Gypsum investigations in the Harcus-Amaranth area, southwestern Manitoba

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Summary

The evaporitic Upper Amanrath Member, Amaranth Formation in the Williston Basin, has been producing gypsum since the turn of the 20th century in Manitoba. Gypsum is used in the manufacturing of cement and to manufacture wallboard in the province. The Manitoba Geological Survey (MGS) is currently investigating this resource, with the primary objective of providing valuable information to industry in the form of updated structure contour and isopach maps for areas of economic interest. In 2016, these maps were modelled using mineral exploration drillcore and water well data for the Harcus-Amaranth area.

Introduction

In 2015, the MGS initiated an investigation into the gypsum resources of Manitoba (Lapenskie and Bamburak, 2015). The aim of this project is to provide a comprehensive update on this commodity, which has been utilized for industrial purposes in Manitoba for over 100 years (Bannatyne, 1959, 1977; Gunter, 1987).

Economic deposits of gypsum occur in the evaporitic Upper Amaranth Member of the Amaranth Formation. The member is composed predominantly of gypsum and/or anhydrite.

Objectives of this investigation are aimed at improving our knowledge of gypsum resources in Manitoba to encourage exploration and aid in future land-use planning:

- **compile the history of gypsum quarrying, exploration, and production;**
- **provide a comprehensive update on the geological description and correlation of the evaporites of the Upper Amaranth Member; and**
- **general detailed structure contour and isopach maps of the overlying Quaternary sediments and Upper Amaranth Member.**

Structure contour and isopach maps

Drillcore data, as well as water well data, for the Harcus-Amaranth area have been compiled, and detailed structure contour and isopach maps of the Quaternary sediments and Upper Amaranth Member have been generated (Figures 1 and 2).

Drillcore and water well data were computer generated to create the structure contour and isopach maps. The underlying grids for the map were created using Spatial Analyst for ArcGIS, with the Spline with Barriers interpolation method. The grids were then contoured using the Contour with Barriers method in Spatial Analyst.

In much of the map area, known member thickness is sparse; therefore, the accuracy of the contours can be low. Due to the highly variable thickness of the Quaternary sediments and gypsum in this area, these maps should only be used to guide exploration as a current best estimate. Karsting and/or erosional features are common in the Upper Amaranth Member, which provides additional caveats when modelling sediment and rock thicknesses.

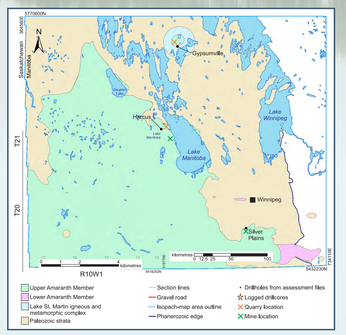


Figure 3: Simplified geological map of southern Manitoba, with the extent of the Upper Amaranth Member in green (from Lapenskie and Bamburak, 2015).

Economic Considerations

Current gypsum quarrying activities significantly contribute to the cement and wallboard industries in the province. The gypsum-based wallboard manufacturing company in Winnipeg is the only one of its kind in Manitoba, and has strong economic significance as it exclusively serves a large geographic region. Detailed isopach and structure contour maps of the Harcus-Amaranth area will help operators guide expansion plans and identify future exploration targets. Investigations into the stratigraphy and karst development in the Upper Amaranth Member will provide valuable information for future land-use planning. Resolving the stratigraphic correlation between the Williston Basin and the Lake St. Martin igneous and metamorphic complex will add to the understanding of the depositional history of Phanerozoic strata in Manitoba.

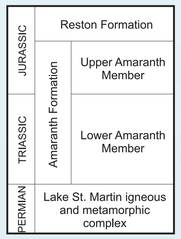
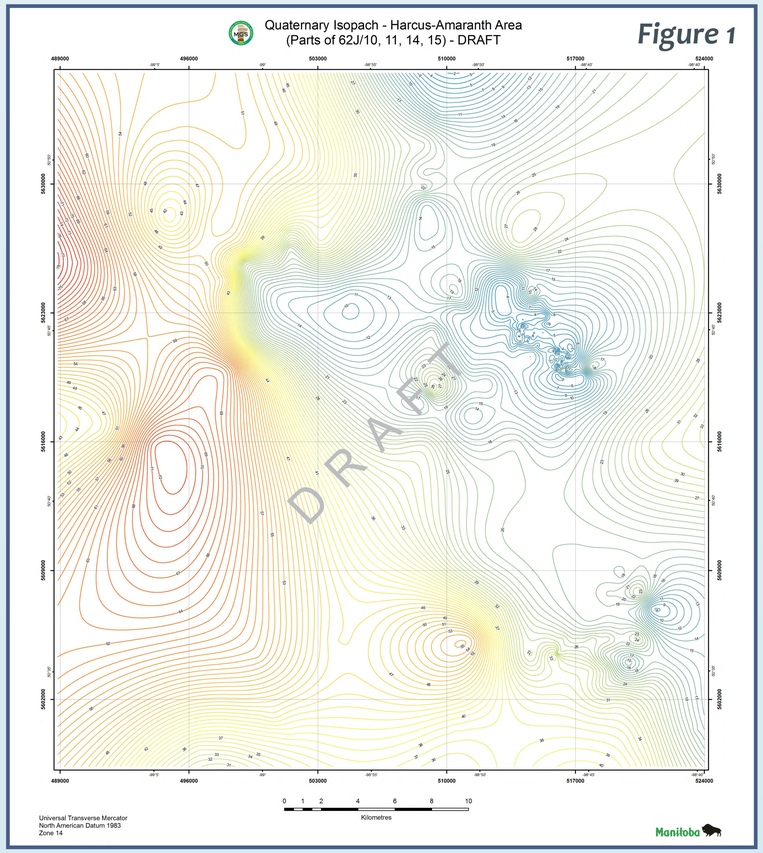


Figure 4: Stratigraph of the Permian to lower Jurassic in Manitoba.

Regional Geology

The Amaranth Formation occurs throughout southwestern Manitoba within the Williston Basin, and also as an outlier in the Lake St. Martin igneous and metamorphic complex (Figure 3). An erosional unconformity separates the Amaranth Formation from the underlying Paleozoic rocks. In the subsurface, the Amaranth Formation overlies truncated, northwest-trending Devonian to Mississippian-aged carbonate and siliciclastic rocks (Bamburak and Christopher, 2004; Nicolas, 2009). In the Gypsumville area, the formation is underlain by the Lake St. Martin igneous and metamorphic complex (Figure 4). The Amaranth Formation is overlain by the Jurassic Reston Formation. See Lapenskie and Bamburak (2015) and Nicolas (2009) for a complete description of the stratigraphy of the Williston Basin as it pertains to the Amaranth Formation.



Quaternary isopach map (Figure 1)

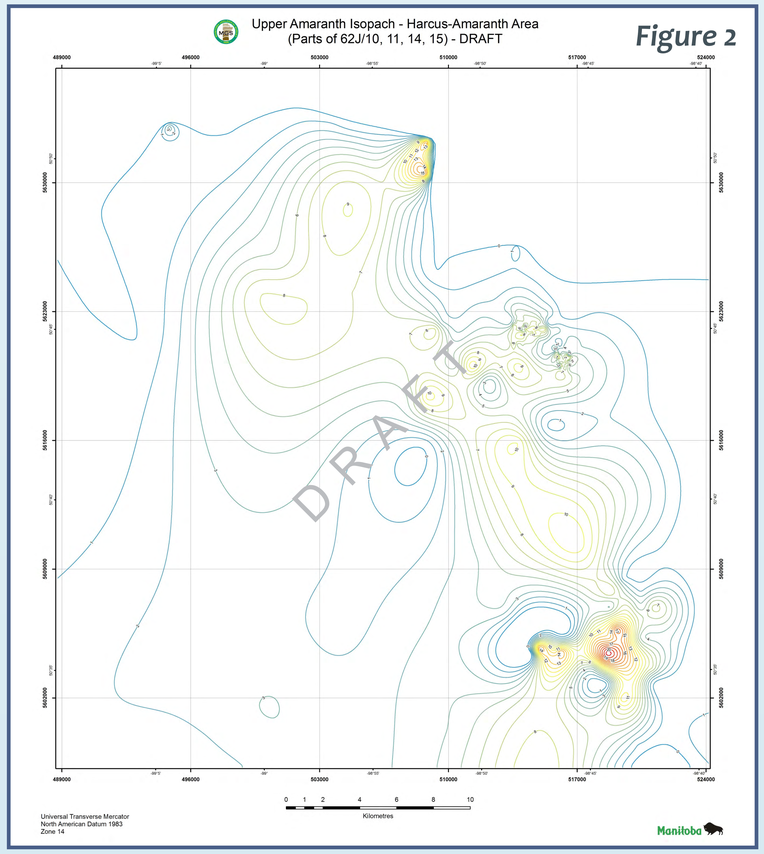
Quaternary sediments are generally thinnest in the central to eastern regions of the map area, and range from <2m to >78m in thickness. Gypsum quarrying is currently taking place in the northeastern region of the map area, where thin Quaternary cover allows easy access.

Elliptical areas of anomalously thicker Quaternary sediments may indicate the presence of large areas of karsting or sinkhole development. This would have occurred within the underling member before the deposition

Upper Amaranth Member isopach map (Figure 2)

The Upper Amaranth Member is generally thickest along a NNW-SSE trend on the right side of the map area. Thickness of the member ranges from 0 m to >20 m. Roughly elliptical areas of decreased gypsum thickness may represent sinkholes or karsted areas.

The edge of the Upper Amaranth Member trends irregularly east to west in the northern part of the map area.



Depositional Model

Evaporites are typically deposited in relatively shallow water, restricted environments from highly concentrated brines. The Upper Amaranth Member was deposited in this setting, under extremely restricted conditions. At depth, the member is characterized by bedded anhydrite, variably calcareous mudstones, and irregular bituminous laminae. The primary lithologies these represent are laminated gypsum, bedded to laminated dolomudstones, and syn-primary, bituminous anhydrite (Kaspryzk, 2003; Warren, 2006). Primary, laminated gypsum is generally deposited in relatively calm shallow brines; beds of mudstone are deposited from less concentrated brines and may represent periods of decreased evaporation and/or increased fresh water influx (Warren, 2006). Syn-primary anhydrite and bituminous laminations are typically deposited in slightly deeper water conditions. In the subcrop-outcrop belt, the Upper Amaranth Member is characterized by bassanite, alabastine textures, and fibrous fracture-fill gypsum.

Anhydrite is present as the dominant evaporite within the member in the mesogenetic realm due to dehydration and compaction within the subsurface post-deposition. The presence of bassanite, alabastine textures, and fibrous gypsum infilling fractures within the subcrop belt are indicative of telogenetic processes, such as dissolution, karsting, rehydration, and localized faulting and/or flowing (Figure 5).

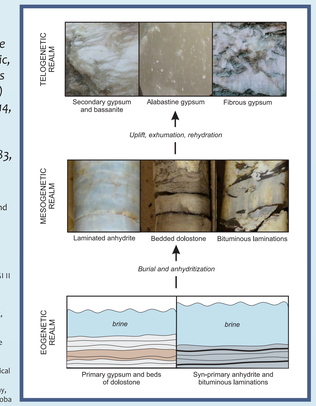


Figure 5: *Depositional and diagenetic model of the Upper Amaranth Member, based on Warren (2006) and Kaspryzyk (2003). Arrows indicate the progression in diagenetic alteration from the eogenetic, mesogenetic, to telogenetic realms. Photographs of the dominant lithological features observed in the Upper Amaranth Member at depth (mesogenetic realm) are from oil core Husky D.D.H. (Baden) No. 3 (from L.S. 15, Sec. 29, Twp. 14, Rge. 14 W 1st Mer.). Photographs of the dominant lithological features observed near or at surface of the member (telogenetic realm) were taken from the CertainTeed Gypsum Canada Inc. quarry in Harcus (NAD83, UTM Zone 14, 516241E, 5619676N).*

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References

Bamburak, J.D. and Christopher, J.E. 2004: Mesozoic stratigraphy of the Manitoba escarpment; MGS and SGS, WCSB/TGI II field trip, Saskatchewan/Manitoba, September 7-10, 2004, 87 p.

Bannatyne, B.B. 1959: Gypsum-anhydrite deposits in Manitoba; Manitoba Mines and Natural Resources, Mines Branch, Publication 58-2, 46 p.

Bannatyne, B.B. 1977: Gypsum in Manitoba; Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, Mineral Education Series 77-1, 8 p.

Gunter, W.R. 1987: Gypsum in Manitoba (revised); Manitoba Energy and Mines, Mineral Education Series 1987, 12 p.

Kasprzyk, A. 2003: Sedimentological and diagenetic patterns of anhydrite deposits in the Badenian evaporite basin of the Carpathian Foredeep, southern Poland; Sedimentary Geology, v. 158, 167-194.

Lapenskie, K. and Bamburak, J.D. 2015: Preliminary results from geological investigations into gypsum, Harcus area, southwestern Manitoba (NTS 62J10); in Report of Activities 2015, Manitoba Mineral Resources, Manitoba Geological Survey, p. 106-114.

Nicolas, M.P.B. 2009: Williston basin project (Targeted Geoscience Initiative II): summary report on Mesozoic stratigraphy, mapping and hydrocarbon assessment, southwestern Manitoba; Manitoba Innovation, Energy, and Mines, Manitoba Geological Survey, Geoscientific Paper GP2009-1, 19 p.

Warren, J.K. 2006: Interpreting evaporite texture; Chapter 1 in Evaporites: Sediments, Resources and Hydrocarbons, J.K. Warren (ed.), Springer, Wurzburg, Germany, p. 1-58.