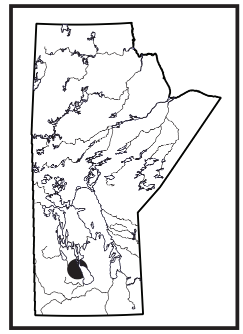
GS-18

Gypsum investigations in the Harcus area, southwestern Manitoba (NTS 62J10): 2016 update

by K. Lapenskie and J.D. Bamburak



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Summary

The evaporitic Upper Amaranth Member, Amaranth Formation of 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 wallboard in the province. The Manitoba Geological Survey 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 area.

Introduction

In 2015, the Manitoba Geological Survey (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 used to manufacture wallboard and cement 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. It is underlain by the dolomitic sandstone and siltstone of the Lower Amaranth Member.

Objectives of this investigation are aimed at improving the knowledge of gypsum resources in Manitoba to encourage exploration and aid in future land-use planning. To achieve this, the priorities of this project are as follows:

- compile the history of gypsum quarrying, mining, exploration and production in the province;
- provide a comprehensive update on the geological description and correlation of the evaporites of the Upper Amaranth Member; and
- generate detailed structure contour and isopach maps of the overlying Quaternary sediments and Upper Amaranth Member of the Harcus–Amaranth area.

This paper presents a summary of structure contour and isopach modelling of the Quaternary sediments and Upper Amaranth Member in the Harcus area. A more refined depositional model is presented as an update to Bannatyne's (1959) depositional hypotheses.

Previous work

Prior to this project, the first comprehensive report on gypsum published by the MGS was by Bannatyne (1959), which documented the historical production of gypsum and its occurrences, and presented the first structure contour and isopach maps of the Upper Amaranth Member. More recent publications have provided updates on the production of gypsum (Bannatyne, 1977; Gunter, 1987).

The exact age of the Amaranth Formation is uncertain; the strata above and below have been definitively dated, leading to an interpreted age of Triassic–Jurassic for the formation. Palynological studies of the Amaranth Formation have yielded few results, except for a solitary occurrence of a species of Mesozoic age (White et al., 2002). Paleomagnetism measurements of the Amaranth Formation in Manitoba and stratigraphically equivalent Watrous Formation in Saskatchewan have resulted in assigned dates ranging from Mississippian to Triassic (Enkin et al., 2001; Cioppa, 2003; Szabó et al., 2009).

In recent years, geochemical analyses have been applied in an attempt to determine the age of the formation. Denison et al. (2001) examined the strontium, sulphur and oxygen isotope ratios from drillcores in Saskatchewan and Manitoba that intersected the anhydrite of the Upper Amaranth Member. Strontium isotopic data suggested a Pennsylvanian to Permian age for the Watrous and Amaranth formations (Denison et al., 2001). Examination of the strontium isotopic curves from Watrous Formation core in Saskatchewan yielded an age of Triassic to early Jurassic (Butcher et al., 2012). Strontium and sulphur isotopes from evaporites within the Lake St. Martin igneous and metamorphic complex suggest a Devonian–Mississippian date and are therefore unlikely to be coeval with the Amaranth Formation within the rest of the Williston Basin (Leybourne et al., 2007). More work is needed to be able to assign a definitive age to the Amaranth Formation and to resolve the correlation of this formation in Manitoba.

During the 2015 field season (Lapenskie and Bamburak, 2015), stratigraphic sections were completed of the Upper Amaranth Member in the CertainTeed Gypsum Canada Inc. quarry at Harcus. Drillcore from an exploration program conducted by Lehigh Cement in the same area was also examined. Historical drillcore data was compiled, and preliminary isopach maps were generated for the Quaternary sediments and Upper Amaranth Member.

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 (Lapenskie and Bamburak, 2015, Figure GS-9-1). An erosional unconformity separates the Amaranth Formation from the underlying Paleozoic rocks. In the subsurface, the Amaranth Formation overlies truncated, northwest-trending Devonian–Mississippian 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. The Amaranth Formation is overlain by the Jurassic Reston Formation. Lapenskie and Bamburak (2015) and Nicolas (2009) provide complete descriptions of the stratigraphy of the Williston Basin as it pertains to the Amaranth Formation.

Preliminary results

Depositional model

Evaporites are typically precipitated from highly concentrated brines and deposited in relatively shallow water, restricted environments. The Upper Amaranth Member was deposited in this setting, under extremely restricted conditions. Features observed in core and at surface provide clues as to the probable depositional framework of the Upper Amaranth Member (Figure GS-18-1). At depth, the member is characterized by bedded anhydrite, variably calcareous mudstone and irregular bituminous laminae. The primary rock types these beds represent are laminated gypsum, bedded to laminated dolomudstone and synprimary bituminous anhydrite (Figure GS-18-1a; Kasprzyk, 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). Synprimary anhydrite and bituminous laminations are typically deposited in slightly deeper water conditions.

After burial, diagenetic alteration of the member destroyed all primary depositional features and lithologies formed in the eogenetic (depositional) realm, as evidenced by pervasive anhydrite at depth. Anhydrite is present as the dominant evaporite within the member in the mesogenetic realm due to dehydration and compaction within the subsurface postdeposition (Figure GS-18-1b). The presence of bassanite, alabastine textures and fibrous gypsum infilling fractures within the subcrop–outcrop belt are indicative of telogenetic processes, such as dissolution, karsting, rehydration and localized faulting and/or flowing (Figure GS-18-1c).

Structure contour and isopach maps

In 2015, preliminary structure contour and isopach maps of the Upper Amaranth Member were made for the Harcus area (Lapenskie and Bamburak, 2015). Additional drillcore data, as well as water well data, for the Harcus area has been compiled, and updated detailed structure contour and isopach maps of the overlying Quaternary sediments and Upper Amaranth Member have been generated (Figures GS-18-2, -3). Complete structure contour and isopach maps of the entire Harcus–Amaranth area will be released in a future report, along with drillcore and water well data.

Drillcore and water well data were computer generated to create the structure contour and isopach maps in Figures GS-18-2 and -3. 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.

Quaternary sediments are generally thinnest in the central region of the map area (Figure GS-18-2), and range from <2 m to >32 m in thickness in the map area. Gypsum quarrying is currently taking place in the central region of the map area, where thin Quaternary cover allows easy access. A roughly elliptical area of thicker Quaternary sediments (up to 28 m thick) in the lower left hand corner of the map is present. This may be due to karsting and sinkhole development occurring within the member before the deposition of the Quaternary sediments, creating a local low-lying area that was subsequently infilled.

The maximum thickness of the Upper Amaranth Member trends in a northwest direction in the lower left quadrant of the map area (Figure GS-18-3), then gradually thins to the northeast. There is also an area of thicker gypsum in the upper left corner of the map. The range in thickness for the Upper Amaranth Member is from 0 to >12 m. The member thins to the east and west within the map area.

Economic considerations

Gypsum has been an important industrial mineral in Manitoba since 1901, with current gypsum quarrying activities significantly contributing to the cement and wallboard manufacturing industry 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

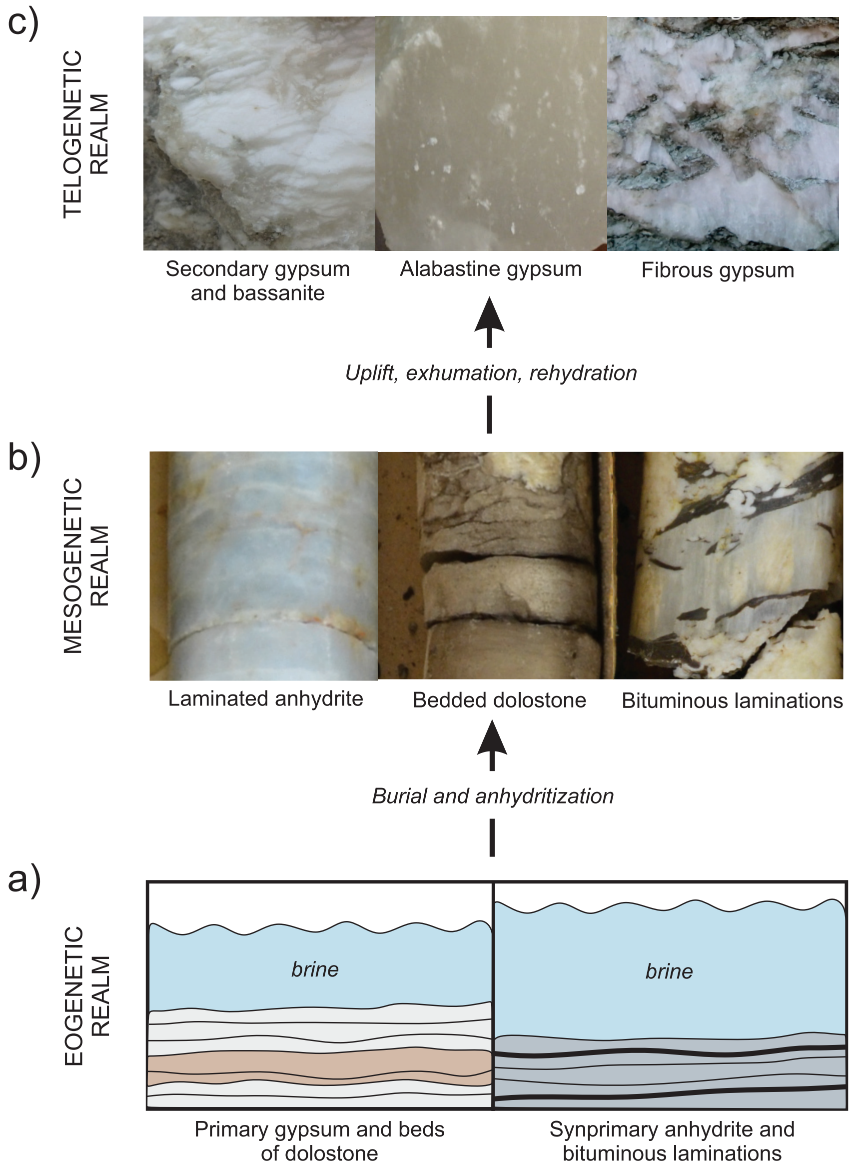

Figure GS-18-1: *Depositional and diagenetic model of the Upper Amaranth Member, based on Warren (2006) and Kasprzyk (2003). Arrows indicate the progression in diagenetic alteration from the* ***a)*** *eogenetic to* ***b)*** *mesogenetic (photographs of the dominant lithological features observed at depth are from oil core Husky D.D.H. (Baden) No. 3 [from L.S. 15, Sec. 29, Twp. 14, Rge. 14 W 1st Mer.; Assessment File 92826, Manitoba Growth, Enterprise and Trade, Winnipeg]) to* ***c)*** *telogenetic realms (photographs of the dominant lithological features observed near or at surface were taken from the CertainTeed Gypsum Canada Inc. quarry in Harcus [NAD83, UTM Zone 14, 516241E, 5619676N]).*

geographic region, including Manitoba, Saskatchewan, northwestern Ontario and parts of the northern United States. 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. Determining the age of the Upper Amaranth Member will assist in resolving the stratigraphic correlation between the Williston Basin and the Lake St. Martin igneous and metamorphic complex, which will add to the understanding of the depositional history of Phanerozoic strata in Manitoba. This understanding is critical to helping develop new exploration strategies and guide exploration programs in the future.

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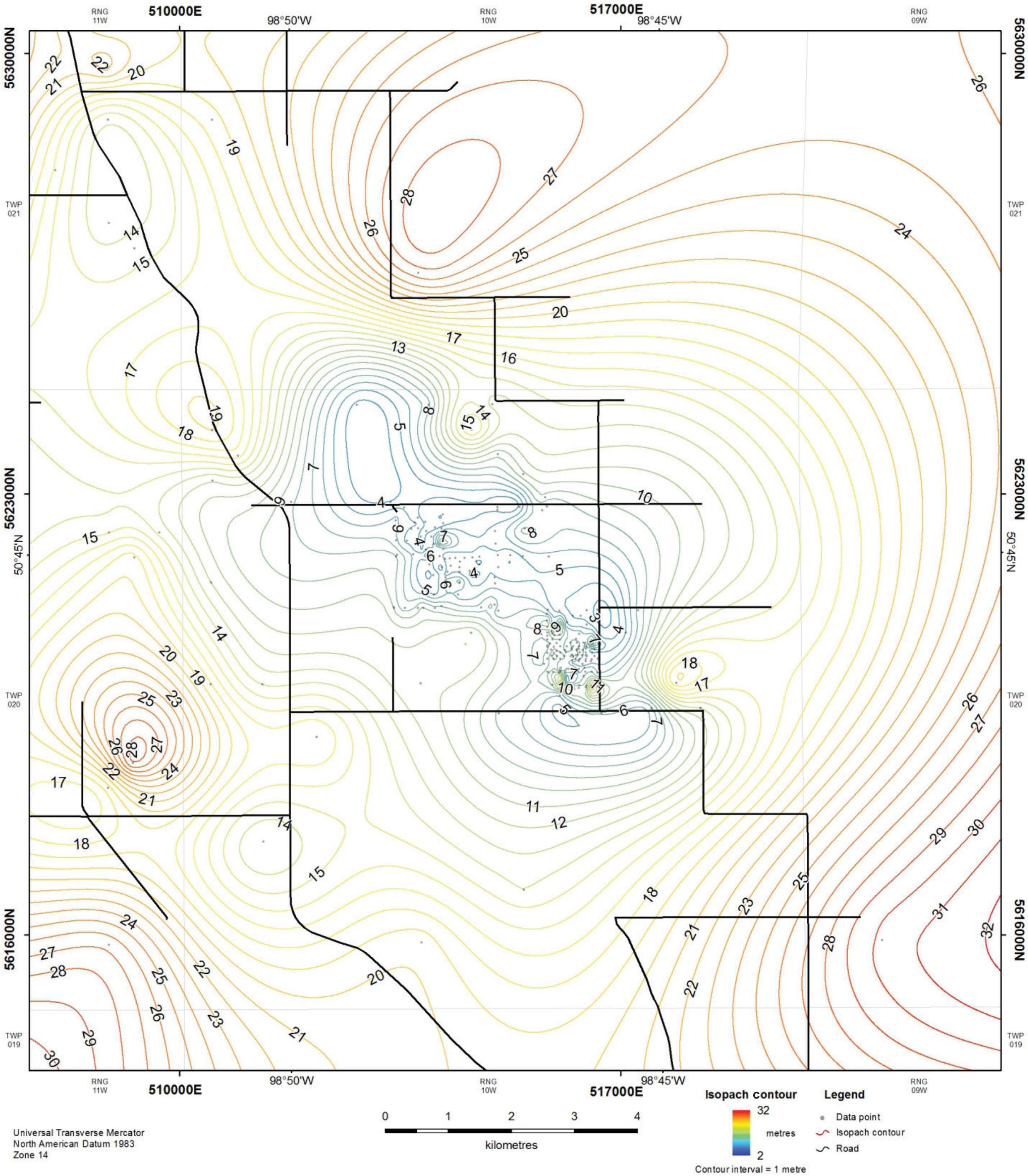

***Figure GS-18-2:** Isopach map of the Quaternary sediments overlying the Upper Amaranth Member of the Amaranth Formation, Harcus area. Cool tones indicate areas of thinner sediment cover and warm tones indicate areas of thicker cover. Drillholes and water wells are indicated with faint grey dots. Contour interval of 1 m.*

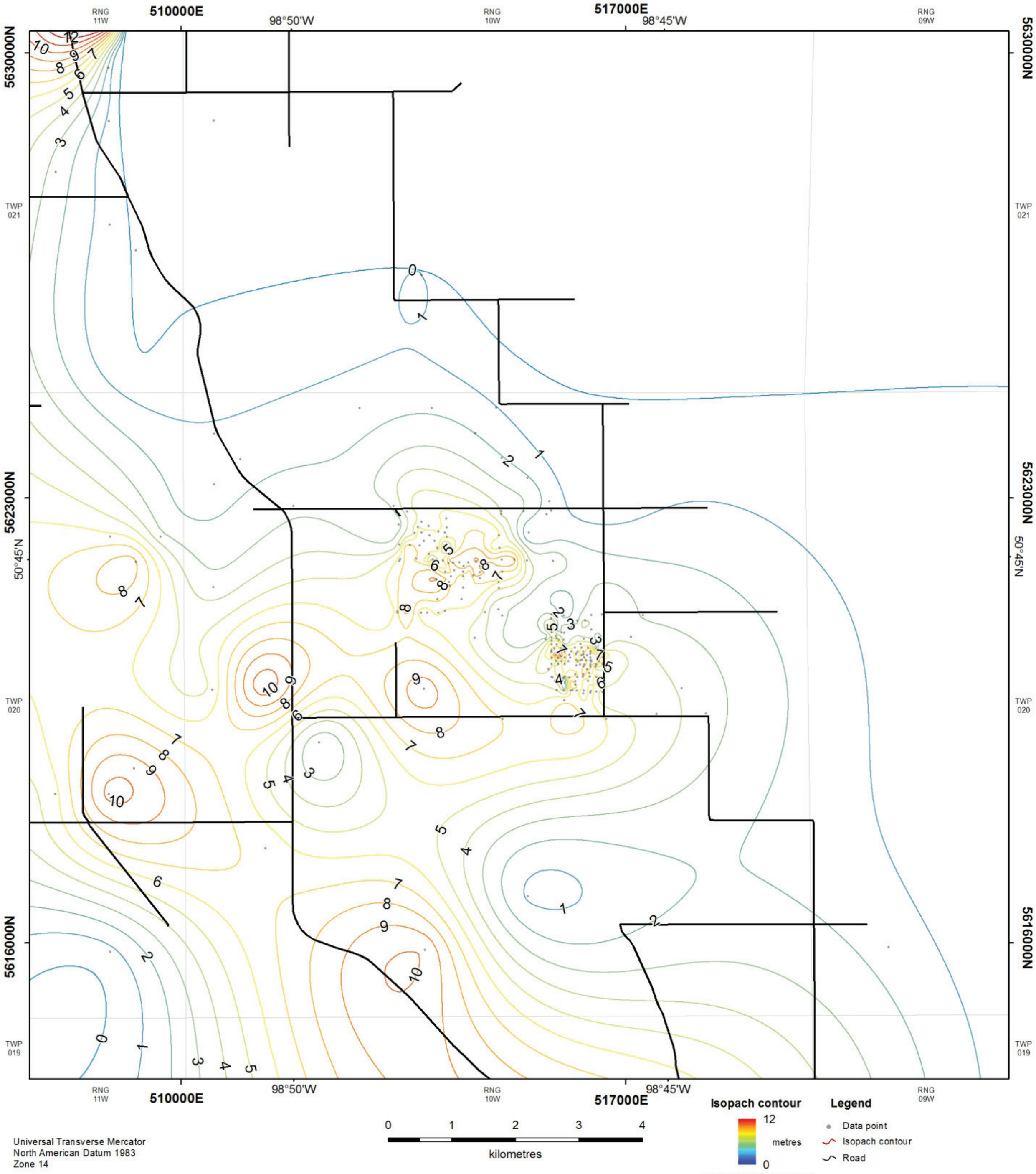

Figure GS-18-3: *Isopach map of total thickness of the Upper Amaranth Member of the Amaranth Formation, Harcus area. Cool tones indicate areas of thin gypsum and warm tones indicated areas of thicker gypsum. Drillholes and water wells are indicated with faint grey dots. Contour interval of 1 m.*

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