Preliminary evaluation of the gypsum-bearing Upper Amaranth Member in Harcus, southwestern Manitoba

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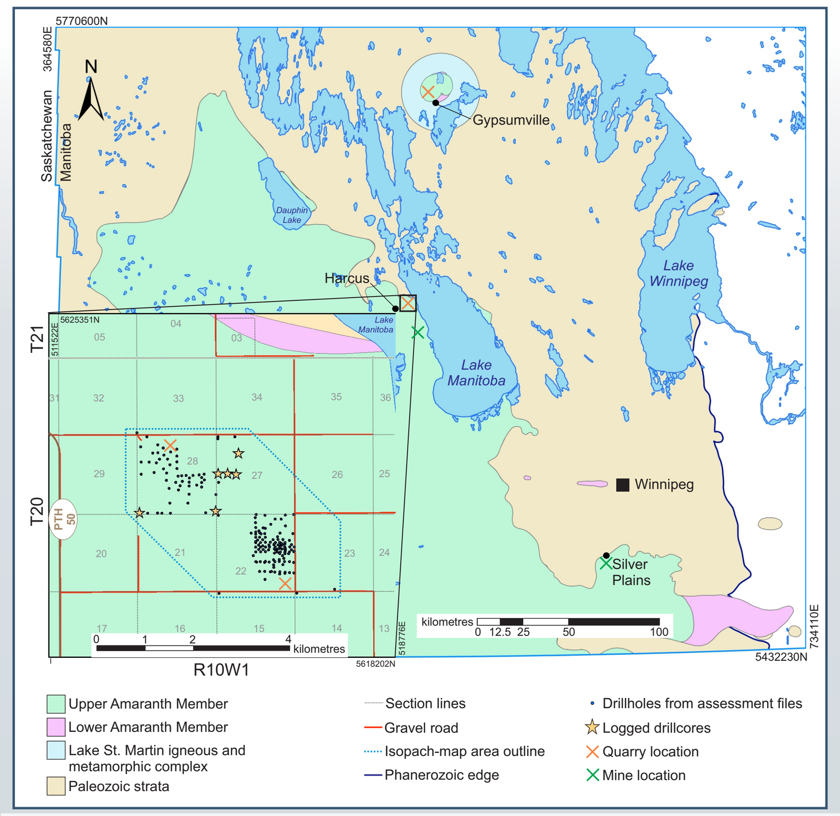

Figure 1: Simplified geological map of southern Manitoba, with inset showing the area around Harcus. Locations of drillholes, logged drillcores and the isopach-map area are shown.

1. INTRODUCTION

Gypsum is an important industrial mineral that has been in near constant production from the Jurassic Upper Amaranth Member of the Amaranth Formation in Manitoba since 1901 (Bannatyne, 1959). Its primary end product is wallboard, but it is also used in the production of concrete (Bannatyne, 1959; 1977; Gunter, 1987). Historically, there have been quarries and underground mines producing gypsum from Gypsumville, Silver Plains and Harcus (Bannatyne, 1977; Gunter, 1987). A wallboard plant still exists in northwest Winnipeg, which processes most of the gypsum that is quarried in the province.

In the spring of 2015, a project to provide a comprehensive update on gypsum resources in Manitoba was initiated. Previous work by Bannatyne (1959) documented the historical production of gypsum in the province and provided geological descriptions of known gypsum deposits. Later work by Bannatyne (1977) and Gunter (1987) captured additional production and geological data. Very few detailed geological investigations have been undertaken on gypsum since these reports were published.

The main objectives of this project are to:

- review the last 56 years of gypsum quarrying, mining, exploration and production in Manitoba;
- provide detailed description of the gypsum-bearing upper member of the Amaranth Formation, and to define its contacts through structure and isopachs maps; and
- compile data from Manitoba Mineral Resources assessment files to define the upper member's contacts through structure and isopachs maps.

Harcus is currently the only locality in Manitoba actively quarrying gypsum, and is the first area of focus for this project (Figs. 1 and 2). A preliminary stratigraphic section was completed at one of the quarries, six drillcores from that area were logged and assessment files were used to create isopachs maps.

2. REGIONAL GEOLOGY

Mesozoic strata of southwestern Manitoba were deposited within the Williston Basin (Nicolas, 2009). During the late Paleozoic Permian Period, a possible meteorite impact formed the Lake St. Martin igneous and metamorphic complex, resulting in a paleotopographic low adjacent to the northeastern edge of the Williston Basin (McCabe and Bannatyne, 1970). In the early Mesozoic, marine waters inundated the interior of North America. Erosional irregularities in the Paleozoic surface of the Williston Basin, including the Lake St. Martin igneous and metamorphic complex, were infilled during this period with the Triassic to Middle Jurassic Amaranth Formation.

The Amaranth Formation is divided into the Triassic Lower Amaranth Member and the Jurassic Upper Amaranth Member (Nicolas, 2009). The Lower Amaranth Member is primarily composed of red, argillaceous, dolomitic sandstone and siltstone. The Upper Amaranth Member is composed of gypsum and/or anhydrite (Bannatyne, 1959). The member is interpreted as being deposited in a restricted basin margin (Nicolas, 2009).

Although the Upper Amaranth Member was deposited as a primary evaporite, diagenesis has significantly altered any original textures or structures that may have formed during deposition. The presence of alabastine and fibrous (satinspar) veins of gypsum indicate exhumation and exposure to flowing groundwater, which has overprinted any primary or secondary textures (Warren, 2006). Fine-grained, equidimensional alabastine forms in the active phreatic zone, and is often associated with karst terrain. Karst terrain is common in places where gypsum occurs at or very near the surface, such as around Harcus and Gypsumville (McRitchie and Voitovici, 1990; McRitchie and Monson, 2000). Toward the southwestern corner of Manitoba, the Upper Amaranth Member occurs as anhydrite at depths over 1000 m (Bannatyne, 1959).

Figure 2: Panoramic views of two gypsum quarries near Harcus: a) east facing photo of the CertainTeed quarry (October, 2015); b) north-east facing photo of the Lehigh quarry (May, 2015).

3. PRELIMINARY STRATIGRAPHIC SECTION

A preliminary stratigraphic section was completed at the CertainTeed Gypsum Canada Inc. Harcus quarry (Fig. 3). The section was approximately 23 m wide, and in places the wall was covered by slumped material. The thickness of the section ranged from 5.3 to 4.1 m from east to west.

The section is composed of light greyish-white to light buff, massive, argillaceous, dolomitic, crystalline gypsum (Fig. 4a). It weathers to a very light grey to white. The gypsum is microcrystalline to coarsely (<2mm) crystalline, and composed of equant grains, giving it a sugary texture. Three clay- and dolomudstone-rich beds occur in this section (Fig. 4b). They are greenish to brownish grey. The beds dip between 2 and 6° to the west and are all roughly parallel to each other. The beds are composed of approximately equal ratios of a) dark greenish-grey, variably calcareous clay, b) light buff, variably calcareous dolomudstone and c) gypsum. In places, the clay and dolomudstone becomes disseminated and the beds can be difficult to recognize. Clay and dolomudstone are often fractured by irregular satinspar veins, and dolomudstone clasts are often brecciated by gypsum. The beds range in thickness from 15 to 48 cm. Gypsum becomes decreasingly argillaceous and dolomitic upward through the section (Fig. 4c). Silica nodules occur from the base of the section up to the second clay- and dolomudstone-rich bed, decreasing in abundance upward. Silica nodules are equant, subangular, orange to red, and range in size from 0.2 to 60 mm in diameter (Fig. 4d).

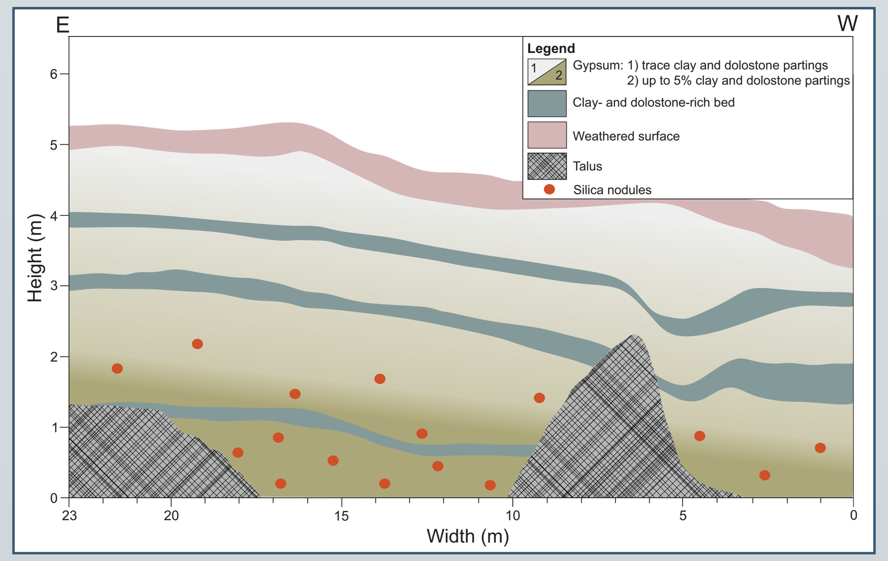

Figure 3: Simplified stratigraphic section from the north-facing wall of the upper pit of the CertainTeed Gypsum Canada Inc. quarry, Harcus, southwestern Manitoba.

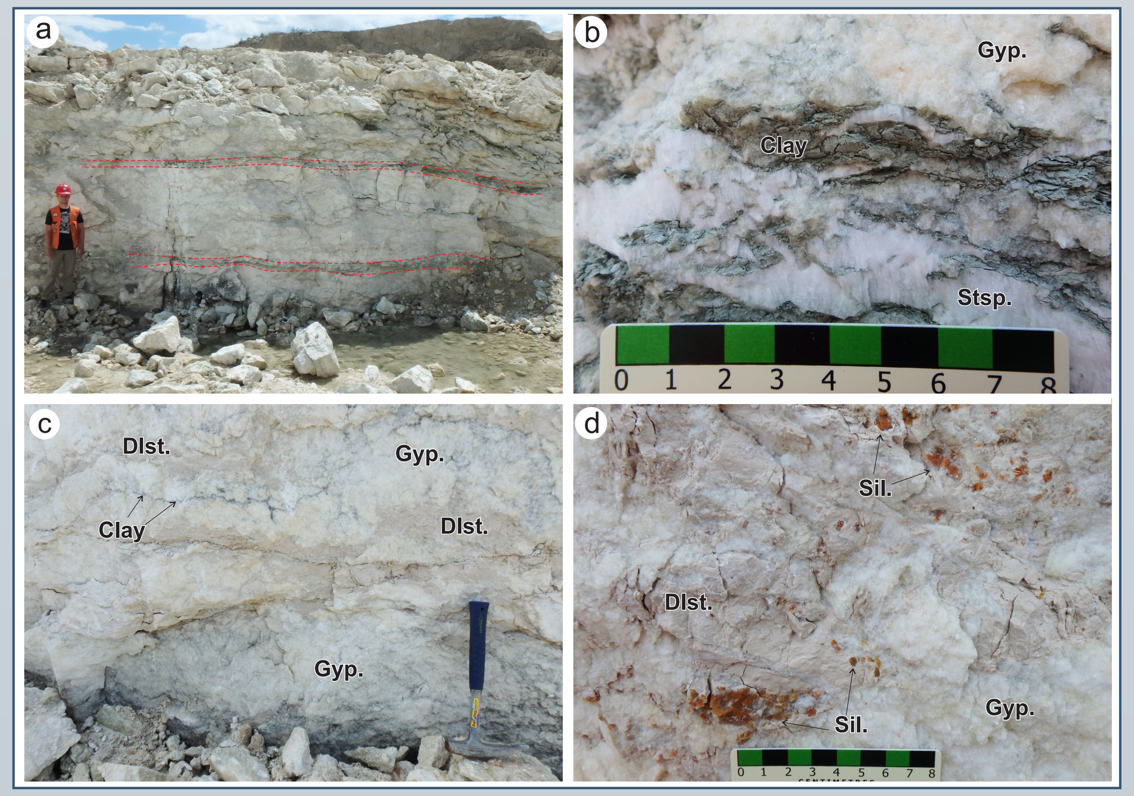

Figure 4: Representative photographs of the lithology and structures from the stratigraphic section: a) section of the north-facing wall from 16 to 11 m (see Figure 3), the two lower clay- and dolostone-rich beds are outlined in dashed red lines; b) upper contact of a clay- and dolostone-rich bed, clay appears as grey parting, with associated satinspar fracture-fill and light orange gypsum above; c) lower part of stratigraphic section with dolomudstone occurring as brecciated, irregular beds; d) orange-red silica nodules associated with light buff dolomudstone in white gypsum. Abbreviations: Dlst., dolomudstone; Gyp., gypsum; Stsp., satinspar fracture; Sil., silica nodules.

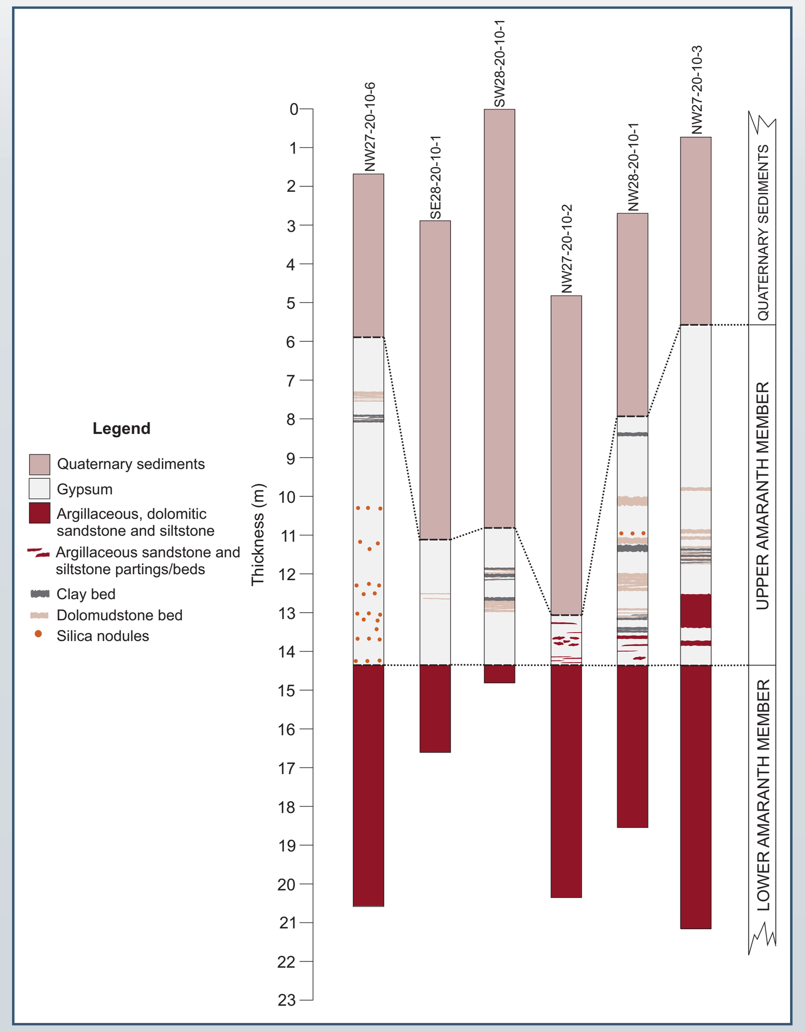

Figure 5: Stratigraphic sections of the upper member of the Amaranth Formation from cores NW27-20-10-6, SE28-20-10-1, SW28-20-10-1, NW27-20-10-2, NW28-20-10-1, and NW27-20-10-3, Harcus area, southwestern Manitoba.

4. DRILLCORE LOGS

Lehigh Cement Ltd. conducted an exploration program in 2006 in the Harcus area, drilling a total of 20 holes. Six of these cores were logged in detail over the summer of 2015 and logs are shown in Figure 5.

The thickness of the Upper Amaranth Member ranges from 1.29 to 8.79 m. The member is composed of argillaceous, dolomitic, white to very light grey, fine-grained gypsum (Fig. 6a). Gypsum is white and opaque in the uppermost portion of the cores, and varies between light grey to very light pink, yellow and orange in places (Fig. 6b), Grey, variably calcareous clay occurs as beds, laminae or infilling irregular partings (Fig. 6b), and becomes less abundant upward. Light buff, variably calcareous dolomudstone occurs as beds, partings or brecciated clasts (Fig. 6c), and also becomes less abundant upward. Some larger beds, up to nearly 0.5 m thick, are composed of a mixture of clay, dolomudstone and gypsum, and are frequently fractured by satinspar veins. In drillcores NW27-20-10-6 and NW28-20-10-1 there are trace amounts of silica nodules (Fig. 6c). In drillcores NW27-20-10-1, NW28-20-10-1 and NW27-20-10-3, beds and clasts of the lower member occur in the basal part of the gypsum. The upper contact with Quaternary sediments and the lower contact with the Lower Amaranth Member are both gradational.

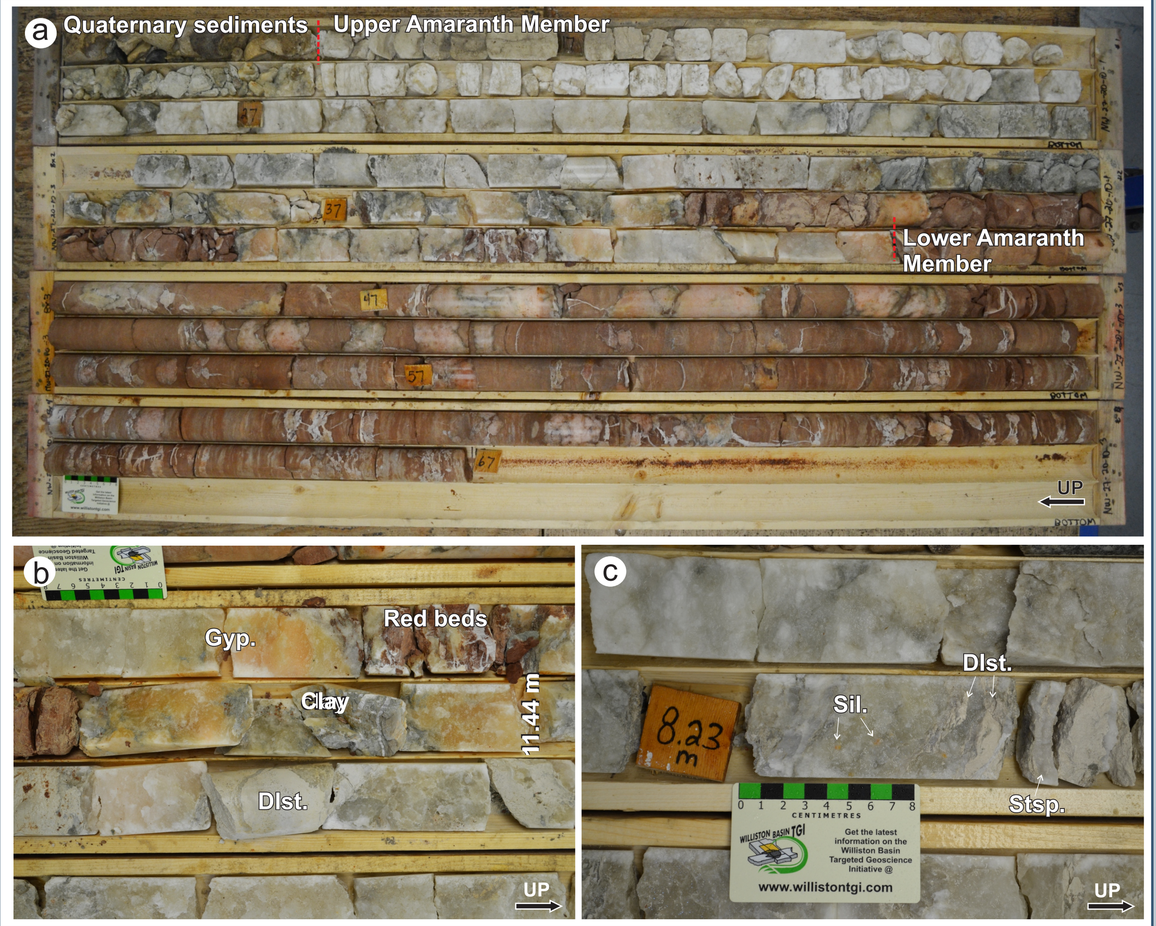

Figure 6: Representative photographs of the lithology and structures from the logged cores: a) core NW27-20-10-3, dashed lines represent contacts between the three lithological units, depth markers in feet; b) grey to light orange gypsum with dolomudstone clasts, clay partings and argillaceous sandstone to siltstone beds; c) core NW28-20-10-1, typical white to light grey-yellow gypsum with brecciated dolomudstone clasts and silica nodules. Abbreviations: Dlst., dolomudstone; Gyp., gypsum; Stsp., satinspar fracture; Sil., silica nodules.

5. ISOPACH MAPS

Two isopach maps (Twp. 20, Rge. 10, W1st Meridian) were generated using drillhole data from assessment files. Figure 7 represents the depth of Quaternary sediments overlying the member and Figure 8 represents the total thickness of the upper member gypsum.

In general, the thickness of the gypsum and of the Quaternary sediments decreases toward the northwest. However, there is a fair amount of variability of both the thickness of gypsum and the overlying sediments within the study area.

The Quaternary sediments are composed of a mixture of cobbles, sand, silt and clay, deposited as glacial till and as lakebottom sediments from glacial Lake Agassiz. Thickness of the Quaternary sediments may be influenced by a variety of factors, including the paleotopography of the upper surface of gypsum, deposition of glacial till and sediment from glacial Lake Agassiz and postdepositional erosion at the surface.

The total thickness of the gypsum has an inverse relationship with the total thickness of Quaternary sediments. The area of anomalously thicker gypsum in the northwest corner of the map corresponds approximately to an area where the Quaternary sediments are thinner. Quaternary sediments are anomalously thick in the south, which is associated with thinner intervals of gypsum. Factors influencing gypsum thickness may include postdepositional erosion and dissolution of gypsum from groundwater and associated karsting and sinkhole development.

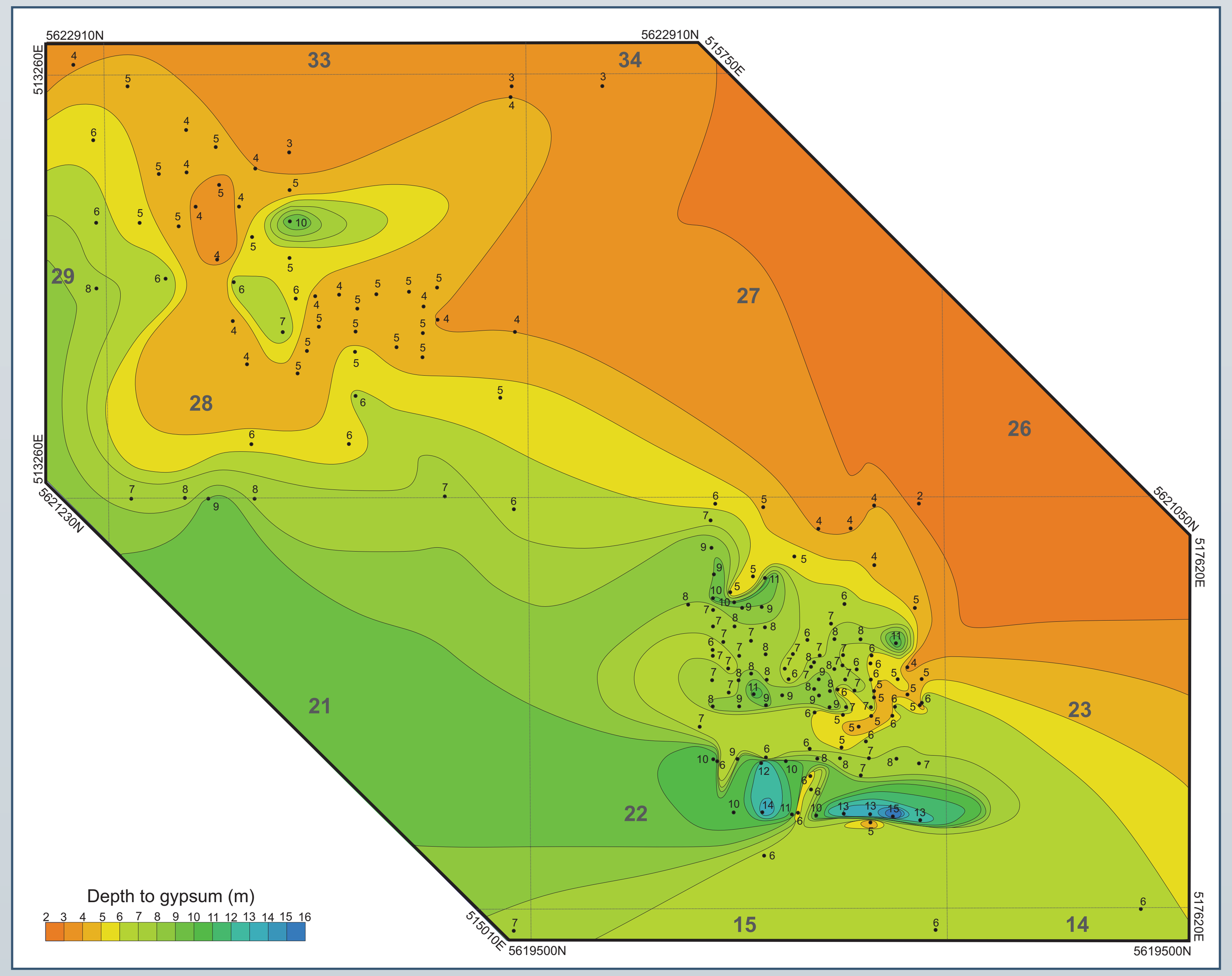

Figure 7: Isopach map showing the total thickness of Quaternary sediments overlying the Upper Amaranth Member, Harcus area, southwestern Manitoba. Black dots represent the drillholes and the thickness at each hole is displayed in metres.

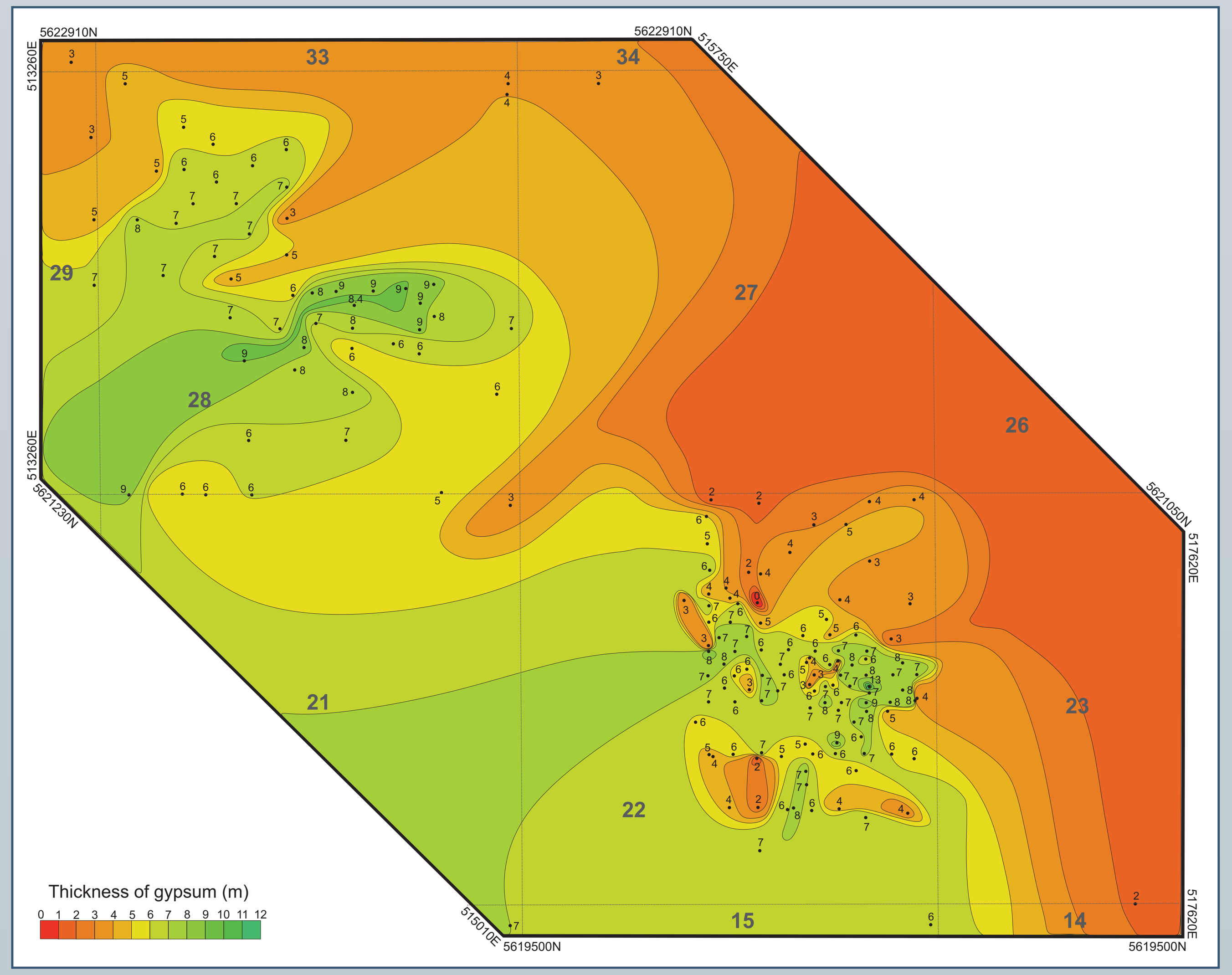

Figure 8: Isopach map showing the total thickness of the Upper Amaranth Member, Harcus area, southwestern Manitoba. Black dots represent the drillholes and the thickness at each hole is displayed in metres.

6. FUTURE WORK

Water levels in the two Harcus quarries were high this summer, and therefore most quarry walls were inaccessible. Once the quarries have been sufficiently drained, additional stratigraphic sections will be completed. Detailed structure and isopach maps will be constructed from the data and used to create updated maps in future reports.

Gypsumville and Silver Plains have been important areas for exploration and gypsum extraction in the past. Providing an update on the geology and production history of these regions is an important aspect of this project. This will involve logging core, detailed thin-section work, examining quarry walls near Gypsumville, and using data from assessment files to create structure and isopach maps.

7. ECONOMIC CONSIDERATIONS

Gypsum is an important industrial mineral in Manitoba, which has seen over 100 years of mining and quarrying in the province. A comprehensive report updating the geological knowledge of this resource will help to support industry in continuing to explore for and develop this resource. Detailed isopach maps will help guide industry in selecting future exploration targets. A better understanding of the stratigraphy and further investigations into the geochemistry of gypsum will help with proper land-use planning and future road development.

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