GS2025-19

Till sampling strategies and surficial geology mapping in the Bird River greenstone belt area, southeastern Manitoba (parts of NTS 52L5, 6, 11, 12)

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In Brief:

- Updating surficial geology mapping of Bird River greenstone belt area
- Till sampling strategies discussed for winnowed tills in bedrock-dominated terrain

Citation:

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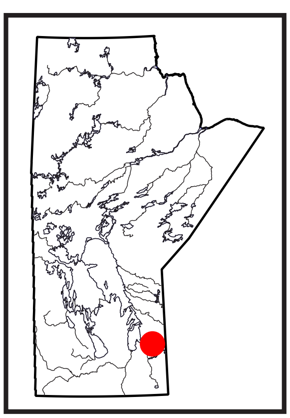

Summary

Quaternary geology investigations in the Bird River greenstone belt area, southeastern Manitoba, are providing updates to the surficial geology mapping at a 1:50 000 scale. Till prospecting in the region is complicated by a relative scarcity of glacial sediments combined with postglacial sediment winnowing processes by glacial Lake Agassiz. Till is preserved mostly as bedrock lee-side (down-ice) deposits, which are relatively easily identified with light detection and ranging (LiDAR) datasets. The degree of sediment winnowing by glacial Lake Agassiz needs to be assessed in the field before a 'till' sample can be taken, as in some cases all of the fines have been winnowed—resulting in a till-derived sandy gravel that no longer reflects primary derivation from bedrock. Ongoing mapping efforts, combined with a paleo–ice-flow reconstruction and till composition studies, will provide an updated framework for till prospecting in the region.

Introduction

The Bird River greenstone belt (BRGB) is situated within the Bird River domain of the Superior Province and is host to a variety of mineral deposits including rare-element–bearing pegmatites and Ni-Cu–platinum group element (PGE) and Cr-PGE deposits (Martins et al., 2023). The Manitoba Geological Survey (MGS) is conducting a multidisciplinary Precambrian and Quaternary geology project to better understand the geological setting of these deposits and the glacial dispersal signature down-ice of these deposits (Martins et al., 2023; Hodder and Lian, 2024). As part of this ongoing work, the scope of the Quaternary geology investigations has been expanded to include updating the surficial geology mapping for the BRGB area (Figure GS2025-19-1), which is detailed within this report along with advice for till sampling in the region based on lessons learned to date.

Surficial geology mapping

Previous mapping

The surficial geology of southeastern Manitoba was mapped at a 1:100 000 scale during the National Geoscience Mapping Program (NATMAP; Southern Prairies and Greater Winnipeg projects; Matile and Fulton, 1994; Matile et al., 1998). This ambitious mapping project used local road and trail access, with limited fixed-wing airplane support in the BRGB area, to obtain field data (Matile et al., 1998). The surficial geology maps produced for the BRGB area indicate that the dominate surficial material consists of discontinuous till and associated glaciofluvial deposits (Mann, 2004a, b), which are defined in the legend vaguely as "gravelly silt to sand diamicton, sand and gravel; 1–30 m thick; low-relief deposits between bedrock outcrops making up 25–75% of the area; sandy till interbedded and interspersed with nearly equal and often greater amounts of sandy glaciofluvial sediments, as well as minor glaciolacustrine sediments." By this definition, these previously mapped till and glaciofluvial polygons can consist of up to 75% bedrock, which is problematic for an area such as the BRGB that is a bedrock-dominated terrain (e.g., Figure GS2025-19-2a, b). Instead, this surficial geology should have been mapped as complex units (e.g., map code Tv.GFv or GFv.Tv; Deblonde et al., 2024) or bedrock (map code R). Using this methodology, the mapped polygons are labelled by the predominant unit first and all other map units that encompass >20% of a polygon are included in the remainder of the label (Deblonde et al., 2024). As such, an unknown proportion of the NATMAP 'till' polygons (code Tp; Figure GS2025-19-2a) should have been mapped as bedrock-dominated terrains (e.g., Figure GS2025-19-2b, c). Problematically, as happens during regional compilation, the overly simplified polygons were identified by their map units (noncalcareous sand diamicton; Matile and Keller, 2004, 2007) and not their full complexity as suggested by the written description in the legend,

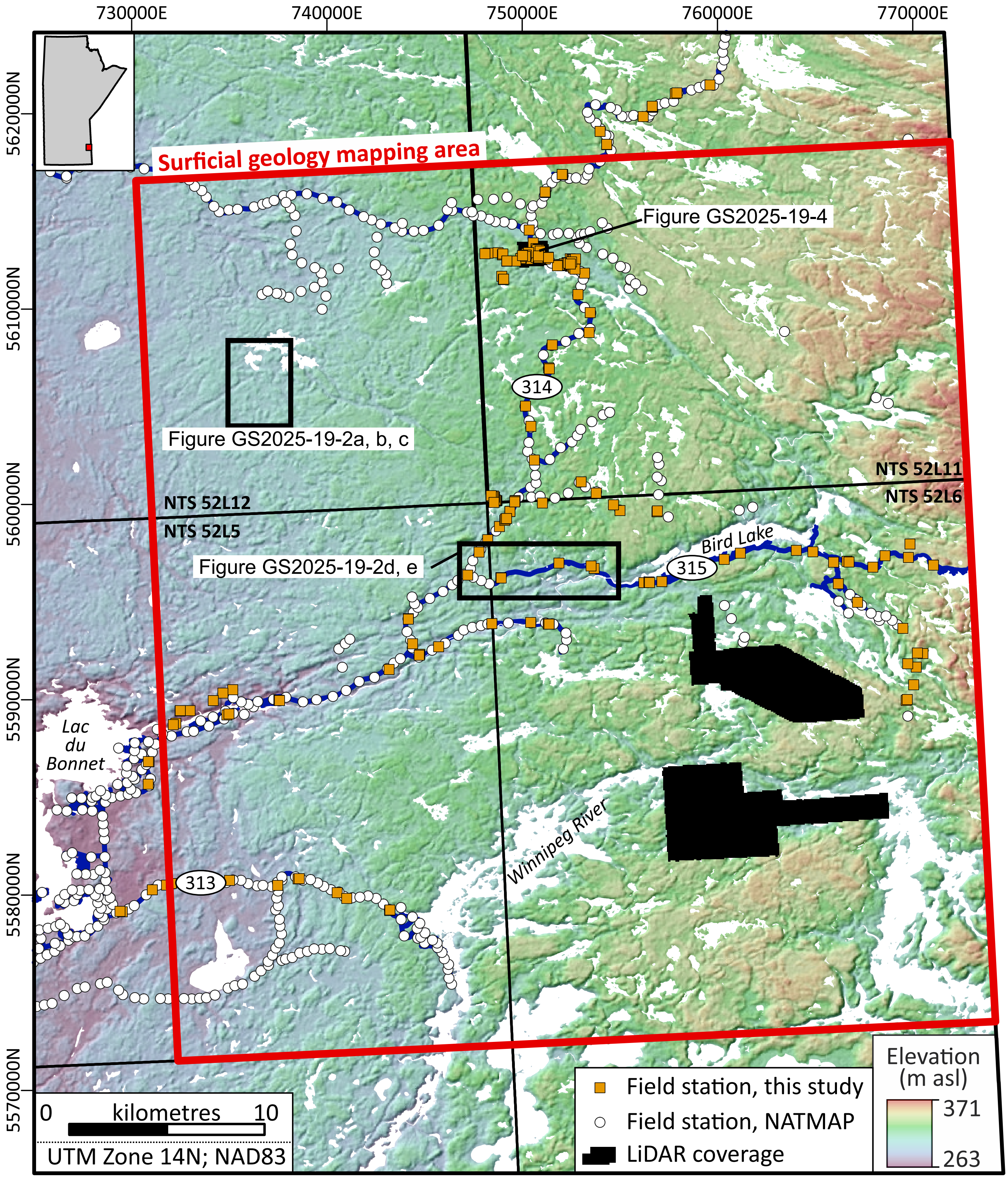

Figure GS2025-19-1: *Region currently being mapped at a 1:50 000 scale focused on the Bird River greenstone belt area of southeastern Manitoba. National Geoscience Mapping Program (NATMAP) field stations from Matile et al. (2023). Background image was generated from Medium Resolution Digital Elevation Model (Natural Resources Canada, 2025). Abbreviation: LiDAR, light detection and ranging.*

compounding the problem. Indeed, 1:50 000 scale mapping by Henderson and Way Nee (1998) just to the north concurs that most of the area is bedrock dominated.

Testing the accuracy of existing mapping

The existing mapping for the BRGB area is a reflection of a problematic mapping approach and regions that are clearly bedrock-dominated terrain have mostly been mapped as complex till (Tp) polygons (Figure GS2025-19-2a, b). The mapping issues are not restricted to bedrock-dominated terrain and persist in areas with relatively thicker sediments (Figure GS2025-19-2d, e). For example, along PR314 east of the junction with PR315, most of the previously mapped 'Tp' polygons (discontinuous till and associated glaciofluvial deposits; Figure GS2025-19-2d) consist of glaciolacustrine sediments, glaciofluvial sediments or bedrock based on fieldwork conducted in the area and new mapping (Figure GS2025-19-2e). Fieldwork conducted in 2022–2024 in the BRGB area has indicated that the current surficial geology mapping is insufficient for till prospecting or land-use planning purposes and is not an accurate reflection of field-based observations collected during NATMAP and this study (Hodder and Martins, 2023).

Current mapping

Parts of NTS 52L5, 6, 11 and 12 are being remapped at a 1:50 000 scale (Figures GS2025-19-1, -2). Considering the limited amount of ground-truthing completed for this area, the mapping approach will first use satellite imagery and digital elevation models to map bedrock and organic deposits. Next, the remaining Quaternary deposits will be differentiated based on interpretation of imagery and digital elevation models alongside field-based observations. This work is being completed to more accurately reflect the surficial geology of the region as a bedrock-dominated landscape instead of a till-dominated landscape (e.g., Figure GS2025-19-2). Fieldwork and preliminary surficial geology mapping indicate that till deposits are rarely mappable at the 1:50 000 scale in the BRGB area.

Till sampling strategies

The BRGB of southeastern Manitoba is a bedrock-dominated terrain with a thin, discontinuous cover of Quaternary sediments over much of the region. Till deposition was generally restricted to the down-ice side (or lee-side) of bedrock outcrops (Figure GS2025-19-3a). Following retreat of the Laurentide Ice Sheet from southern Manitoba, the area was inundated by glacial Lake Agassiz. This large ice-dammed lake experienced numerous lake level changes throughout its history (e.g., Thorleifson, 1996; Fisher and Breckenridge, 2022). This dynamic lake modified previously deposited sediments through wave and current processes, while also depositing nearshore and offshore sediments throughout most of Manitoba. In the BRGB area, till deposits were winnowed by these lacustrine processes and an extensive boulder and cobble lag developed at surface; at these sites, till needs to be sampled from below this lag (Figure GS2025-19-3b, d). In some cases, generally in areas of thinner Quaternary sediments, the till has been completely reworked by lacustrine processes and the deposit is now a till-derived sandy gravel (Figure GS2025-19-3c, e). Furthermore, till deposits seem to be highly localized and can exhibit lateral thickness variations at the outcrop scale. Thus, the local topography needs to be carefully considered to find the optimal sampling location, where till is the thickest, and could require several digging attempts. The relative scarcity of till across the BRGB means that sampling using a defined grid spacing is not possible; till sampling programs need to focus on identifying lee-side deposits where the least modified till is found. It is recommended to sample lee-side deposits, where possible, along lines oriented approximately northwest-southeast, which is perpendicular to the dominant ice-flow direction(s) based on field-based mapping (Hodder and Lian, 2024), at a defined spacing suitable for the study objectives.

High-resolution digital elevation models, such as those derived from LiDAR, are advantageous for identifying till sampling targets and mapping geomorphology and they provide valuable information regarding bedrock structure; thus, LiDAR acquisition is highly recommended for mineral exploration programs in the BRGB area at the property scale. For example, access to LiDAR around the F.D. no. 5 pegmatite and Eagle pegmatites was obtained after completing fieldwork (e.g., Figure GS2025-19-4a, b). From a LiDAR-derived digital elevation model, the lee-side till deposits discovered in the field (e.g., Figure GS2025-19-4c) are easily identifiable and additional potential till sampling localities can be mapped quickly, which saves significant time in the field. Interestingly, the streamlined bedrock mapped with LiDAR, including the F.D. no. 5 outcrop, is predominantly oriented toward the south-southwest. This is not in agreement with the last ice-flow event the region experienced (230–250°; Hodder and Lian, 2024), but instead with the penultimate ice-flow event mapped across the region, toward the south-southwest (205–228°; Hodder and Lian, 2024), as evidenced by striations mapped on a protected face of the F.D. no. 5 pegmatite indicating a 212° ice-flow direction (Figure GS2025-19-4d). This new information was only observable with the LiDAR dataset and suggests that the penultimate ice-flow event was possibly more erosive compared to the last ice-flow event the BRGB experienced, which is important information to consider when interpreting sediment-landform relationships.

Future work

Ongoing work is focusing on 1:50 000 scale surficial geology mapping of the BRGB area. This mapping, along with till compositional studies and ice-flow mapping, will provide an updated framework for till prospecting in the region.

Economic considerations

Surficial geology maps provide important information on the distribution of sediments across a region and the processes that

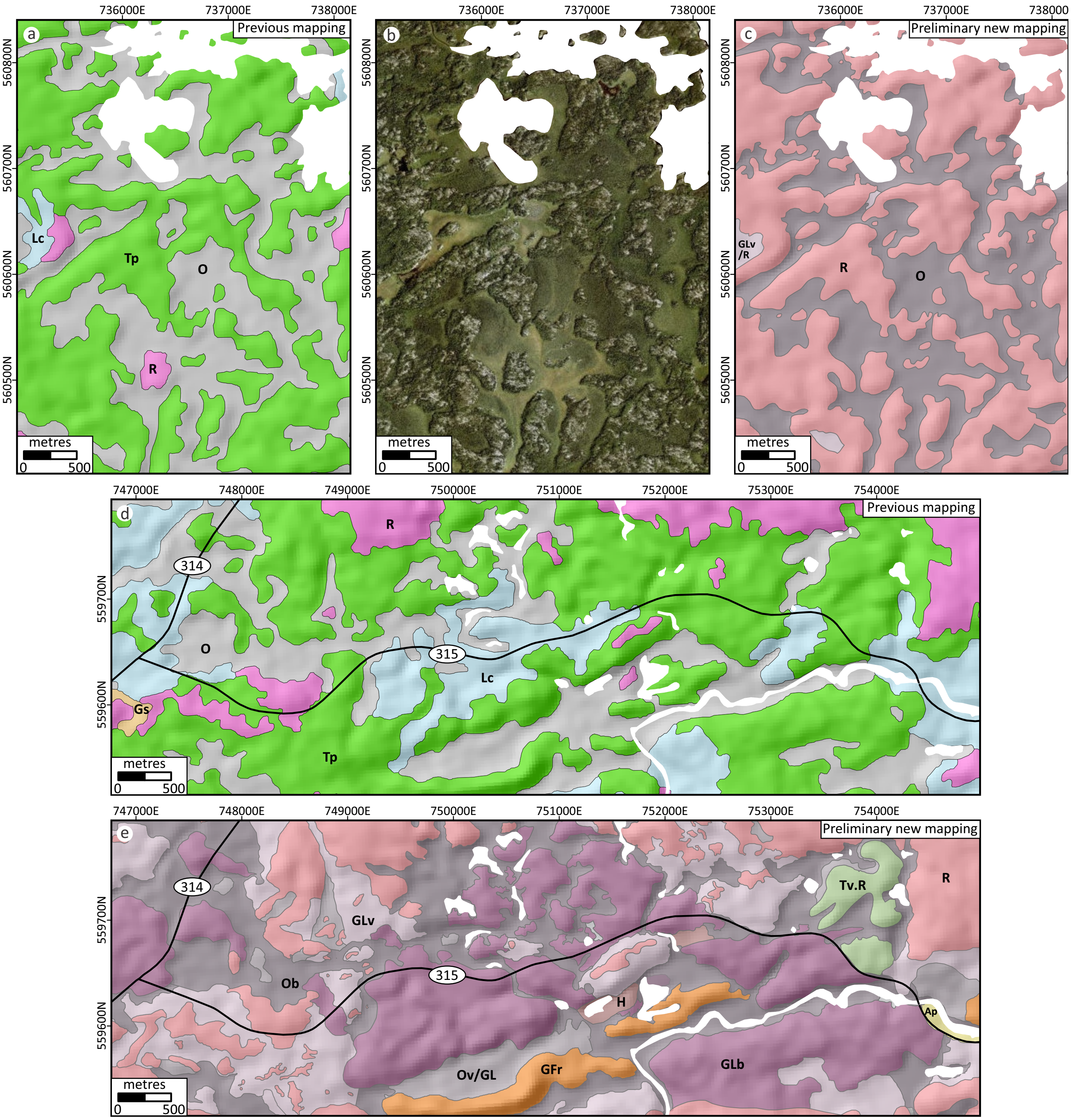

__Figure GS2025-19-2:__ Example of mapping in progress for this study and a comparison to previous mapping: __a)__ previous 1:100 000 scale surficial geology mapping in the area (Mann, 2004b); __b)__ aerial photograph of the mapping area with visible bedrock outcrops; __c)__ preliminary new 1:50 000 scale surficial geology mapping of the area shown in (a) and (b); __d)__ previous 1:100 000 scale surficial geology mapping in the area (Mann, 2004b); __e)__ preliminary updated 1:50 000 scale surficial geology mapping of the area shown in (d). Basemap imagery in (b) was created using ArcGIS® software by Esri. ArcGIS® is the intellectual property of Esri and is used herein under license. Copyright © Esri. All rights reserved. For more information about Esri software please visit <https://esri.ca/>. Abbreviations: Ap, alluvial floodplain sediment; GFr, esker sediment; GL, glaciolacustrine deposit; GLb, glaciolacustrine blanket sediment; GLv, glaciolacustrine veneer sediment; Gs, subaqueous outwash; H, anthropogenic deposit; Lc, lacustrine clay to silty clay; O, organic deposit; Ob, organic blanket deposit; Ov, organic veneer deposit; R, bedrock; Tp, discontinuous till and associated glaciofluvial sediment, predominantly derived from igneous and metamorphic rocks; Tv.R, till veneer deposit and bedrock.

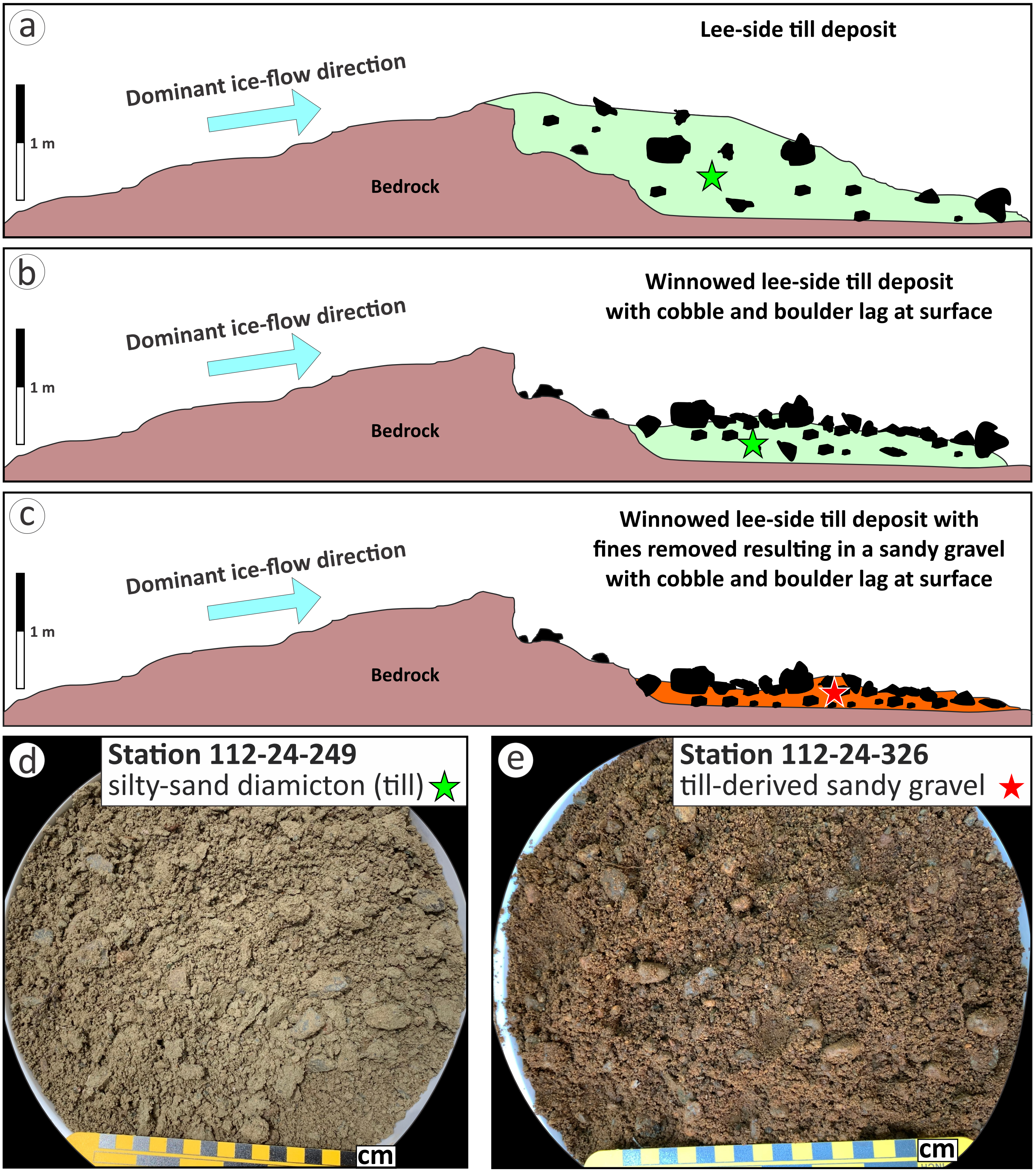

Figure GS2025-19-3: *Schematic of lee-side sediment deposits and sediment examples:* ***a)*** *unmodified lee-side till deposit;* ***b)*** *lee-side till deposit that has been winnowed by glaciolacustrine processes and is now cladded by an extensive cobble and boulder lag at surface;* ***c)*** *lee-side till deposit that has been winnowed by glaciolacustrine processes to the point that fines have been removed and a sandy gravel cladded by an extensive cobble and boulder lag at surface remains;* ***d)*** *example of till uncovered beneath the lag in the geological setting depicted in (b);* ***e)*** *example of a sandy gravel uncovered beneath the lag in the geological setting depicted in (c).*

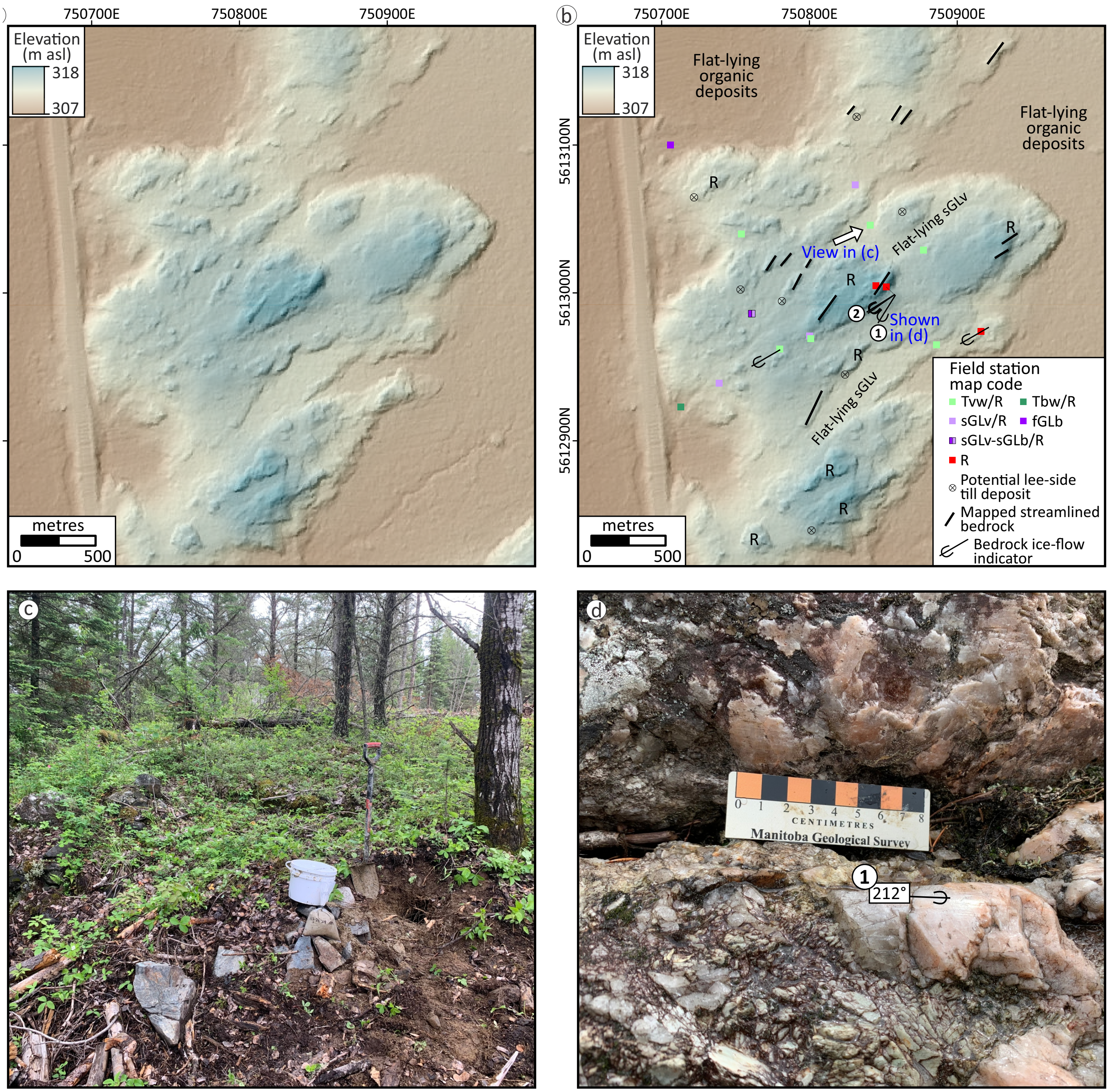

Figure GS2025-19-4: *Imagery and photographs of the F.D. no. 5 pegmatite area:* ***a)*** *light detection and ranging (LiDAR) imagery;* ***b)*** *annotated LiDAR imagery of the area with field stations and potential lee-side till deposits identified;* ***c)*** *lee-side till deposit in the area;* ***d)*** *fine striations oriented toward 212° on a protected face of the F.D. no. 5 outcrop. Background LiDAR-derived digital elevation model imagery from New Age Metals Inc. (unpublished data, 2025). Abbreviations: fGLb, fine-grained glaciolacustrine blanket sediment; sGLb, sandy glaciolacustrine blanket sediment; sGLV, sandy glaciolacustrine veneer sediment; R, bedrock; Tbw, till blanket sediment, winnowed; Tvw, till veneer sediment, winnowed.*

deposited these sediments. When combined with a better understanding of the direction(s), timing and nature of major and minor ice-flow events in the region, the surficial geology maps provide an updated framework for till prospecting in the Bird River greenstone belt area. Till indicator-mineral and matrix geochemistry datasets collected during this study provide information on the mineral potential across the region and the dispersal signature from known deposits is also being investigated. These datasets can be used to facilitate mineral exploration across the region.

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