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Groundwater Resources of the Lake Saint-Martin Area, Manitoba

Sheet 2 of 6

Overburden Thickness

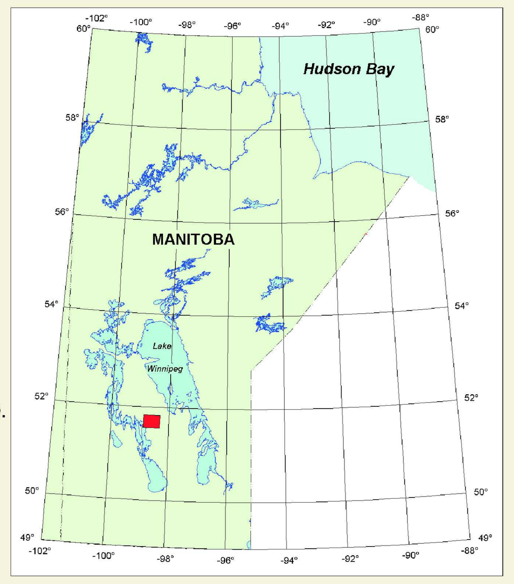

Figure 1: Location of study area

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Map Notes

Introduction

The overburden thickness in the Lake Saint-Martin area (Figure 1) was mapped previously by Betcher (1987) at a scale of 1:250 000. As part of hydrogeological and hydrogeochemical investigations in the Gypsumville area, the Geological Survey of Canada has prepared these updated and more detailed maps of overburden thickness and the bedrock surface elevation (see Map Production Notes). In Figure 2, the bedrock surface is displayed in terms of its depth below ground level or, equivalently, in terms of overburden thickness. In Figure 3, it is displayed in terms of its elevation above sea level. For reference, the regional topography (Matile and Keller, 1999) and surficial geology (Betcher, 1987) are shown in Figures 4 and 5, respectively. Nielsen and Matile (1984) present a more detailed map of surficial geology in area.

The maps in Figures 2 and 3 are based on overburden thickness values derived from provincial water well records. Locations and elevations of known bedrock outcrops are also used in the preparation of these maps. Large, anomalous, thickness values have been excluded from the contouring. Such values are usually associated with sink-holes which have been identified in an area extending toward the northwest from Lake Pineimuta, notably in sections 4-Tp32-R09 and 1-Tp32-R10. Thus, the maps presented in Figures 2 and 3 represent only general trends in overburden thickness and bedrock surface elevation, respectively.

Geological and Hydrogeological Setting

The hydrogeology of the bedrock aquifers in the study area is described on sheet 3 of this GSC Open File Report. This sheet is concerned with the hydrogeological significance of the overlying surficial deposits.

Reference to the DEM in Figure 4 and the map of surficial geology in Figure 5 shows that upland areas are usually associated with partial or complete bedrock outcrop. However, in the western part of the study area, shoe-string sand and gravel deposits of glacio-fluvial or beach origin occur on the uplands. Because of the high permeability of such deposits and that of the underlying fractured dolomites, these upland areas represent groundwater recharge zones for the carbonate aquifer. The most significant recharge zone is in the northwest of the study area, at the southern tip of a low bedrock ridge. Another recharge zone, covered by a thin, discontinuous layer of till, is located between Lakes Manitoba and Pineimuta. The extensive area of thin overburden to the north and northeast of Gypsumville is characterized by numerous sinkholes and small, isolated outcrops of gypsum. It is the recharge area for a shallow, unconfined aquifer hosted by karstic evaporites that occur in the northern half of the Lake Saint-Martin Impact Structure.

Figure 5 shows that most of the study area is covered by till and lacustrine silts and clays. The till consists mainly of unsorted clays, silts, sands and gravels. However, near the Fairford River and on the north shore of Lake Saint-Martin, large granitic boulders are encountered at depth, just above the bedrock surface. Because of the low permeability of the till and lacustrine deposits, they form an extensive confining layer above the bedrock aquifers. Evidence of this confinement is manifested by the strong artesian or flowing-well conditions found in the low-lying area northwest of Lake Pineimuta.

The remainder of the study area is covered by organic deposits, such as swamps, marshes and bogs. These are found in the lowest-lying areas and they are usually associated with groundwater discharge zones. This is notably the case in the Lake Pineimuta drainage basin.

Overburden Thickness

The map of overburden thickness (Figure 2) shows several large areas where bedrock outcrops or lies just below the ground surface. These areas include low carbonate ridges in the western part of the study area and the extensive karstic uplands north and northeast of Gypsumville. Perhaps the most striking feature of this figure is the large area of very thick overburden on the north shore of Lake Saint-Martin. This overburden consists of layers of till separated by gravel or boulder interbeds making for rather difficult drilling conditions. Given that bedrock outcrops on a small island offshore, the overburden must thin rapidly as it extends to the south beneath Lake Saint-Martin. A smaller area of thick overburden is seen to extend along the Fairford River, between Lakes Manitoba and Pineimuta. Here, the overburden consists of till layers with thick sand and gravel interbeds. In these areas of thick overburden, water wells are sometimes completed within permeable, coarse-grained interbeds or at the bedrock contact.

Bedrock Surface Elevation

Figure 3 shows the elevation of the bedrock surface above sea level. The most striking feature of this map is the large depression located on the north shore of Lake Saint-Martin, corresponding to the area of thick overburden discussed above. This depression is located in the southeast quadrant of the Lake Saint-Martin Impact Structure. It may be the result of preferential erosion or glacial scouring of soft crater-fill sediments given that it terminates rather abruptly on contact with harder meltrock associated with the crater rim and outcropping on the small island offshore. Another area of depressed bedrock elevation and thick overburden appears to be associated with the Fairford River Lake Pineimuta drainage system. This feature possibly represents an incised paleo-channel in the carbonate bedrock.

Map Production Notes

The overburden thickness and bedrock surface elevation values represented in Figures 2 and 3 have been compiled from provincial water well records. This information was supplemented by the elevation of known bedrock outcrops, where overburden thickness is nil. Depth to bedrock measurements are referenced to topographic elevations of the Digital Elevation Model (DEM) shown in Figure 4. This DEM, with a 100m resolution, has been modified from that of Matile and Keller (1999) to remove artifacts of digital image processing.

The overburden thickness was interpolated from measurement locations using the geostatistical method known as kriging with an "external drift" or deterministic spatial trend, described in Goovaerts (1997) and Desbarats et al. (2002). The spatial trend in the bedrock elevation is modeled by the topographic elevation given by the DEM. The trend residual, to be estimated, is the overburden thickness. This kriging method takes advantage of fine-resolution topographic information in the DEM to improve the estimation of bedrock surface elevation in areas of sparse well control. It is based on the empirical notion that outcrops generally occur in elevated areas whereas overburden thickness is generally greatest in low-lying areas.

The uncertainty in overburden thickness is less in the central portion of the study area, where well control is fairly tight, and greater in peripheral areas. Because thickness measurements are referenced to the topographic surface, the uncertainty in bedrock elevation includes that in the Digital Elevation Model. The uncertainty in the DEM is reported to average 3m over southern Manitoba although this figure is likely quite conservative for the study area. The locations of wells in the provincial database is another source of uncertainty. Generally, well locations are assigned to the centre of the nearest quarter-section.

References

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Matile, G. and G. Keller (1999) : Digital elevation model of Southern Manitoba, Version 1.0, Open File Report 99-15, Manitoba Industry, Trade and Mines, Winnipeg, Manitoba.

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OVERBURDEN THICKNESS

Figure 2

Overburden Thickness

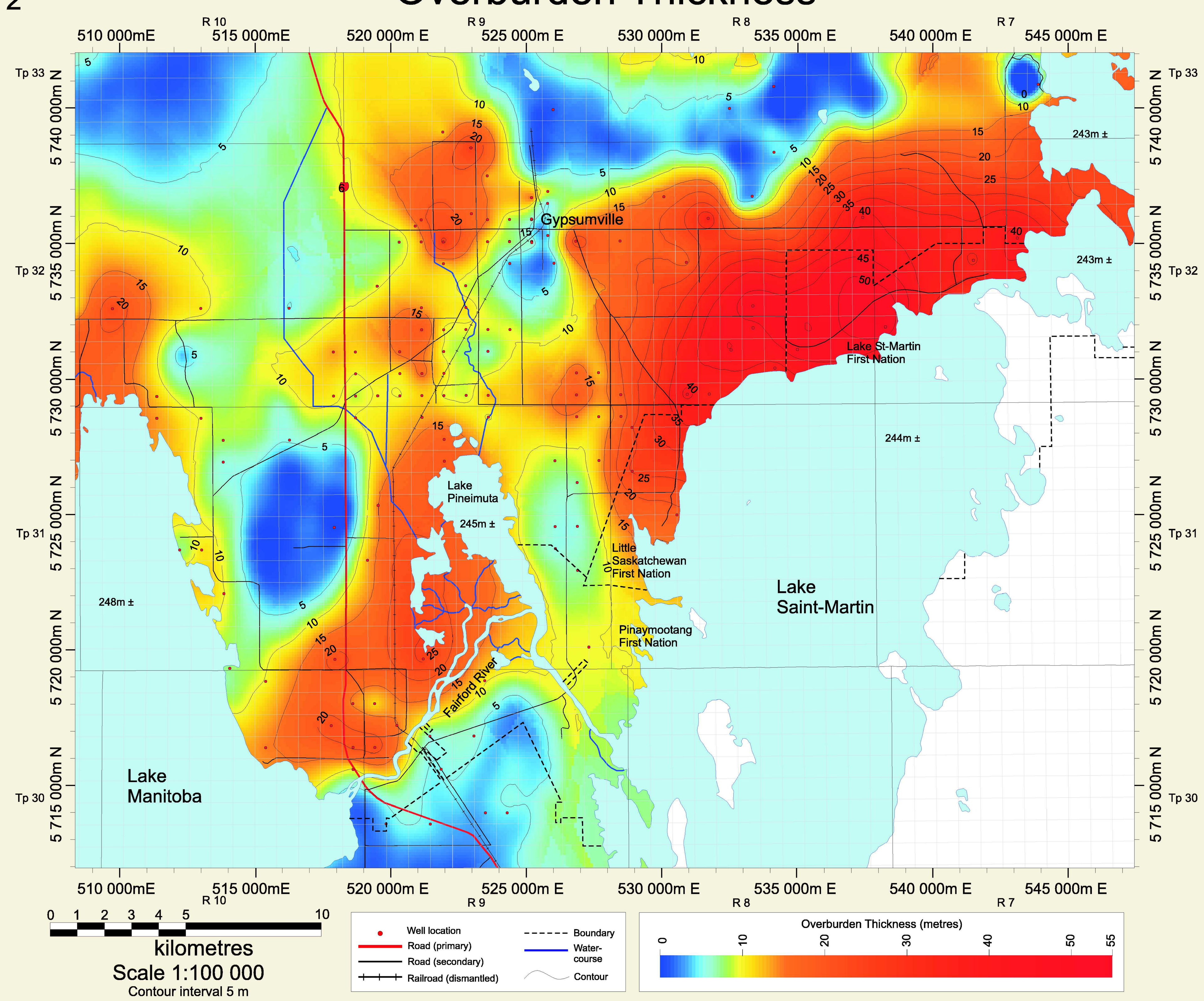

Figure 3

Bedrock Surface Elevation

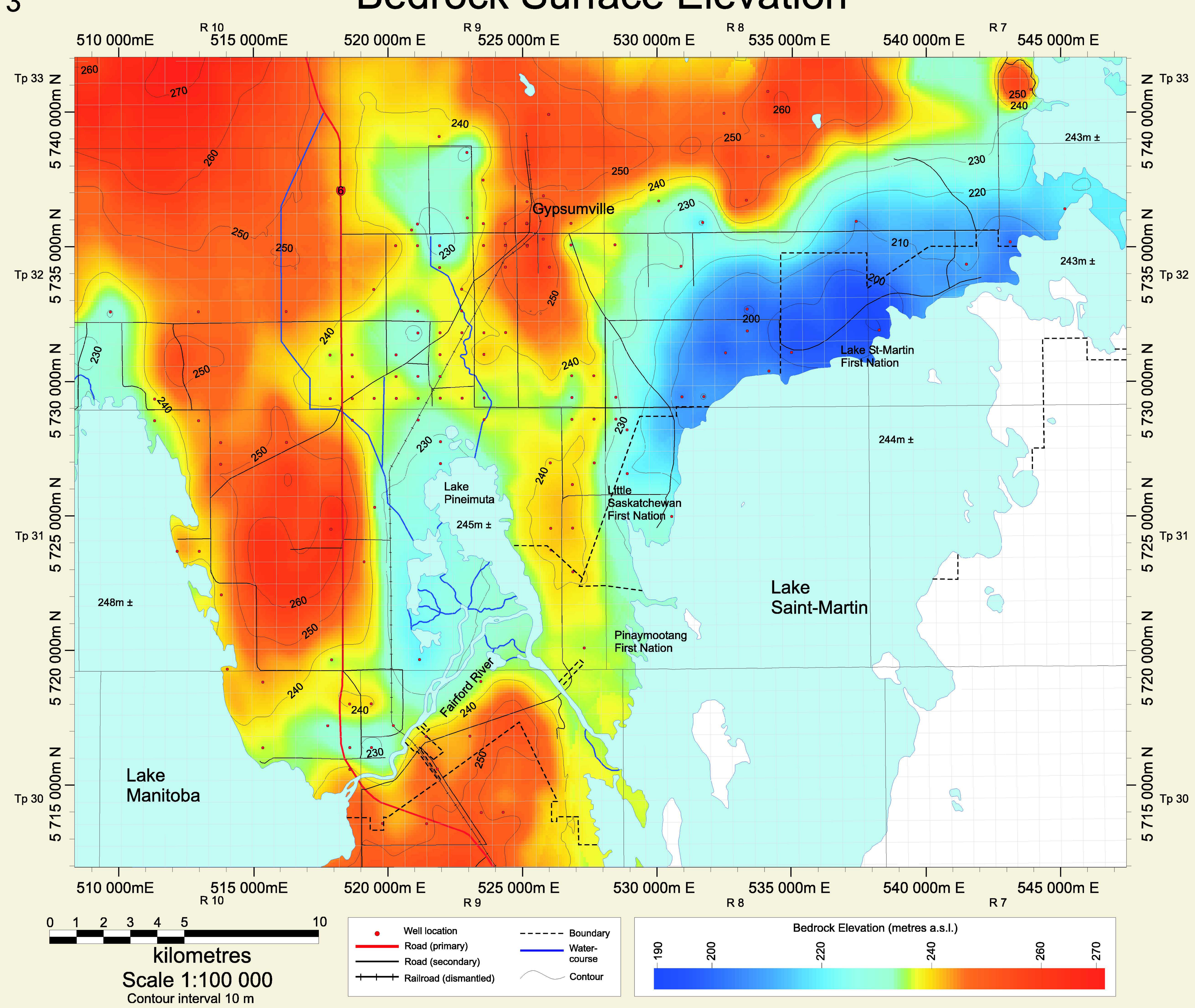

Figure 4

Digital Elevation Model

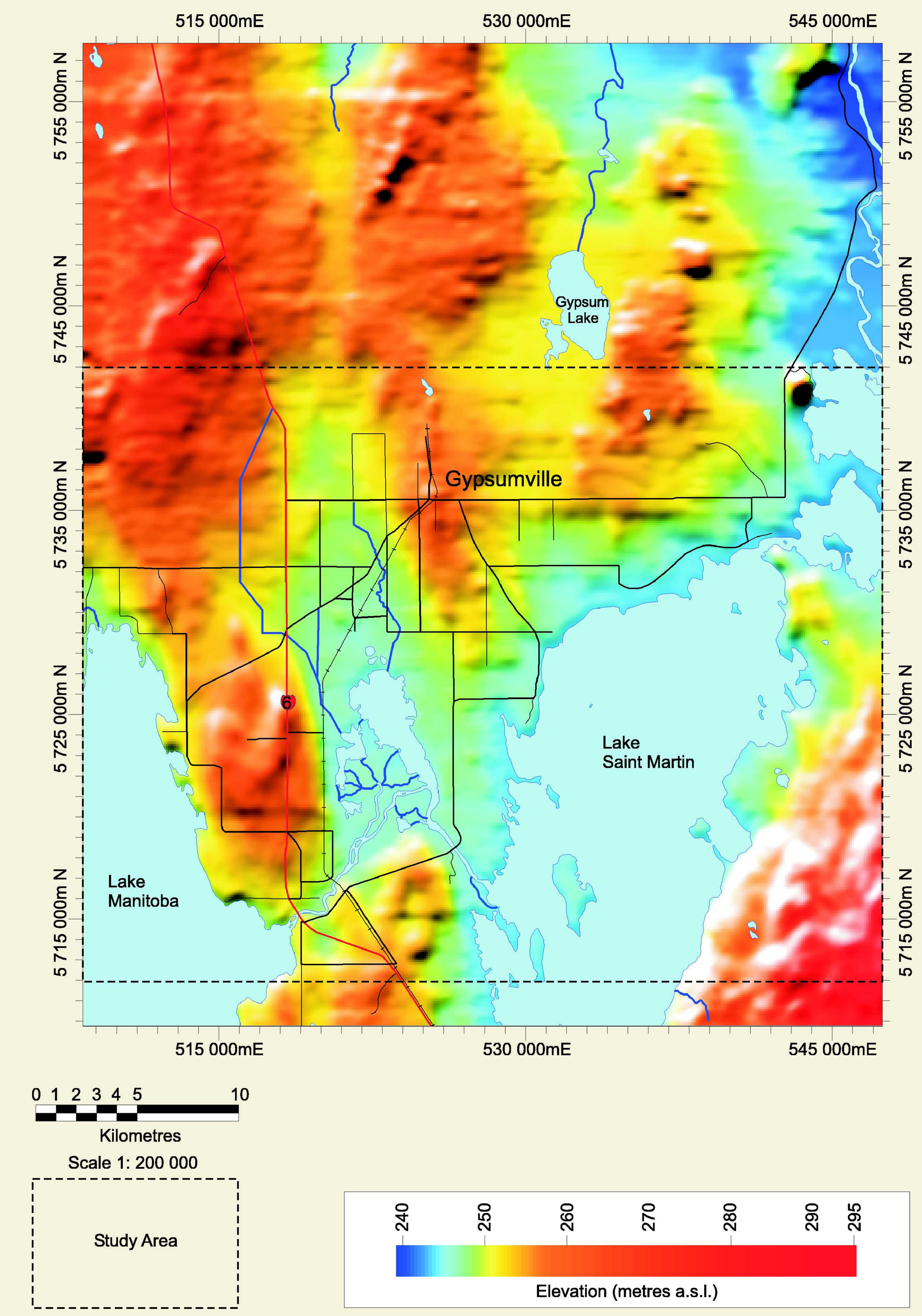

Figure 5

Surficial Geology