) and Saskatchewan Industry and Resources (SIR) have embarked on a two-year collaborative investigation (April 1, 2003–March 31, 2005), in partnership with Natural Resources Canada (NRCan), as part of NRCan's second round of Targeted Geoscience Initiatives (TGIs). The resulting study, the Williston Basin Architecture and Hydrocarbon Potential Project (Phase 1), falls under a federal government program called 'Consolidating Canada's Geoscience Knowledge' (Kreis et al., 2004). This project will build upon similar geoscience framework studies carried out originally within the Saskatchewan IEA Weyburn CO₂ Monitoring and Storage Project (Gilbooy et al., 2001; Whittaker et al., 2002; Whittaker and Gilbooy, 2003). Such projects have been developed in recognition that an in-depth understanding of the geological framework of the Williston Basin is fundamental to assessing the basin's mineral and hydrocarbon potential.

Objectives

The primary objective of the TGI project is to develop a seamless 3-D geological model of Paleozoic- and Mesozoic-age rocks from basement to outcrop in an area that includes most of the Phanerozoic succession present in both eastern Saskatchewan and Manitoba (Figure GS-25-1). This model will integrate stratigraphic, geophysical and hydrogeological data to enhance knowledge of subsurface mineral potential (e.g., of brines and potash) and hydrocarbon migration paths and entrapment mechanisms within and beyond traditional geographic areas of potash and hydrocarbon production. Manitoba and Saskatchewan researchers have established the stratigraphic horizons to be picked and, to assist in correlation, have constructed cross-sections across the study area. A database is currently being built that consists of geological picks derived from most of the drillholes penetrating Devonian and deeper horizons, and from selected wells (approximately 4–6 wells per township in densely drilled areas) penetrating Mississippian- and Mesozoic-age rocks. When completed, it is expected to include information from more than 4000 Saskatchewan wells and approximately 3000 Manitoba wells. A grid of regional cross-sections and computer-generated structure and isopach maps for all major geological units will be produced from these data. The project will acquire remotely sensed imagery, along with seismic, aeromagnetic, gravity and hydrogeological data, all of which will be integrated with the stratigraphic data into an ArcView® GIS product and a gOcad® 3-D geological model that will be made publicly available on

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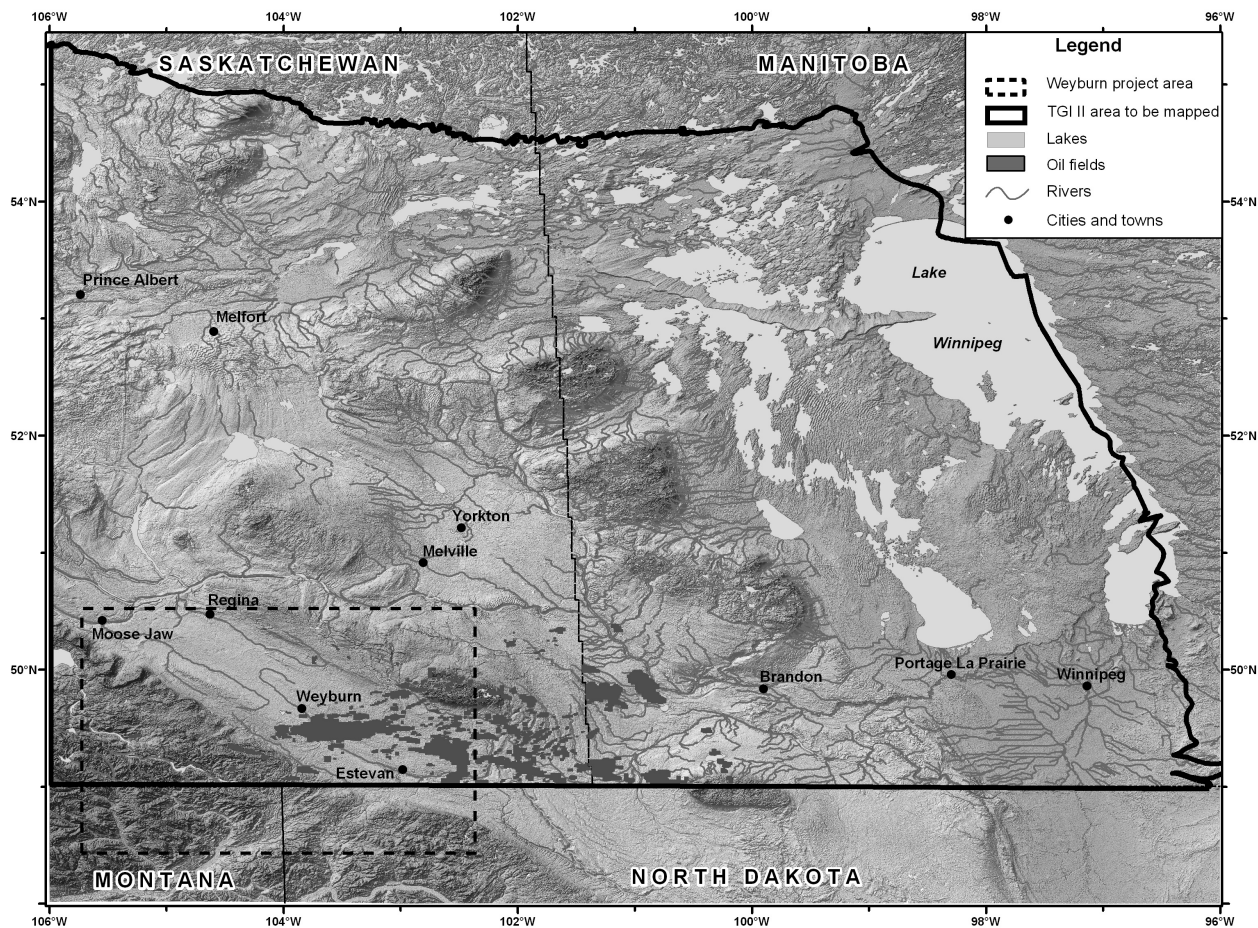


Figure GS-25-1: Digital elevation model (DEM), showing location of Targeted Geoscience Initiative (TGI) project area in Manitoba and Saskatchewan (solid outline) and IEA Weyburn CO₂ Monitoring and Storage project area (dashed outline).

CD-ROM. A written summary, describing known and conceptual plays, will accompany this release. Compilation of a comprehensive bibliography of published geoscience information covering the study area is part of the ‘Consolidating Canada’s Geoscience Knowledge’ program and is an important component of this TGI project.

Project structure

This project has eight principal tasks:

- geoscience knowledge inventory
- regional geological mapping
- geophysical investigations
- regional hydrogeology
- remotely sensed imagery
- hydrocarbon assessment
- 3-D gOcad® geological model
- summary report

One or more principal task leaders have been assigned to each task. Overall responsibility for management of the project is shared between SIR (Kim Kreis and Steve Whittaker), IEDM (Ruth Bezys and Carol Martiniuk), and NRCAN (Benoit Beauchamp). The TGI project has attempted to assemble a team with expertise in different geoscience disciplines. Geophysical expertise will mainly come from the Geophysics Department at the University of Saskatchewan.

Hydrogeological support will be obtained from the University of Alberta. Biostratigraphic and geochemical work is to be carried out by the Geological Survey of Canada (GSC), Calgary.

Project participants

Manitoba Industry, Economic Development and Mines (IEDM)

Led by Ruth Bezys and Carol Martiniuk, Manitoba is responsible for coordinating research work in Manitoba for the TGI project. Ruth Bezys (Manitoba Geological Survey [MGS]) will direct mapping activities; Carol Martiniuk (Petroleum Branch) will direct stratigraphic data collection and interpretation, and both will share their stratigraphic capabilities as part of their Task 2 responsibilities (regional geological mapping). Michelle Nicolas is the chief researcher for Task 2, providing stratigraphic expertise and coordinating regional correlations with contract staff in Manitoba and fellow researchers in Saskatchewan. Ruth Bezys will be leading the remotely sensed imagery studies (Task 5). Gaywood Matile and Greg Keller, assisted by Steve Whittaker in Saskatchewan, will guide the development of a 3-D geological model (Task 7) for the project.

Saskatchewan Industry and Resources (SIR)

Under the direction of Kim Kreis and Steve Whittaker, Saskatchewan is responsible for the coordination of all research tasks in Saskatchewan. Regional geological mapping (Task 2) for the Saskatchewan portion of the TGI area will be led by Kim Kreis. Steve Whittaker will lead compilation of hydrocarbon assessment data (Task 6) and will work with Gaywood Matile from MGS on developing a 3-D geological model using gOcad[®] software (Task 7). Melinda Yurkowski will direct Saskatchewan's compilation of a comprehensive geoscience bibliography and development of an ArcView[®] GIS product for the geoscience knowledge inventory (Task 1). Her stratigraphic expertise with Mesozoic strata will also be used in support of Task 2.

University of Saskatchewan

Igor Morozov will be responsible for regional geophysical investigations (Task 3) in the TGI project area. Jiakang Li, a Post-Doctoral Fellow with the University of Saskatchewan, will work with Morozov on the compilation, integration and interpretation of regional gravity and aeromagnetic datasets in an effort to improve current understanding of the Precambrian basement. These data and interpretations will be augmented by seismic data where available. Comparison of regional geological mapping results derived from well-control data (Task 2) with geophysical mapping (Task 3) may provide insights into basement structural controls on overlying Phanerozoic rocks.

University of Alberta

Under the leadership of Ben Rostron, Dan Palombi (M.Sc. student) will map existing hydrogeological and hydrochemical data for major deep aquifers (>250 m) to describe their flow in three dimensions (Task 4). Mapping of regional fluid-flow directions and flow rates is expected to enhance understanding of migration paths and potential traps within the project area.

Consultants

Consultants have been hired in support of the geoscience knowledge inventory and regional geological mapping (Tasks 1 and 2). Don Kent and Patty Thomas will be working with SIR geologists, primarily in Saskatchewan, on Paleozoic stratigraphy, while Jim Christopher will focus on Mesozoic stratigraphy. Dan Barchyn will be working with Manitoba geological staff on all Phanerozoic stratigraphy in Manitoba. These consultants have a wealth of experience in the geology of the Williston Basin, and will help ensure the development of a consistent and seamless stratigraphy throughout the study area. Geological assistants Stacey Spooner, in Saskatchewan, and Derek Bogdan, in Manitoba, will provide technical support to Tasks 1 and 2.

Current Manitoba update

The initial phases of the geological mapping in Manitoba included the creation of a TGI stratigraphic column, identification and resolution of cross-border stratigraphic issues, and agreement on top-picking criteria for each horizon between Manitoba and Saskatchewan. Manitoba's portion of the subsurface top picking resulted in a total of 1406

wells, with 1114 of these wells penetrating the Paleozoic sequence to varying degrees. When available, a minimum density of 5 wells/township was used to pick wells for the project; included were all oil and gas wells that penetrated the Mississippian Bakken Formation to the Precambrian. Mesozoic picks were from the uppermost mappable Cretaceous unit interpreted from geophysical logs (the Boissevain Member of the Pierre Shale). The TGI maps will only include as far up the stratigraphic column as the Odanah Member of the Pierre Shale. To allow for accurate border mapping, tops were picked in North Dakota along the international border, up to four townships south of the border, using the same minimum density of 5 wells/township. The oil and gas well database is now going through the data verification stage. Once this is completed, all available stratigraphic drillhole data will be added to the overall Manitoba TGI pick database and map production will begin.

To help understand depositional environments and resolve stratigraphic issues, a total of 67 samples from Manitoba strata were sent for biostratigraphic analysis: 20 samples from the Mesozoic for palynology, 20 samples from the Mesozoic for foraminiferal analysis and 37 samples from the Paleozoic for conodont analysis. Twenty-two samples were also collected for total organic carbon geochemical analysis (4 Mesozoic samples and 18 Paleozoic samples).

Final production of all maps for the project will be handled by the cartographic staff of the MGS. The first set of maps, to be completed by March 31, 2005, will consist of the Lower Paleozoic strata. As geological database picks become available, the next sequence of maps will be completed (Devonian, Mississippian and Cretaceous). All data and maps will be available on a joint SIR-IEDM TGI website, presently being developed.

A 3-D model of all geological surfaces will be constructed using gOcad[®] software once all stratigraphic pick data are available and verified. Both provinces will be involved in the final construction of these surfaces, but Manitoba will proceed on edge definition of the Precambrian-Paleozoic boundary in Manitoba and Saskatchewan, where outcrop exists.

Economic considerations

The total budget for this two-year TGI is \$768 500, with \$378 500 budgeted for fiscal 2003–2004 and \$390 000 for fiscal 2004–2005. The breakdown of total financial contribution to the project is \$720 000 from NRCan, \$28 500 from Manitoba and \$20 000 from Saskatchewan. This represents a large amount of federal dollars being spent in both provinces on geoscience compilation and research in the Williston Basin.

Exploration for prospective hydrocarbon reservoirs and mineral resources in the Williston Basin is usually led by small Canadian companies, which rely on government and universities for development of advanced modelling techniques of basins. These large regional syntheses are essentially the framework upon which all subsequent exploration will be based, and it is hoped that further hydrocarbon and mineral exploration will be conducted in southwestern Manitoba as a result of the new compilations and advancements.

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