GS2024-27

Preliminary results of a multi-electrode resistivity survey of a buried gravel deposit in the Rural Municipality of Taché, southeastern Manitoba (part of NTS 62H15)

by J. Marks and J.W. Rentz

In Brief:

- Multi-electrode resistivity imaging was successful at resolving anomalies correlating to typical sand and gravel resistivity values
- Resistivity imaging may assist in delineating buried gravel deposits, and may allow for more precise aggregate mining techniques

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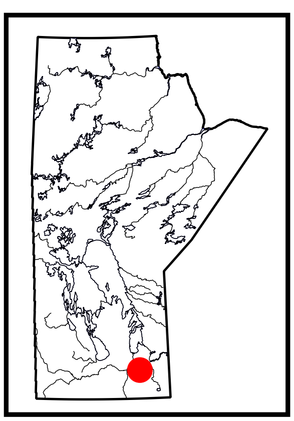

Summary

A series of multi-electrode resistivity transects were collected by the Manitoba Geological Survey over the Monominto gravel pit as part of an ongoing project to update Manitoba's remaining aggregate resources. The objective of this study was to conduct a resistivity survey over a known shallow-buried aggregate deposit to better understand the deposit geometry for future extraction, and document the resistivity signature of this deposit to guide future aggregate exploration. The preliminary results of this resistivity survey indicate the ability to resolve relatively resistive anomalous features (300–4039 ohm-metre) in the subsurface. These features are interpreted to represent buried sand and gravel, as they strongly correspond to typical sand and gravel resistivity ranges. Future work will investigate the cause of the relatively low resistivity anomalies in transect 1 and will add geological constraints to inversion models to investigate the potential artifacts present in transect 2.

Introduction

The Manitoba Geological Survey (MGS) recently began updating its provincial aggregate resource maps, which have remained mostly unchanged since the mid-1990s (Rentz, 2023). One aspect of this work is to identify shallow-buried gravel deposits and further develop exploration techniques for these types of deposits. For this reason, a known buried gravel deposit was selected for a subsurface resistivity analysis with the objective of identifying the geometry and resistivity characteristics of the gravel deposit, which will guide ongoing deposit extraction and future aggregate exploration projects. The University of Manitoba (UM), in collaboration with the MGS, previously collected two transects of resistivity data over the same gravel deposit as part of their field school program (Rentz et al., 2024; Figure GS2024-27-1). This study focuses on three new transect locations, which were chosen to expand upon this pre-existing data.

The selected gravel pit, informally named the Monominto gravel pit, is located within the Rural Municipality (R.M.) of Taché in southeastern Manitoba, ~30 km east-southeast of Winnipeg (Figure GS2024-27-1), and has been in operation since the 1970s. Around that time, the deposit was characterized as sand and gravel overlain by silt till of varying thickness, and active pits exposed 1.5–4 m of gravel, with no mining occurring below the water table (Matile and Conley, 1979a, b). The Monominto pit is currently operated by the R.M. of Taché. Most of the pit area has been excavated to ~262 m asl, which is ~1 m above the water table, but sandy gravel is currently being extracted up to ~10 m below the water table (Rentz et al., 2024).

Methodology and survey design

The Monominto gravel pit is approximately 1300 m long, 250 m wide and is oriented north-northwest–south-southeast (340–160°). Three resistivity transects were surveyed approximately perpendicular to the pit orientation, extending beyond the current east-west pit boundaries (Figure GS2024-27-1). Transects are 415 m long and comprise four lines (datasets) of 24 electrodes at 5 m station spacing, with a 15 m horizontal overlap between adjacent lines. The equipment used to gather data was an IRIS Instruments Syscal Junior Switch-24, used in a dipole-dipole configuration.

The raw resistivity data were processed using IRIS Instruments Prosys II software. Processing steps included

- removal of data points with erroneous resistivity values or relatively high standard deviations,
- shifting electrode stations horizontally to achieve continuity between adjacent lines, and
- adding elevation data to electrode stations using a high-resolution dataset collected in 2014 (ATLIS Geomatics Inc., 2016).

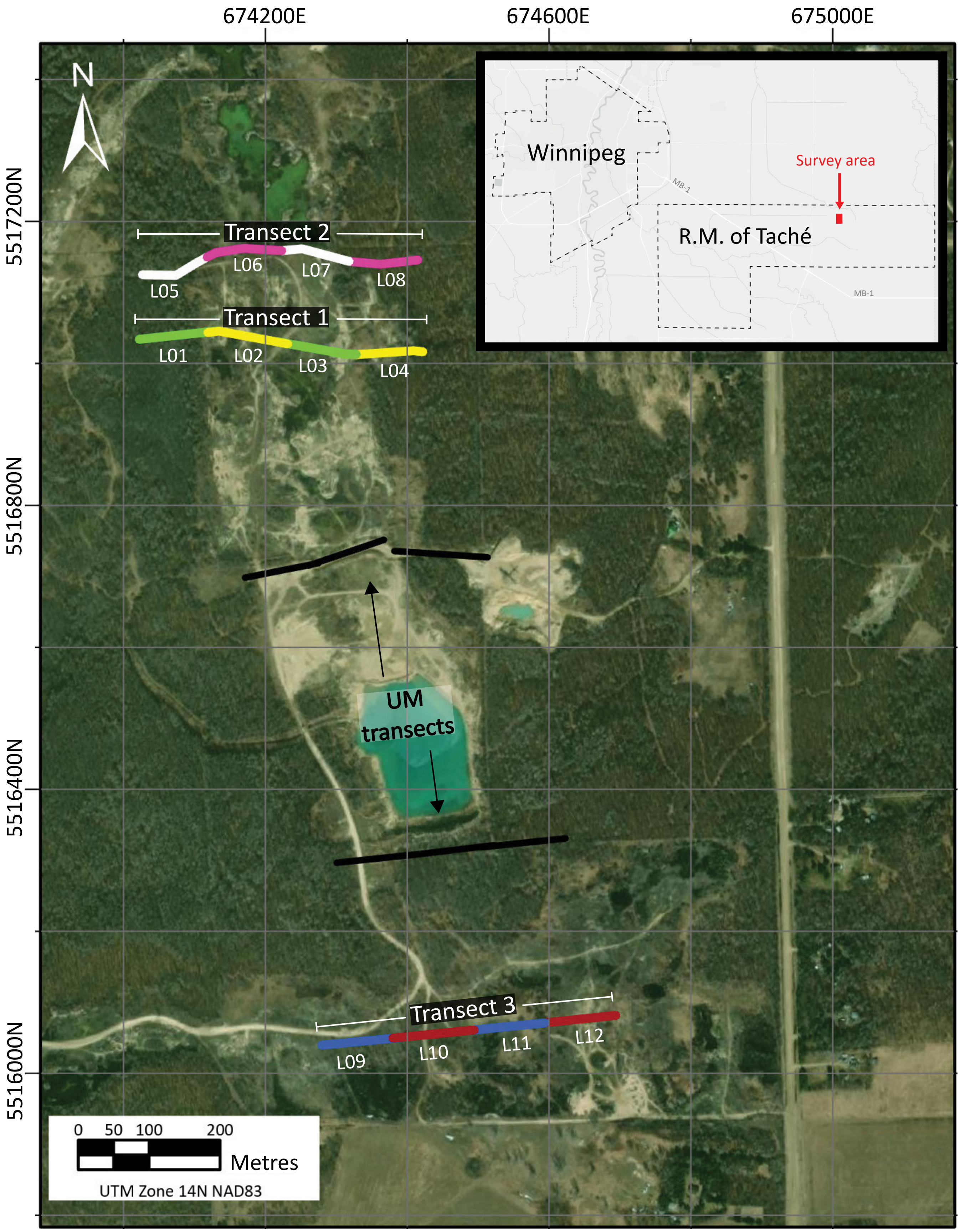

Figure GS2024-27-1: *Locations of resistivity transects over the Monominto gravel pit within Sec. 28, Twp. 9, Rge. 7, E 1st Mer., southeastern Manitoba. Coloured lines indicate where data were collected by the Manitoba Geological Survey in August 2024. Black lines indicate where data were collected by the University of Manitoba (UM) in May 2024. Satellite imagery from Esri® (2021). Abbreviations: L, line; R.M., Rural Municipality.*

Finally, the data were imported into the Geotomo Software Res2DInv software package and inverted using a least squares method. To prevent overfitting the data, an iteration maximum of seven and root-mean-square (RMS) convergence threshold of <5% was selected. Additionally, the model cell width was set to half the unit electrode spacing to help manage large resistivity variations at the surface, and a horizontal weighting filter was applied to some datasets to optimize data fit.

Preliminary results

Transect 1

Both lines L01 and L04 show an ~8 m thick linear resistive anomaly at ~260 m asl. In line L01, this anomaly occurs from stations 10 to 75 and has a resistivity range of 400–2540 ohm-metre (Ω•m; T1-A in Figure GS2024-27-2), whereas in line L04, it occurs from stations 330 to 375 with a resistivity range of 1008–4039 Ω•m (T1-B in Figure GS2024-27-2). In both lines, this linear resistive anomaly trends to the surface with a resistivity range of 400–1600 Ω•m (T1-C and T1-D in Figure GS2024-27-2). In contrast, the linear resistive anomaly is less resolved in lines L02 and L03, appearing sporadically and with a significantly lower resistivity range of 252–800 Ω•m (T1-E in Figure GS2024-27-2).

Transect 2

The results from transect 2 show three distinct resistive anomalies (Figure GS2024-27-3). The first anomaly occurs from stations 15 to 75, is ~10 m thick from ~250 to 260 m asl and has a resistivity range of 400–1600 Ω•m (T2-A in Figure GS2024-27-3). At station 55, this anomaly's thickness changes to ~3 m thick and it is shallower, from ~259 to 262 m asl. The second anomaly occurs from stations 125 to 250 and is characterized as two east-west-trending resistive anomalies, segmented vertically by an ~5 m wide conductive trend. The top of this anomaly has a resistivity range of 400–3200 Ω•m (T2-B in Figure GS2024-27-3), whereas the bottom has a relatively lower resistivity range of 400–1300 Ω•m (T2-C in Figure GS2024-27-3). Lastly, the third anomaly is a highly resistive body that occurs from stations 260 to 360 (T2-D in Figure GS2024-27-3). This feature is ~8 m thick from 257 to 265 m asl and has a resistivity range of 400–4039 Ω•m.

Transect 3

Transect 3 results show a resistive anomaly from stations 170 to 400 (Figure GS2024-27-4). This anomaly occurs from ~240 to 260 m asl, varies in thickness from 10 to 20 m and increases in resistivity from west to east within a range of 300–4039 Ω•m (T3-A in Figure GS2024-27-4). This feature is continuous across lines L10, L11 and L12, with a change in the intensity of the resistivity between lines L10 and L11, from ~635 to ~320 Ω•m, respectively (T3-B and T3-C in Figure GS2024-27-4). However, the similarity of the geometry and depth increases confidence that the anomaly is continuous between the lines. To determine if this anomaly exists to the east, two additional datasets were collected adjacent to line L12 (data processing is still in progress thus the data are not shown in this report). Preliminary analysis of this data indicates no subsurface resistive anomalies, suggesting the resistive anomaly in transect 3 terminates abruptly near station 400.

Discussion

Table GS2024-27-1 shows typical resistivity ranges of earth materials, compared with the resistivity ranges of anomalies from this study. Most anomalies correspond well to typical sand and gravel resistivity values and provide confidence that sand and gravel deposits are resolved as relatively resistive features within a more conductive medium.

In transect 1, the results in lines L02 and L03 show unexpectantly low resistivity values (T1-E in Figure GS2024-27-2), as most of the stations are within an area where sand and gravel is known to extend ~10 m deeper than the current pit elevation (Rentz et al., 2024). One possible theory for this resistivity signature is that the water table is influencing the measurements at this location. The water table is measured to be 0.6 m below the ground surface at station 220. More research will be necessary before any definite conclusions can be drawn. Additionally, sand and gravel is observed at the surface on line L04 near stations 330 to 350, which may explain why the anomaly at depth trends toward the surface at this location (T1-D in Figure GS2024-27-2). Conversely, the western part of line L01 (stations 0–60) occurs within a densely forested area, with no sand and gravel observed at the surface. It is unknown why the resistivity trends toward the surface in this area (T1-C in Figure GS2024-27-2); it may be related to electrode-ground contact.

It is unclear if the imaged conductive feature that bisects the second anomaly in transect 2 (between T2-B and T2-C in Figure GS2024-27-3) is a real geological feature, or an artifact created from the inversion process. This highlights a need to add geological constraints to future iterations, which may improve the subsurface model.

Economic considerations

Aggregate mining is a vital part of Manitoba's economy as it provides essential materials for the construction of buildings, roadways, railways and bridges. Multi-electrode resistivity imaging can assist in accurately delineating buried gravel deposits and allow for more precise, noninvasive exploration techniques, which in turn increases efficiency and reduces exploration costs. With the increasing scarcity of aggregate resources within the Winnipeg Metropolitan Region, it is imperative to be able to effectively identify shallow-buried aggregate resources and map the buried extent of known deposits using innovative approaches.

Acknowledgments

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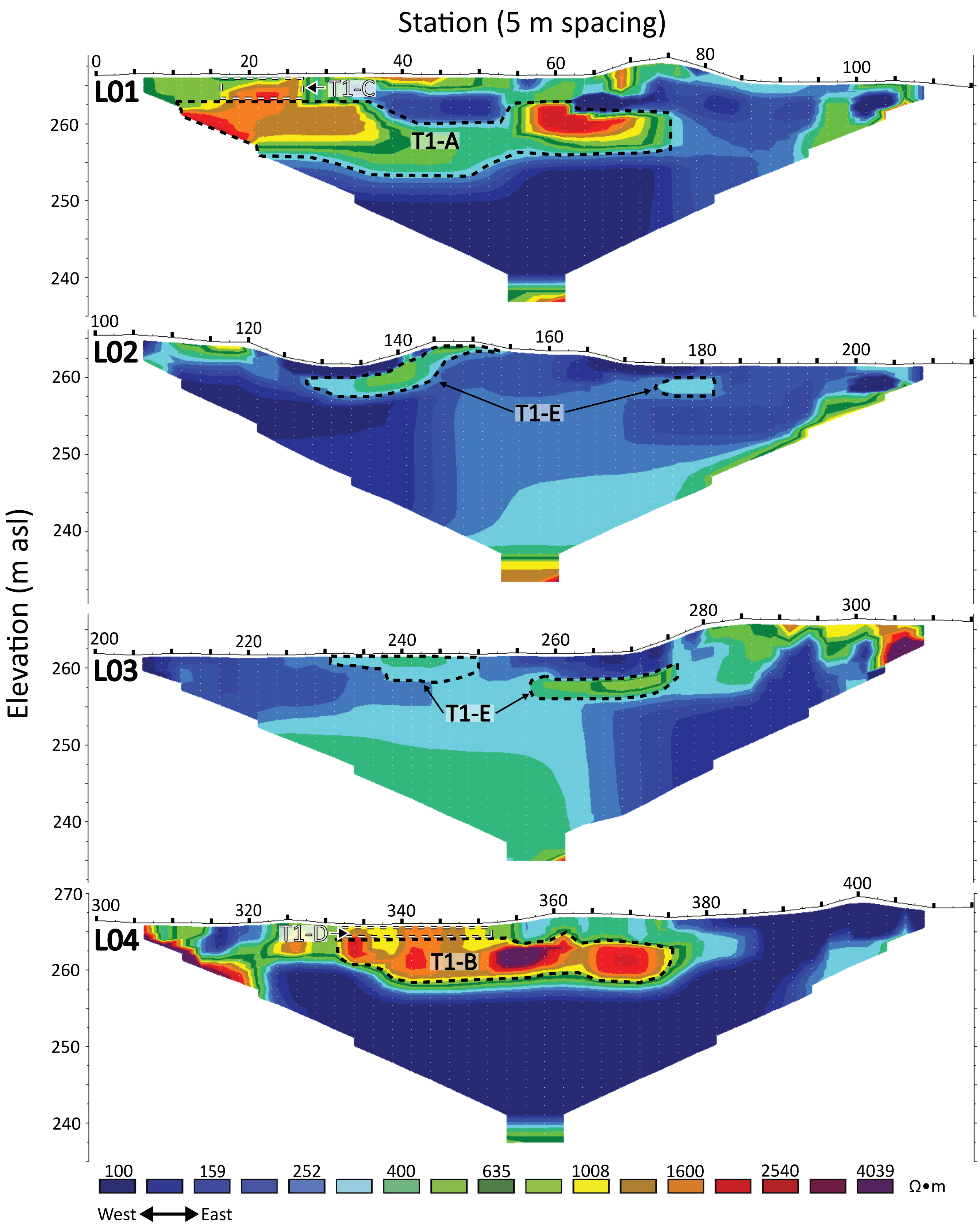

Figure GS2024-27-2: *Inversion results for transect 1 showing a resistivity cross-section with elevation data and electrode station locations, southeastern Manitoba. Anomalies at depth are outlined with black dashed lines. Areas where anomalies trend toward the surface are outlined in white dashed lines. Cooler colours indicate areas with lower resistivity, warmer colours indicate areas with higher resistivity. See Figure GS2024-27-1 for locations of lines. Abbreviations: Ω•m, ohm-metre; L, line; m asl, metres above sea level.*

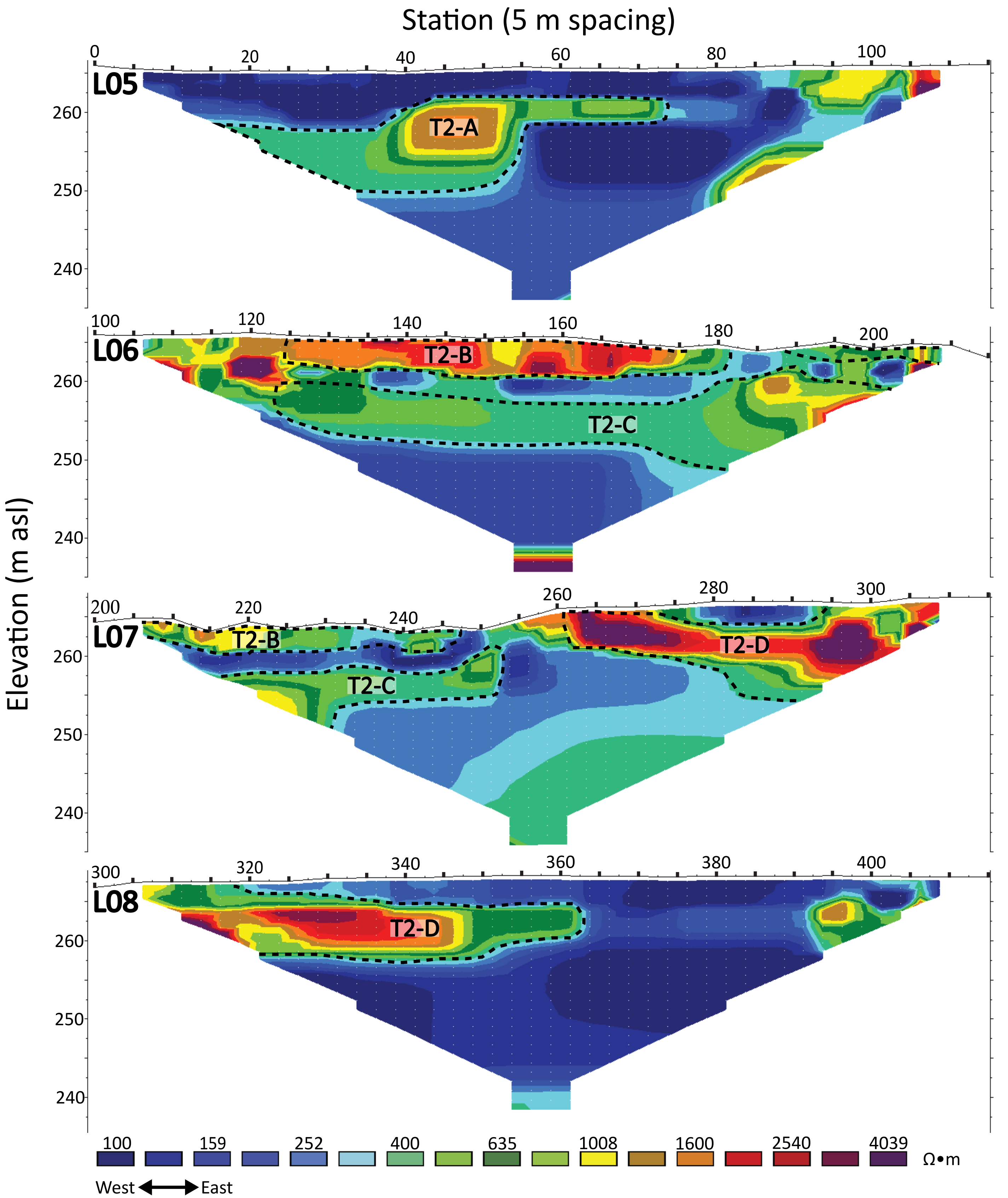

Figure GS2024-27-3: *Inversion results for transect 2 showing a resistivity cross-section with elevation data and electrode station locations. Anomalies at depth are outlined with black dashed lines. Cooler colours indicate areas with lower resistivity, warmer colours indicate areas with higher resistivity. See Figure GS2024-27-1 for locations of lines. Abbreviations: Ω•m, ohm-metre; L, line; m asl, metres above sea level.*

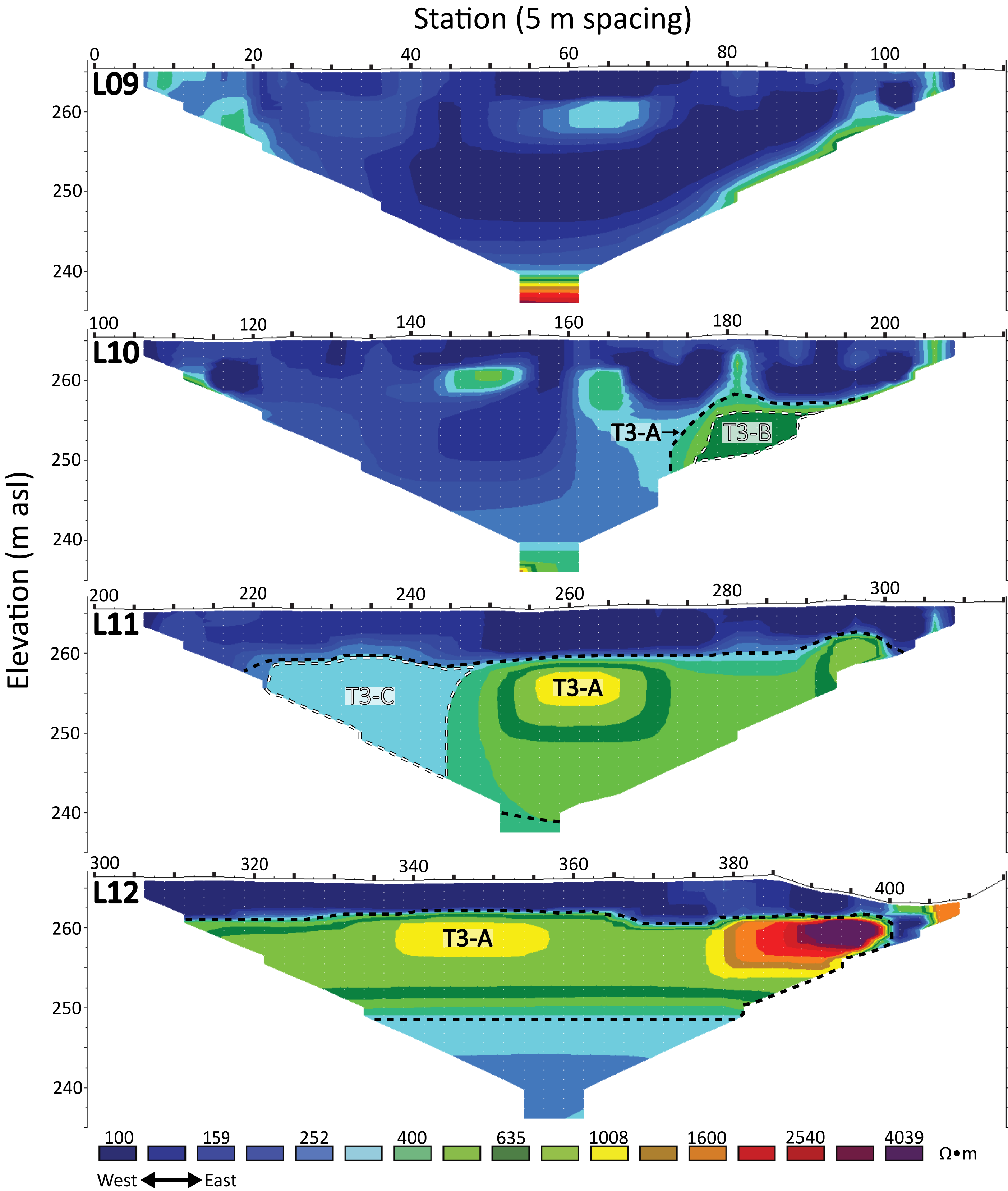

Figure GS2024-27-4: *Inversion results for transect 3 showing a resistivity cross-section with elevation data and electrode station locations. Anomalies at depth are outlined with black dashed lines. Areas showing discontinuity of resistivity intensity are outlined with white dashed lines. Cooler colours indicate areas with lower resistivity, warmer colours indicate areas with higher resistivity. See Figure GS2024-27-1 for locations of lines. Abbreviations: Ω•m, ohm-metre; L, line; m asl, metres above sea level.*

Table GS2024-27-1: Typical resistivity ranges of earth materials (from Palacky, 1988) and resistivity ranges of shallow-buried anomalies identified from the results of this multi-electrode resistivity study in southeastern Manitoba (see Figures GS2024-27-2 to -4 for details of anomalies).

Earth material	Resistivity (ohm-metre)
Fresh water	2–100
Clay	3–100
Till	50–1100
Sand and gravel	400–10000

Anomaly	Resistivity (ohm-metre)
T1-A	400–2540
T1-B	1008–4039
T1-E	252–800
T2-A	400–1600
T2-B	400–3200
T2-C	400–1300
T2-D	400–4039
T3-A	300–4039

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