

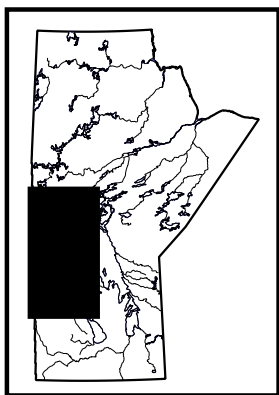
by K. Lapenskie

In Brief:

- Sixteen drillcore from central and northern portions of the Williston Basin were examined
- Stratigraphic information collected aid in refining and resolving the stratigraphic framework of Manitoba
- Northern drillcore provided important insights into the lithofacies of the Winnipeg Formation

Citation:

Lapenskie, K. 2019: Summary of Phanerozoic core logging activities in Manitoba in 2019 (parts of NTS 63C3, 14, 63J5, 6, 11, 12, 14); *in* Report of Activities 2019, Manitoba Agriculture and Resource Development, Manitoba Geological Survey, p. 77–82.



Summary

Sixteen drillcore from central and northern portions of the Williston Basin in Manitoba were examined in 2019. These drillcore were examined for the purposes of collecting stratigraphic information, investigating carbonate-hosted lead-zinc mineralization potential in the Swan River–Minitonas area, and characterizing the silica sands of the Winnipeg Formation of the northern Williston Basin.

Drillcore from the Swan River–Minitonas area provided insight into the subsurface stratigraphy of an understudied area and yielded positive indicators for the potential for carbonate-hosted lead-zinc mineralization; however, no occurrences of mineralization were identified. Drillcore from northern portions of the Williston Basin also provided valuable subsurface stratigraphic information from the Stonewall to Winnipeg formations. The Winnipeg Formation displayed a significant amount of lithological variation in these drillcore, but further work is required to assess the quality of the silica sand from different lithofacies. However, due to the very thin nature of the Winnipeg Formation in the northernmost region of the Williston Basin, the formation likely has limited potential as an economic source of high-purity silica sand.

Introduction

Exploration drillcore that transects Phanerozoic strata has been integral to the Manitoba Geological Survey's (MGS) efforts to refine and resolve the stratigraphic framework of the Manitoba portion of the Williston Basin, as well as to better understand industrial mineral potential. Detailed lithostratigraphy is performed on Phanerozoic core when possible, as the lower Paleozoic framework of southwestern Manitoba contains significant inconsistencies (Lammers, 1988; Bezys and Conley, 1998; Nicolas and Barchyn, 2008; Lapenskie and Nicolas, 2017).

During 2019, 16 exploration drillcore were examined as part of ongoing stratigraphic correlation activities and industrial minerals projects (Figure GS2019-8-1, Table GS2019-8-1). Core drilled by Husky Oil Ltd. (Husky) and Gulf Minerals Canada Limited (GMCL) in the Swan River–Minitonas area were re-examined specifically to perform detailed lithostratigraphic examination, refine stratigraphic errors and address inconsistencies in previous logs, and to examine drillcore for any indicators of carbonate-hosted lead-zinc mineralization. Exploration core drilled by Hudbay Minerals Inc. (Hudbay) in northern parts of the Williston Basin were also examined. These drillcore were examined for their stratigraphic information and to assess the silica sands of the Winnipeg Formation. A summary of the lithostratigraphy and brief lithological descriptions are provided in MGS Data Repository Item DRI2019006¹. Geographic location, associated assessment file and well licence numbers are also provided in Table GS2019-8-1.

Husky-GMCL drillcore

Drillcore from the Swan River–Minitonas area were drilled by Husky and GMCL in the 1970s. These core were originally drilled as stratigraphic testholes for mineral and petroleum exploration purposes. In total eight core were drilled by the two companies, five of

¹ MGS Data Repository Item DRI2019006 containing the data or other information sources used to compile this report is available online to download free of charge at <https://www.gov.mb.ca/iem/info/library/downloads/index.html>, or on request from minesinfo@gov.mb.ca, or by contacting the Resource Centre, Manitoba Agriculture and Resource Development, 360–1395 Ellice Avenue, Winnipeg, Manitoba R3G 3P2, Canada.

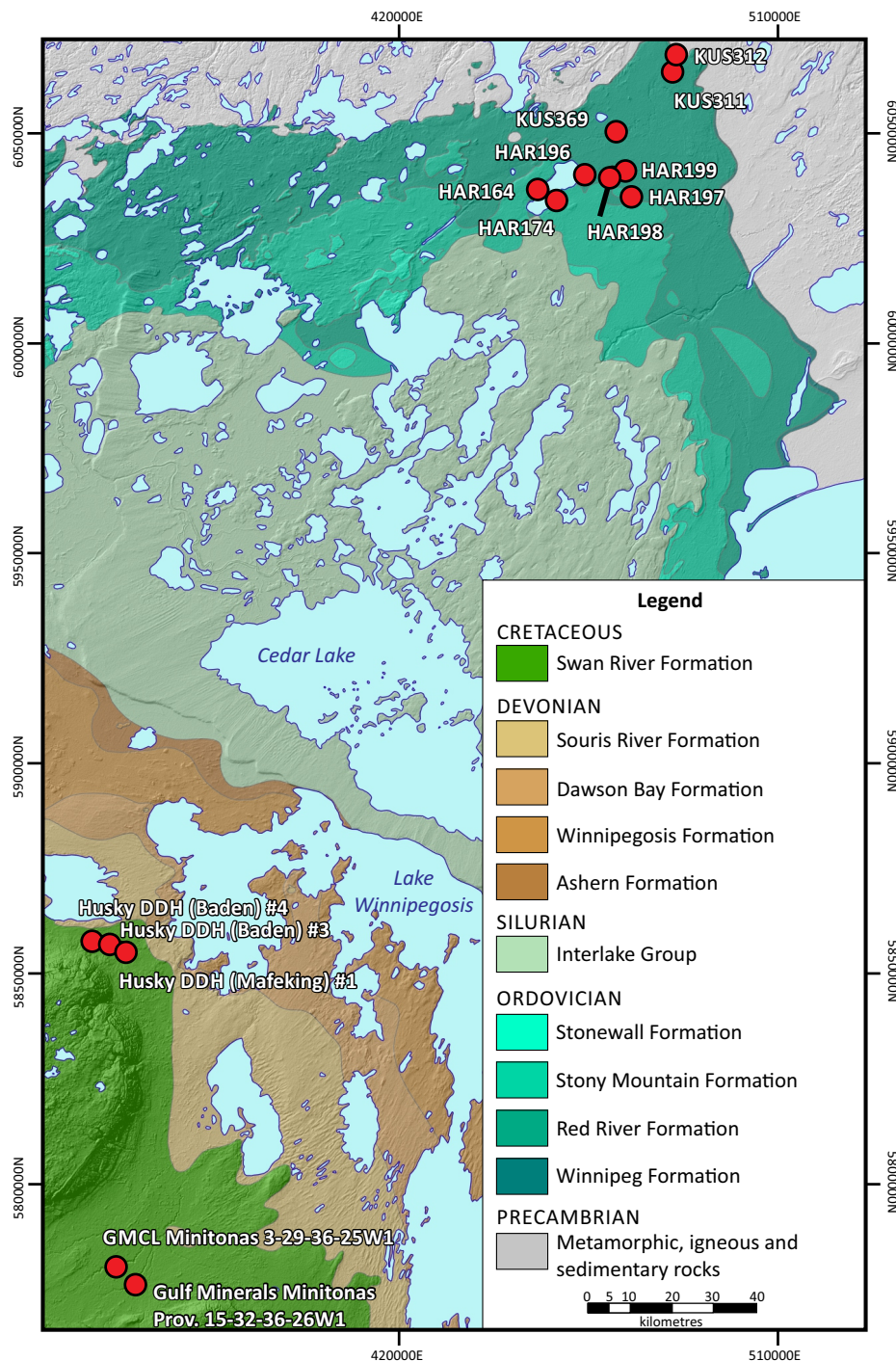


Figure GS2019-8-1: Regional bedrock geology of the central to northern portions of the Williston Basin in Manitoba (after Nicolas et al., 2010); formations younger than the Swan River Formation are not depicted. Drillhole locations are indicated by red dots. Co-ordinates are in UTM Zone 14, NAD83.

which have been stored and are available for examination at the MGS Midland Sample and Core Library (Winnipeg, Manitoba; Table GS2019-8-1).

The drillholes primarily transected Devonian strata, with two drilled to Precambrian basement. The entire Paleozoic section in only one of those drillcore was retained by the MGS. Although these drillcore were drilled in close

proximity, there was a high degree of variation in Devonian strata in some drillcore, most notably in the Souris River Formation. The Souris River Formation is known to have a degree of lateral lithological variation (Glass, 1990; Natural Resources Canada, 2019) and is relatively understudied in parts of the outcrop belt, including the Swan River–Minitonas area.

Table GS2019-8-1: Geographic and general information for logged drillcore. The UTM co-ordinates are in NAD83, Zone 14.

Core ID	Easting	Northing	Depth (m)	Assessment File	Licence number	Company
KUS311	484775	6066695	221.00	74703	n/a	Hudbay Minerals Inc.
KUS312	485092	6067742	206.00	74703	n/a	Hudbay Minerals Inc.
HAR174	456059	6034206	302.00	74565	n/a	Hudbay Minerals Inc.
HAR199	471841	6040150	179.00	74565	n/a	Hudbay Minerals Inc.
HAR196	463996	6039630	302.00	74565	n/a	Hudbay Minerals Inc.
HAR164	453364	6035930	293.00	74565	n/a	Hudbay Minerals Inc.
HAR197	474415	6035211	238.00	74582	n/a	Hudbay Minerals Inc.
HAR198	470089	6040200	185.00	74565	n/a	Hudbay Minerals Inc.
KUS369	470991	6050394	224.00	74705	n/a	Hudbay Minerals Inc.
RES372*	-	-	-	-	n/a	Hudbay Minerals Inc.
RES361*	-	-	-	-	n/a	Hudbay Minerals Inc.
Husky DDH (Mafeking) #1	352800	5855453	152.40	91776	2465	Husky Oil Ltd.
Husky DDH (Baden) #3	350411	5856365	144.80	91776	2467	Husky Oil Ltd.
GMCL Minitonas 3-29-36-25W1	355592	5775895	526.40	92116	2548	Gulf Minerals Canada Limited
Gulf Minerals Minitonas Prov. 15-32-36-26W1	352568	5779003	517.20	92116	2547	Gulf Minerals Canada Limited
Husky DDH (Baden) #4	348383	5856856	109.70	91776	2468	Husky Oil Ltd.

* Drillcore are under confidentiality and the location and depths of these drillcore are unable to be shared publicly at this time

No examples of carbonate-hosted mineralization were identified in the Husky and GMCL drillcore. However, positive indicators of carbonate-hosted lead-zinc mineralization in a Mississippi Valley–type deposit were identified, such as extensive brecciation, reefal to inter-reefal facies, evidence of evaporites and possible karsting (Paradis et al., 2007; Leach et al., 2010).

Stratigraphy

A brief discussion of important features observed in the Husky and GMCL drillcore is provided below.

GMCL Minitonas 3-29-36-25W1

Drillcore GMCL Minitonas 3-29-36-25W1 (oil and gas well licence 2548, Manitoba Agriculture and Resource Development, Winnipeg; Assessment File 92116, Manitoba Agriculture and Resource Development, Winnipeg) transected over 500 m of Phanerozoic strata, including 430.1 m of Paleozoic rock. This drillcore offers a complete section, with excellent core recovery, of the lower Paleozoic strata of the Manitoba outcrop belt, from the lowermost Ordovician Winnipeg Formation to the uppermost Devonian Hatfield Member of the Souris River Formation.

The Winnipeg Formation and Ordovician Bighorn and Silurian Interlake groups in drillcore GMCL Minitonas 3-29-36-25W1 are typical of this area in the Williston Basin. The lowermost Winnipeg Formation was subdivided into the lower sandstone Black Island Member and upper shaly

Icebox Member. The upper Red River Formation was subdivided into the Lake Alma Member, Coronach unit and Redvers unit. The Gunton Member is the only member of the Stony Mountain Formation present in this drillcore, confirming the absence of other members in the northern extent of the Williston Basin (Kendall, 1976; Glass, 1990; Natural Resources Canada, 2019). The t-marker bed, an argillaceous and arenaceous bed that approximates the Ordovician-Silurian boundary, is well developed in the Stonewall Formation.

The Interlake Group was subdivided into its constituent formations: the Fisher Branch, Moose Lake, Atikameg, East Arm and Cedar Lake formations, in ascending order. Previous attempts to identify the individual formations of the Interlake Group in the subsurface have been largely unsuccessful (Bezys and Conley, 1998). However, examination of this drillcore, coupled with drillcore Neepawa DDH No. 1 Prov. 15-29-14-14W1 (Lapenskie and Nicolas, 2018), led to the identification of the formations of the Interlake Group in the subsurface; the availability of complete sections of core made this possible. The u_1 -, u_2 - and v-marker beds are all well developed in drillcore GMCL Minitonas 3-29-36-25W1.

The Devonian section includes the basal Ashern Formation to uppermost Hatfield Member of the Souris River Formation. The upper member of the Winnipegosis Formation is composed of a thin interval of inter-reefal facies. The overlying Prairie Evaporite is composed only of lime-

stone and diamictite transitional beds, as all evaporites have been dissolved in this part of the Williston Basin. The Sagemace and Hatfield members of the Souris River Formation are composed of a complex series of interbeds, and are each defined by a basal shaly to very argillaceous bed. The upper beds and upper contact of the Hatfield Member were not recovered in this core.

Husky DDH (Mafeking) #1

Drillcore Husky DDH (Mafeking) #1 (oil and gas well licence 2465; Assessment File 91776) transected uppermost Interlake Group to lower Souris River Formation strata. The section is typical of these stratigraphic units, and correlates well with GMCL Minitonas 3-29-36-25W1. The upper member of the Winnipegosis Formation is composed of a relatively thin interval of reefal facies.

Husky DDH (Baden) #3, Husky DDH (Baden) #4 and Gulf Minerals Minitonas Prov. 15-32-36-26W1

Drillcore from Husky DDH (Baden) #3 (oil and gas well licence 2467; Assessment File 91776), Husky DDH (Baden) #4 (oil and gas well licence 2468; Assessment File 91776) and Gulf Minerals Minitonas Prov. 15-32-36-26W1 (oil and gas well licence 2547; Assessment File 92116) were problematic for logging due to poor core recovery. Extensive brecciation, coupled with a high degree of lithological variation, made large portions of the drillcore stratigraphically undefinable. Chaotic brecciation (Figure GS2019-8-2) due to karsting and/or evaporite dissolution is the most likely cause of the disturbed lithologies. An uppermost sand/sandstone interval was transected in both the Husky DDH

(Baden) #4 and Husky DDH (Baden) #3 holes and is interpreted to be the Cretaceous Swan River Formation.

Hudbay drillcore

A total of 11 Hudbay exploration drillcore, which transected Paleozoic strata across the northern portion of the Williston Basin, were examined during the 2019 field season (Table GS2019-8-1). These drillcore are stored at Hudbay's Stall concentrator site outside of the town of Snow Lake, and at the Hudbay hanger on Schist Lake near the community of Channing. The primary objectives of examining these drillcore were to compile stratigraphic information, and to define the lithofacies and purity of the silica sand of the Winnipeg Formation.

Most of the drillholes transected the Red River and Winnipeg formations, whereas holes located in the southerly portions of Hudbay exploration areas also transected the Stony Mountain and Stonewall formations.

The Winnipeg Formation is disconformably underlain by regolith and unweathered Precambrian metamorphic, igneous and sedimentary rocks, and conformably overlain by a thick succession of Red River Formation dolostones (Figure GS2019-8-3a). The Winnipeg Formation is very heterogeneous in the northern portion of the Williston Basin. Lithologies vary from unconsolidated sand, kaolin-rich mudstone, quartz wacke to arenite, feldspathic wacke to arenite, and quartzose conglomerate to diamictite (Figure GS2019-8-3b-d). Immature sandstones containing garnet, biotite and gravel-sized quartz clasts were observed in some drillcore. The sandstones are variably pyritic (Figure GS2019-8-3b), with elevated concentrations

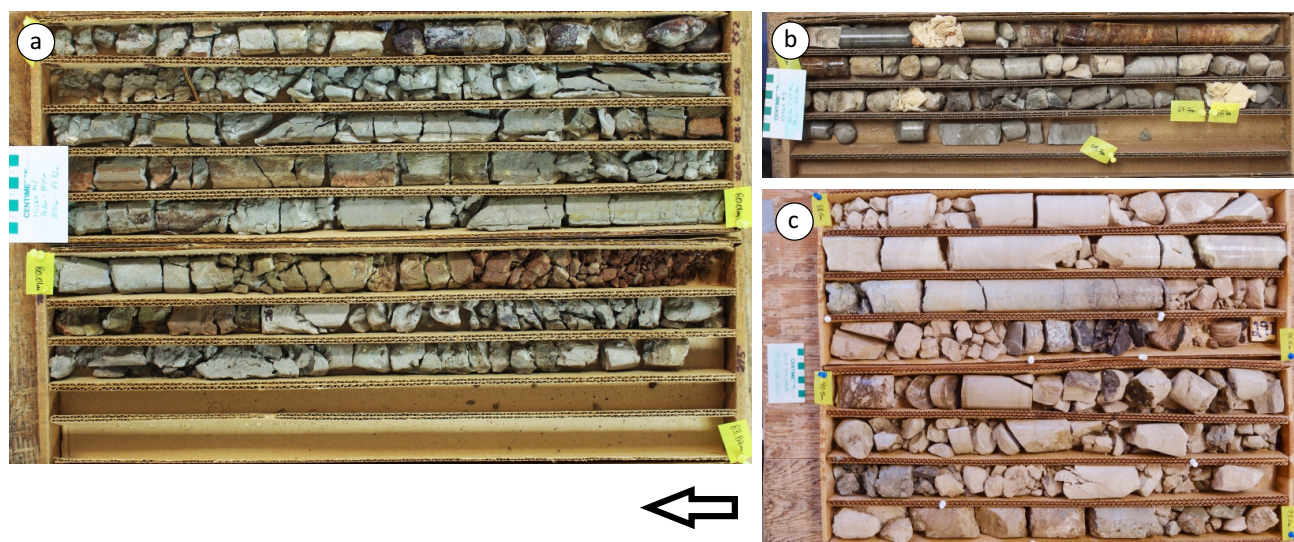


Figure GS2019-8-2: Examples of brecciation: **a)** drillcore Husky DDH (Baden) #4 (oil and gas well licence 2468; Assessment File 91776), 76.20 to 80.00 m and 80.00 to 83.80 m; **b)** drillcore Husky DDH (Baden) #3 (oil and gas well licence 2467; Assessment File 91776), 20.10 to 27.70 m and 38.10 to 45.70 m; **c)** drillcore Gulf Minerals Minitonas Prov. 15-32-36-26W1 (oil and gas well licence 2547; Assessment File 92116), 88.50 to 93.00 m. Arrow indicates up direction in core. Scale cards in centimetres.

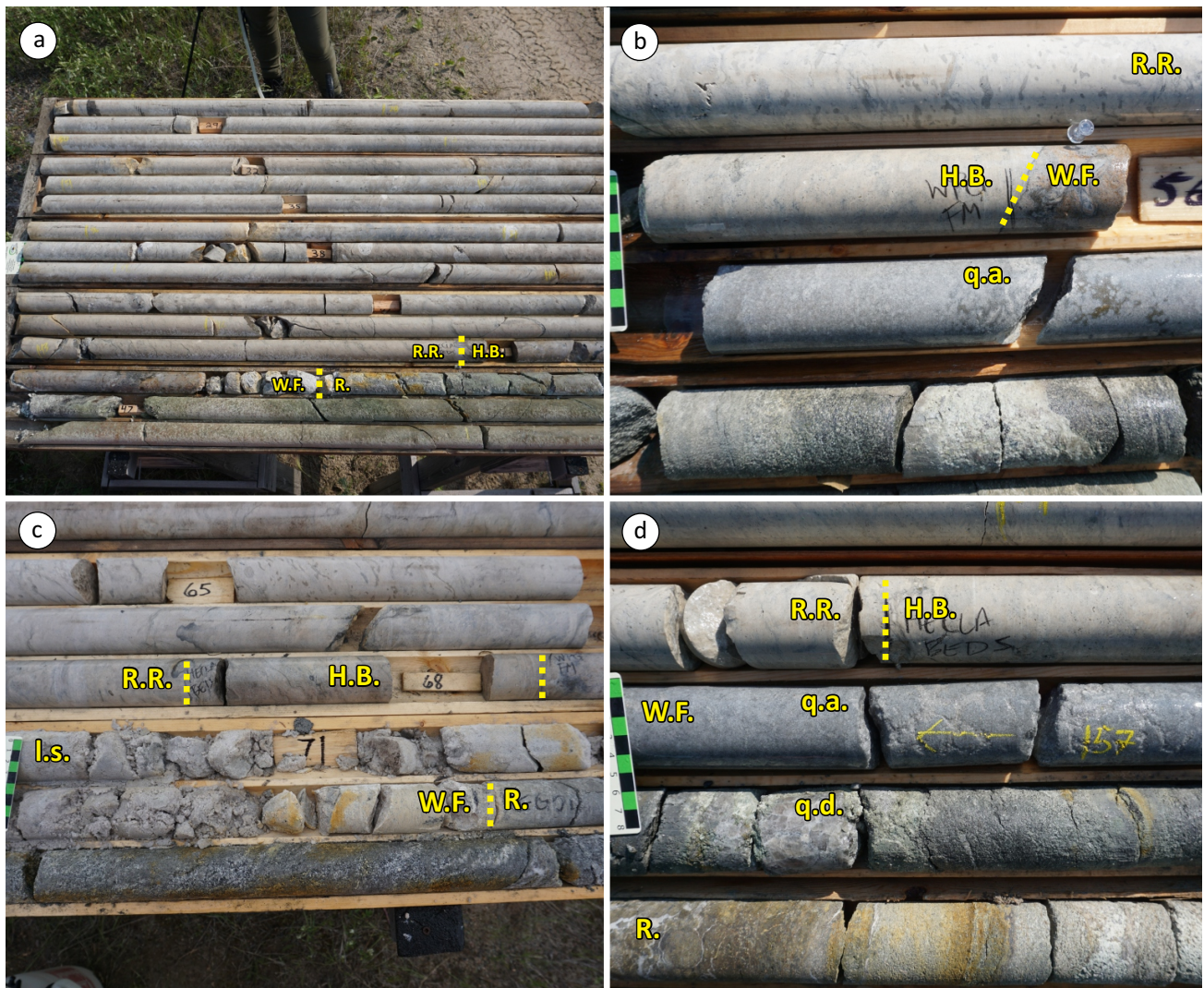


Figure GS2019-8-3: Photographs of the Winnipeg Formation in drillcore: **a)** Red River Formation, Hecla Beds, Winnipeg Formation and Precambrian basement of drillcore KUS369 (Assessment File 74705), showing undifferentiated lower Red River Formation strata; **b)** Red River Formation, Hecla Beds and Winnipeg Formation of drillcore HAR164 (Assessment File 74565), showing pyritic quartz arenite; **c)** Red River Formation, Hecla Beds, Winnipeg Formation and Precambrian basement of drillcore HAR197 (Assessment File 74582), showing unconsolidated sand of the Winnipeg Formation; **d)** Red River Formation, Hecla Beds, Winnipeg Formation and Precambrian basement of drillcore HAR164, showing multiple lithofacies of the Winnipeg Formation. Arrow indicates up direction in core. Dashed yellow lines represent lithostratigraphic contacts. Scale cards in centimetres. Abbreviations: H.B., Hecla Beds; I.s., loose sand; q.a., quartz arenite; q.d., quartz diamictite; R., regolith; R.R., Red River Formation; W.F., Winnipeg Formation.

of sulphides most commonly occurring near the upper contact of the Winnipeg Formation with the overlying Red River Formation. Thickness of the Winnipeg Formation ranges from 0.55 to 5.20 m. The Winnipeg Formation was not observed in drillcore KUS311 (Assessment File 74703) because the basal portion of the drillcore was stored separately and inaccessible for logging.

Microscope and thin section observations will be conducted to quantitatively describe and classify the lithofacies of the Winnipeg Formation. Geochemical analysis will be

performed to quantitatively assess the quality of the silica sands of the different facies. Further core logging will be conducted in future field seasons to continue to better understand the quality and characteristics of the silica sands of the Winnipeg Formation in northern portions of the Williston Basin, and to define the lateral facies variation across the basin in Manitoba. However, due to the very thin nature of the Winnipeg Formation in the northernmost region of the Williston Basin, the formation likely has limited potential as an economic source of high-purity silica sand.

Economic considerations

Phanerozoic drillcore are important to refining and building the MGS's stratigraphic database, and providing valuable insight into resolving and formalizing stratigraphic relationships. An accurate and well-defined stratigraphic framework for the Williston Basin in Manitoba is required for petroleum exploration, understanding brines and hydrogeology, industrial mineral exploration, and carbonate-hosted lead-zinc exploration. Examining exploration drillcore provides important insights into the geology of the Winnipeg Formation and in assessing the purity and economic potential of silica sands in the northern parts of the Williston Basin.

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References

- Bezys, R.K. and Conley, G.G. 1998: Geology of the Silurian Interlake Group in Manitoba; Manitoba Energy and Mines, Stratigraphic Map SI-1, scale 1:2 000 000.
- Glass, D.J. (ed.) 1990: Lexicon of Canadian Stratigraphy, Volume 4, Western Canada; Canadian Society of Petroleum Geologists, Calgary, Alberta, 772 p.
- Kendall, A.C. 1976: The Ordovician carbonate succession (Big-horn Group) of southern Saskatchewan; Saskatchewan Department of Mineral Resources, Report 180, 185 p.
- Lammers, G.E. 1988: Silurian stratigraphy of the Interlake area; *in* Report of Field Activities 1988, Manitoba Energy and Mines, Geological Services, p. 43–48.
- Lapenskie, K. 2019: Lithostratigraphy and brief lithological descriptions of logged Phanerozoic core, southwestern and central Manitoba (parts of NTS 63C3, 14, 63J5, 6, 11, 12, 14); Manitoba Agriculture and Resource Development, Manitoba Geological Survey, Data Repository Item DRI2019006, Microsoft® Excel® file.
- Lapenskie, K. and Nicolas, M.P.B. 2017: Detailed examination of drillcore RP95-17, west-central Manitoba (NTS 63C7): evidence of potential for Mississippi Valley-type lead-zinc deposits; *in* Report of Activities 2017, Manitoba Growth, Enterprise and Trade, Manitoba Geological Survey, p. 158–172.
- Lapenskie, K. and Nicolas, M.P.B. 2018: Lithostratigraphy of the Neepawa DDH No. 1 Prov. core at 15-29-14-14W1, southwestern Manitoba (part of NTS 62J3); *in* Report of Activities 2018, Manitoba Growth, Enterprise and Trade, Manitoba Geological Survey, p. 136–149.
- Leach, D.L., Taylor, R.D., Fey, D.L., Diehl, S.F. and Saltus, R.W. 2010: A deposit model for Mississippi Valley type lead-zinc ores, chapter A of mineral deposit models for resource assessment; United States Geological Survey, Scientific Investigations Report 2010-5070-A, 52 p.
- Natural Resources Canada 2019: Weblex Canada: lexicon of Canadian geological names on-line; Natural Resources Canada, URL <https://weblex.nrcan.gc.ca/weblexnet14/weblex_e.aspx> [September 2019].
- Nicolas, M.P.B. and Barchyn, D. 2008: Williston Basin Project (Targeted Geoscience Initiative II): summary report on Paleozoic stratigraphy, mapping and hydrocarbon assessment, southwestern Manitoba; Manitoba Science, Technology, Energy and Mines, Manitoba Geological Survey, Geoscientific Paper GP2008-2, 21 p.
- Nicolas, M.P.B., Matile, G.L.D., Keller, G.R. and Bamburak, J.D. 2010: Phanerozoic geology of southern Manitoba; Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, Stratigraphic Map SM2010-1, 2 sheets, scale 1:600 000.
- Paradis, S., Hannigan, P. and Dewing, K. 2007: Mississippi Valley-type deposits; *in* Mineral Deposits of Canada: A Synthesis of Major Deposit-Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods, W.D. Goodfellow (ed.), Geological Association of Canada, Mineral Deposits Division, Special Publications No. 5, p. 185–203.