AER/AGS Open File Report 2026-02

Alberta Energy Regulator

Turtle Mountain Field Laboratory, Alberta (NTS 82G): 2023 Data and Activity Summary

AGS
ALBERTA GEOLOGICAL SURVEY

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November 2026

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ISBN 978-1-4601-5735-0

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Chao, D.K. and Kelly, S.A. (2026): Turtle Mountain Field Laboratory, Alberta (NTS 82G): 2023 data and activity summary; Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Open File Report 2026-02, 14 p.

Publications in this series have undergone only limited review and are released essentially as submitted by the author.

Published November 2026 by:
Alberta Energy Regulator
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Acknowledgements

We acknowledge the following colleagues and collaborators who have contributed to the operation, maintenance, or studies of the Turtle Mountain Monitoring System during 2023:

C. Filewich, J.A. Yusifbayov, D.E. Wood, M. Grobe, and G.S. Driedger (Alberta Geological Survey)

T.C. Shipman (Alberta Energy Regulator, Regulatory Compliance)

J. Guo, B. Charney, U. Grewal, L.A. Kaura, and O. Adeogun (Alberta Energy Regulator, Information Management and Technology)

C. Rivolta, D. Leva, A. Gusmeroli, and M. Andreozzi (Ellegi s.r.l, Milan, Italy)

R. Macciotta Pulisci (University of Alberta, Department of Civil and Environmental Engineering, Edmonton, Alberta)

S. Lacasse (Norwegian Geotechnical Institute, Oslo, Norway)

S. Alberti (HPC Italia S.r.l., Milan, Italy)

P. Thomas (Municipality of Crowsnest Pass, Crowsnest Pass, Alberta)

Municipality of Crowsnest Pass Council Members (Crowsnest Pass, Alberta)

Frank Slide Interpretive Centre Staff (Crowsnest Pass, Alberta)

BGIS (Crowsnest Pass, Alberta)

A special thanks to Ellegi s.r.l who provided the scientific review of the LiSAmobile section.

Abstract

This report provides a summary of the lessons learned from both the Turtle Mountain Monitoring System (TMMS), and from studies undertaken by the Alberta Geological Survey (AGS) and collaborators between January 1 and December 31, 2023. The TMMS is a near–real-time remote monitoring system that provides data from a network of sensors and monitoring systems on Turtle Mountain, located in the Crowsnest Pass of southwestern Alberta.

As of April 1, 2005, the AGS took ownership of this system, and the responsibility for long-term monitoring, interpreting data, and notifying the Alberta Emergency Management Agency should significant movements occur.

The AGS performs an annual detailed review of the data stream from the TMMS. To help in this interpretation, the AGS initiated specific studies to better understand the structure of the mountain and its relationship to the style and rate of movement seen in recent and historical deformations of South Peak. These studies also better define the unstable volumes of rock from the South, North, and Third Peak areas.

This report comprises five main sections:

The first section contains information about the significant changes to the TMMS's network during 2023. This includes a summary of system performance and reliability.

The second section describes the Turtle Mountain Monitoring Program's periodic external expert panel workshops, which happen every 10 years and are designed to assess the project's monitoring technologies and strategies. This workshop was held in 2023.

The third section provides analysis and interpretation of data from the primary monitoring equipment, known as LiSAmobile.

The fourth section discusses supporting studies and research.

The fifth section features information on two videos produced by the Alberta Energy Regulator to highlight the changes on Turtle Mountain in 2023.

1 Introduction

In 2005, the Alberta Geological Survey (AGS), a branch of the Alberta Energy Regulator (AER), assumed responsibility for the long-term monitoring of Turtle Mountain, the site of the 1903 Frank Slide in southwestern Alberta (Figure 1). In July 2016, the Turtle Mountain Monitoring Program (TMMP) transitioned from a near–real-time early warning monitoring system to a near–real-time remote monitoring network. This transition encompassed monitoring advancements due to improved displacement measurement technologies and a review of over a decade of monitoring data and techniques. For more information, refer to Wood et al. (2017a, b, 2018a, b).

The first priority of the TMMP is to provide monitoring of Turtle Mountain, review site characterization, review monitoring practices, and make recommendations for the future of the monitoring program. The second priority is to provide an opportunity for the research community to test and develop instrumentation and monitoring technologies to better understand the mechanics of slow-moving rock masses. This ongoing research will aid in understanding the rock movements on Turtle Mountain.

This annual report provides the public and researchers with a synthesized update on data trends, monitoring on the mountain, and changes to the monitoring program.

2 Sensor Network Activity

This section provides an overview of the major upgrades, repair, maintenance activities, and performance of the sensor network of the monitoring system during 2023.

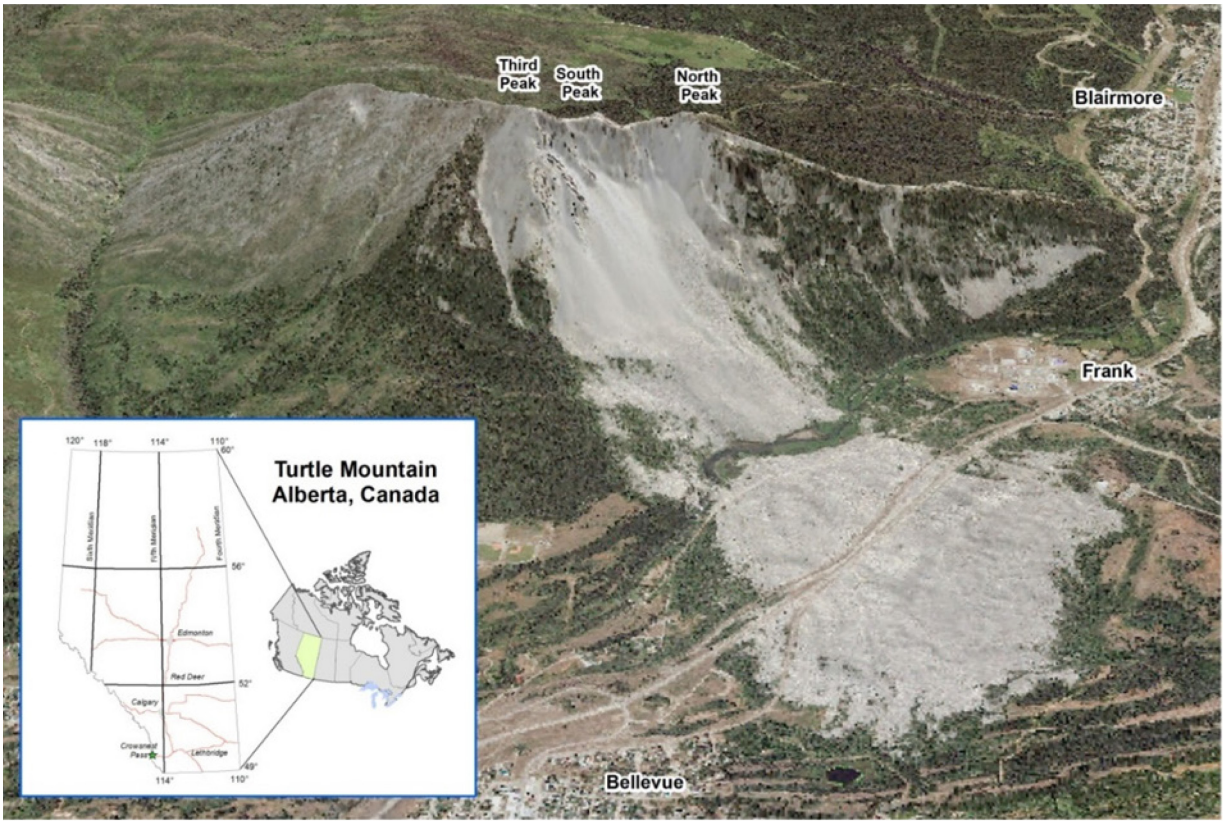


Figure 1. Location of Turtle Mountain in southwestern Alberta and full-extent aerial view of the Frank Slide.

The AGS leases a ground-based interferometric synthetic aperture radar (GB-InSAR) monitoring system known as LiSAmobile from Ellegi s.r.l (hereafter, Ellegi), Milan, Italy. LiSAmobile was installed in June 2014 and has been in continuous operation, except during annual repair and maintenance, as well as a short outage in 2020. Ellegi is responsible for the operations, maintenance and data collection of the GB-InSAR monitoring system. Their expertise is rooted in pioneering radar technology, scientific leadership and proven field performance in both routine monitoring and emergency situations for natural hazards and critical infrastructure worldwide. The AGS's lease with Ellegi provides for customer service and technical support in case of an emergency or equipment changes.

In 2016, LiSAmobile was transitioned from being the secondary monitoring system to the primary monitoring system. In addition, the AGS supports secondary aerial monitoring campaigns to ensure the data collected from the primary LiSAmobile system match data collected from other monitoring methods, such as airborne light detection and ranging (LiDAR), photogrammetry, and terrestrial laser scanning (TLS). These secondary campaigns are completed at the discretion of the AGS and depend on monitoring needs.

The AGS receives and reviews monitoring reports on a quarterly basis from Ellegi. Ellegi also provides *Quick Reports* if an area has displacement values outside of the defined thresholds determined by Ellegi technicians. Ellegi continues to provide a premium level of technical support, innovative radome shelter technology (protective housing for monitoring equipment), and timely detailed reporting. The AGS will continue to use LiSAmobile as the primary monitoring sensor.

The AGS has a radio licence from Innovation, Science and Economic Development Canada that allows them to operate the Turtle Mountain Monitoring System (TMMS) network link without interference from other frequencies in the surrounding Crowsnest Pass area.

2.1 Repairs and Maintenance

2.1.1 LiSAmobile Annual Maintenance

In 2023, an annual maintenance campaign was conducted in early July by a joint team from Ellegi and the AGS. The field maintenance objectives included:

- visually inspecting the radome for any structural or waterproofing issues;
- performing mechanical maintenance, cleaning, and oiling the rail;
- checking the measuring head for its functionality and performance, and the inclination of its plate;
- examining the linear positioner, its belt condition and functionality, and adjusting the tension of the belt and its alignment on the free pulley;
- replacing the filters for the measuring head;
- inspecting the air conditioning unit of the radome for any operating issues and cleaning its filters;
- confirming the functionality and performance of the processing unit; and
- rebooting the system to test for normal data acquisition.

During the site maintenance, the LiSAmobile radome was inspected for signs of physical damage, structural deterioration, and water leak exposure. The radome protects LiSAmobile from significant fluctuations in precipitation and temperatures, which are typical throughout the year in the Crowsnest Pass. Environmental conditions at the site include high and low temperatures during summer and winter, high wind gusts, and heavy precipitation events. The inspection revealed that the radome had continued to withstand all the environmental factors and protected the LiSAmobile system efficiently as designed.

2.1.2 Battery Replacement for the South Peak Webcam

The webcam on South Peak provides a live video stream of the Turtle Mountain ridge, North Peak, and eastern slope. It is part of the TMMS and provides year-round images of Turtle Mountain. The webcam images are captured at five-minute intervals and posted to the AGS website on the Turtle Mountain page.

Also on the webpage are daily video recordings, which are uploaded every hour and cover the previous 24 hours.

As South Peak lacks electrical infrastructure to power the webcam and live video transmission, the webcam is powered by solar panels and eight deep-cycle batteries housed inside two weatherproof protective cases. The batteries were replaced during a field visit in September 2023 to ensure the continuous operation of the live video streams. The batteries at South Peak are replaced during inspections that occur every five years.

2.1.3 Dismantling Non-Operational Historical Monitoring Equipment

A deteriorating historical monitoring station located near South Peak was dismantled and transported back to the AGS in September 2023 (Figure 2).

The station was part of the original equipment for the sensor network that was decommissioned in 2017 (Yusifbayov et al., 2018). It consisted of two solar panels, a control box, a radio antenna mounted on a metal pole, and two deep-cycle batteries housed inside a protective case. Its poor condition was noticed during the 2022 field visit, and it was decided that the station should be removed to avoid further deterioration.



Figure 2. Decommissioning of deteriorating historical monitoring station near South Peak of Turtle Mountain, southwestern Alberta, in September 2023.

3 External Expert Panel Review

As part of the TMMP, a workshop is held approximately every 10 years with an external panel of experts who evaluate the program's monitoring efforts and technologies and recommend future monitoring directions. Members of the panel include geological, geotechnical, and geohazards experts from local and international universities and institutions. Based on the recommendation of several options from the panel

in 2013 (see Warren et al., 2016), the AER decided to transition from a near–real-time early warning system to a near–real-time remote monitoring system. This transition was completed in July 2016 (Wood et al., 2018b).

In May 2023, the AGS convened a workshop which included a panel of three specialists in geological, geotechnical, and geohazard monitoring from Canadian and international institutions to evaluate the TMMP.

Objectives for the panel were to:

- review and evaluate the TMMP's current monitoring effort and technology,
- provide recommendations on monitoring efforts for the next 10 years, and
- provide recommendations on emerging monitoring and backup technologies.

A final report was delivered to AGS in October 2023. The panel provided several recommendations which are currently being reviewed by the AGS and will be reported on in our next annual report.

4 Data Collection and Analysis

4.1 LiSAmobile GB-InSAR Data Collection

LiSAmobile was installed at the Bellevue pumphouse in June 2014 to monitor small displacements on the eastern face of Turtle Mountain. The LiSAmobile system (depicted in Figure 3 without the radome) uses the GB-InSAR technique to measure small displacements at each point on the surface of the mountain. For additional information, refer to Wood et al. (2016).

The LiSAmobile system is connected via the Internet through a Wi-Fi connection that allows virtual private network access. The LiSAmobile system obtains raw measurement data from the radar head. These data are processed onsite by LiSAmobile, the results are transferred, and the data quality is evaluated by Ellegi and used to create displacement maps showing a pixelated image of ground displacements that range from positive to negative values Figure 4a). Positive values (blue colours) indicate displacement away from the sensor, whereas negative values (red colours) indicate displacement towards the sensor.



Figure 3. LiSAmobile system without the radome (housing structure), Turtle Mountain, southwestern Alberta.

4.2 Discussion and Interpretation of Monitoring Data from LiSAmobile System

The displacement map displayed in Figure 4a depicts how the slopes on the east face of the mountain are affected by slow and small movements, measured in the millimetre range. Displacement maps are created through a collection of data from the LiSAmobile system over an approximately 90-day period (per quarter), with approximately 15-day increments. The displacement maps were produced from data collected from the start of LiSAmobile operation in June 2014 to the end of December 2023 and are provided by Ellegi to the AGS in quarterly reports (quarterly reporting period [Q] 35 to Q38 for 2023). Each report contains the cumulative data starting from June 20, 2014, to the end of the respective quarterly reporting period.

The data are divided into nine regions of interest (A–I, Figure 4a and b), which are further subdivided into 18 points of interest (POIs; labelled P_1 through P_12, P_17, P_18, and P_20 through P_23 in Figure 4b). Regions H and I, and POIs P_18 and P_20 belong to the morphologically connected channels extending to the valley bottom below region D (South Peak). They were added to the data collection in February 2020 (Q23) after displacements were observed in December 2019. Points of interest P_21 to P_23 were added to region D in June 2021 (Q28) after displacements were observed in the previous month to provide a better understanding of movement in the area (Figure 5). Additional documentation of the LiSAmobile parameters can be found in Wood et al. (2016).

The high displacement rates detected in the vegetation zone (region F, Figure 4a and b) are considered to be measurement errors introduced by atmospheric moisture within the line of sight and the presence of vegetation.

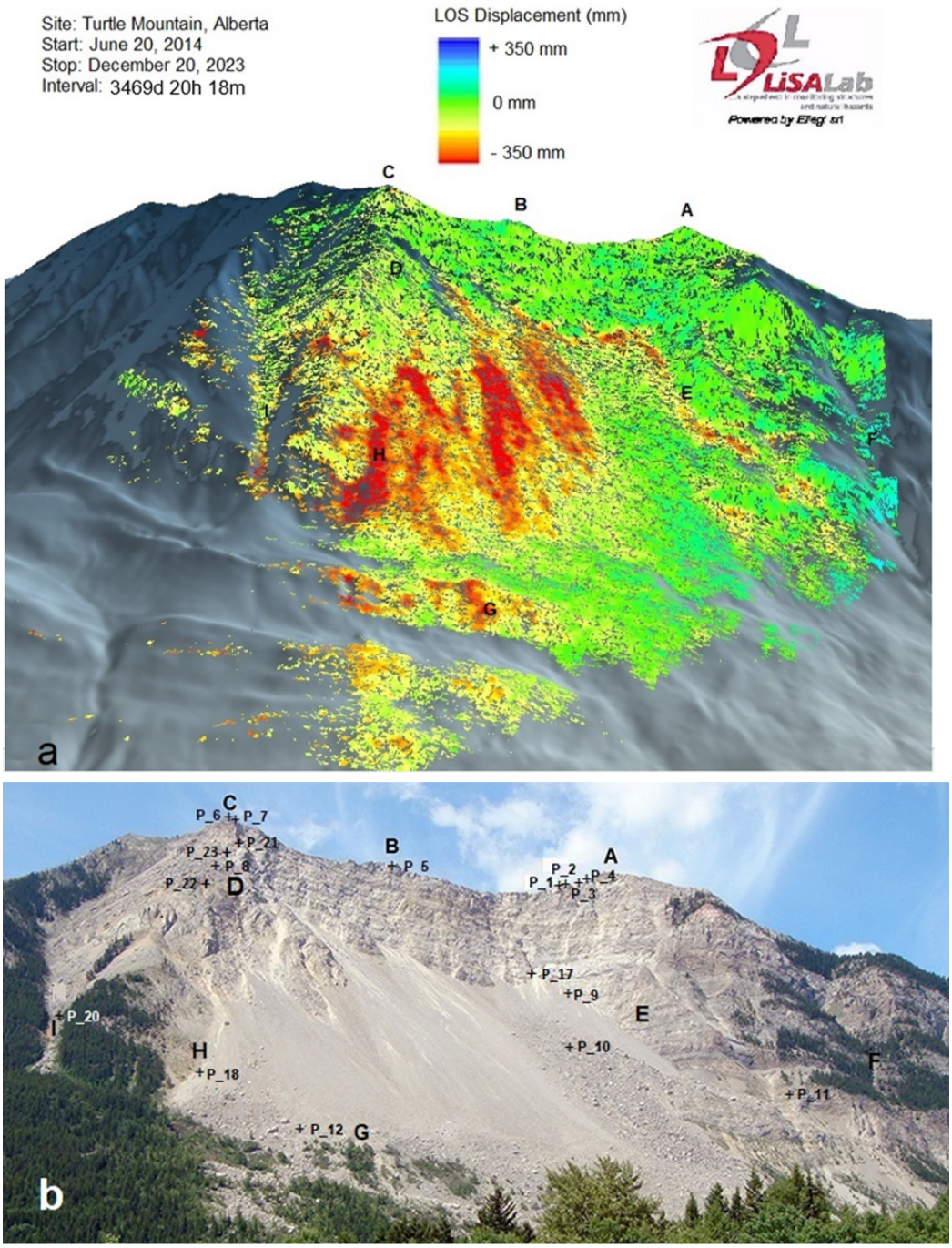


Figure 4. Three-dimensional (3D) displacement map (a), measured from June 20, 2014, to December 20, 2023 (3469 days [d], 20 hours [h], 18 minutes [m]), and view (b) of the eastern face of Turtle Mountain, southwestern Alberta. Letters A to I denote the locations of the regions of interest. Letters P_1 through P_12, P_17, P_18, and P_20 through P_23 denote points of interests. Abbreviation: LOS, line of sight.

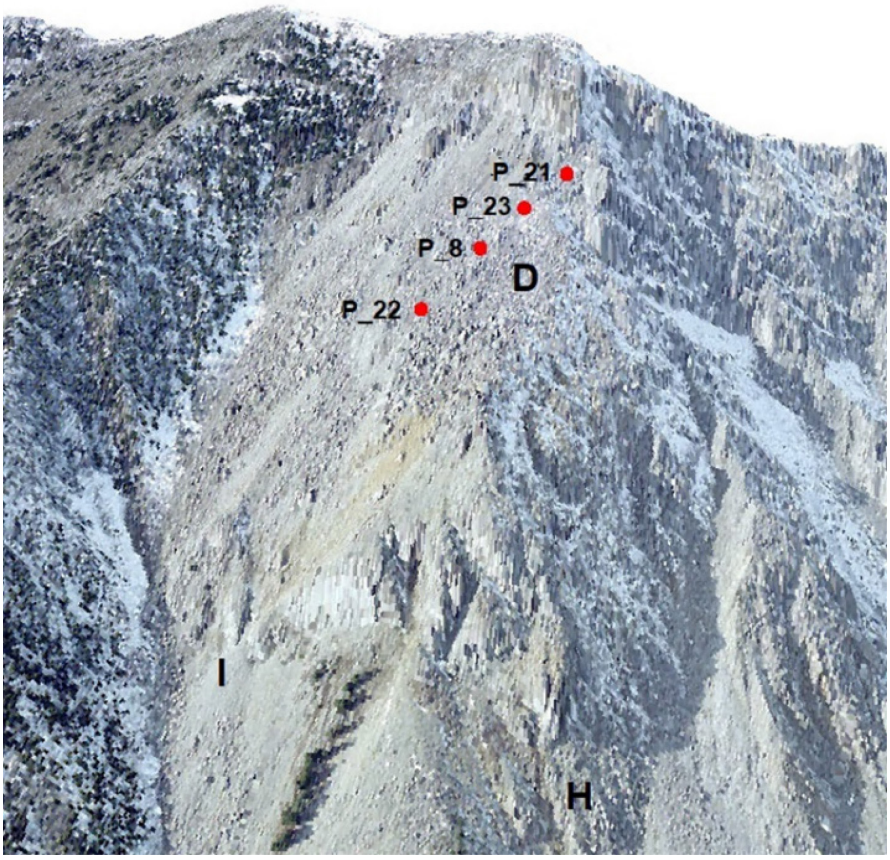


Figure 5. In region D, data from points of interest P_8 and P_21 to P_23 provide a better understanding of displacements in the area, Turtle Mountain, southwestern Alberta.

The results from reports Q35 to Q38 provided to the AGS by Ellegi are presented in Table 1 through Table 8. Generalized displacements in the regions of interest for the period from June 20, 2014, to the end of the respective quarterly reporting period (i.e., Q35, Q36, Q37, Q38) are shown in Table 1, Table 3, Table 5, and Table 7, respectively. Measured displacements at POIs for the same periods are presented in Table 2, Table 4, Table 6, and Table 8.

On the displacement maps (Figure 4a and Figure 6), both positive and negative displacement values are depicted using colours. Blue colours indicate displacement away from a sensor (positive value), for example, rocks calving off and exposing new rock surfaces from behind. Red colours (and purple colours on Figure 6) indicate displacement towards the sensor (negative value), such as rocks falling and accumulating in the debris zones (regions E and G). Green colours depict a neutral range of displacement with minimal movements towards or away from the sensor.

For simplicity, the AGS has removed the negative sign from the reported displacement tables (Table 1 to Table 8) and is reporting the cumulative movements towards the sensor (i.e., only the red colours on Figure 4a). The AGS monitors all displacement movements (blue, red, and green) reported by Ellegi.

4.2.1 Report to the End of Q35

Generalized displacement in Q35 for regions A to I was relatively small except for the slope including regions H and I, below the rocky ridge (Table 1 and Table 2). In this area, significant displacements occurred at large gulleys and elongated channels towards the bottom of the valley. Their progressive displacements were caused by the movement of snow. Since June 20, 2014, the debris zone has

experienced the most deformation whereas the least deformation (<5 mm/year) has occurred on the ridge. Displacement in other regions, particularly on the top of the mountain, were negligible. Positive fluctuation in these regions was largely caused by the presence of snow. During the winter months, the Crowsnest Pass area is subject to large amounts of snow accumulation that impact the data.

Table 1. LiSAmobile generalized displacement in regions of interest from June 20, 2014, to the end of quarterly reporting period (Q) 35 on March 20, 2023 (3195 days), Turtle Mountain, southwestern Alberta.

Region	Location Description	Displacement (mm)	Approximate Region Area (m^2)
A	Close to North Peak	≤65.1	3405
B	Between North and South peaks	≤8.6	3034
C	Close to South Peak	≤79.5	8031
D	Below South Peak	≤73.7	10030
E	Debris area toe of North Peak rock wall	≤6.7	12928
F	Mid to lower vegetated rock wall	-	2865
G	Debris zone runout area	≤148.8	11494
H	Elongated channel (right) to the valley	≤313.5	17718
I	Elongated channel (left) to the valley	≤228.2	8684

Table 2. LiSAmobile measured displacement at POIs from June 20, 2014, to March 20, 2023 (3195 days), with observations specific to Q35, Turtle Mountain, southwestern Alberta.

Region	Point of Interest (POI)	Displacement (mm)	Displacement Description Specific to Q35
A	P_1 to P_4	47.3 to 228.7	Generalized stability and only minor fluctuations in Q35. Positive displacement at P_3 influenced by snow.
B	P_5	≤25.0	Generalized stability and only minor fluctuations in Q35.
C	P_6 and P_7	17.5 to 141.7	Generalized stability and only minor fluctuations in Q35. Slight negative displacement at P_7 influenced by snow.
D	P_8, P_21 to P_23	47.6 to 72.1	Generalized stability and minor positive displacements caused by snow cover in Q35.
E	P_9, P_10, and P_17	≤199.6	Generalized stability and only minor fluctuations in Q35.
F	P_11	-	Data are omitted due to errors introduced by atmospheric moisture within the line of sight or presence of vegetation.
G	P_12	≤135.2	Negative displacement likely caused by snow cover in Q35.
H	P_18	≤401.0	Negative displacement caused by snow movement in Q35.
I	P_20	≤216.5	Negative displacement caused by snow movement in Q35.

4.2.2 Report to the End of Q36

Generalized displacements for most regions were minor in Q36 (Table 3 and Table 4). All regions continued to exhibit similar behaviours as in the previous quarter, with the only significant displacement occurring on the slope due to snow cover. Region B was stable with some positive displacement and fluctuation likely due to changes in snow cover and did not exhibit any acceleration or anomalies in this quarter.

Table 3. LiSAmobile generalized displacement in regions of interest from June 20, 2014, to the end of Q36 on June 20, 2023 (3287 days), Turtle Mountain, southwestern Alberta.

Region	Location Description	Displacement (mm)	Approximate Region Area (m^2)
A	Close to North Peak	≤62.6	3405
B	Between North and South peaks	≤4.9	3034
C	Close to South Peak	≤79.7	8031
D	Below South Peak	≤78.3	10030
E	Debris area toe of North Peak rock wall	≤13.1	12928
F	Mid to lower vegetated rock wall	-	2865
G	Debris zone runout area	≤150.3	11494
H	Elongated channel (right) to the valley	≤324.3	17718
I	Elongated channel (left) to the valley	≤235.8	8684

Table 4. LiSAmobile measured displacement at points of interest (POI) from June 20, 2014, to June 20, 2023 (3287 days), with observations specific to quarterly reporting period (Q) 36, Turtle Mountain, southwestern Alberta.

Region	Point of Interest (POI)	Displacement (mm)	Displacement Description Specific to Q36
A	P_1 to P_4	39.6 to 234.0	Generalized stability with only minor fluctuations in Q36. Displacement at P_3 influenced by snow.
B	P_5	≤21.9	Generalized stability with only minor fluctuations in Q36.
C	P_6 and P_7	18.0 to 181.8	Generalized stability with only minor fluctuations in Q36. Slight negative displacement at P_7 influenced by snow.
D	P_8, P_21 to P_23	51.7 to 67.6	Generalized stability and minor positive displacements likely caused by changes in snow cover in Q36.
E	P_9, P_10, and P_17	≤206.1	Generalized stability with only minor fluctuations in Q36.
F	P_11	-	Data are omitted due to errors introduced by atmospheric moisture within the line of sight or presence of vegetation.
G	P_12	≤141.2	Negative displacement caused by snow cover in Q36.
H	P_18	≤403.7	Negative displacement caused by snow movement in Q36.
I	P_20	≤223.5	Negative displacement caused by snow movement in Q36.

4.2.3 Report to the End of Q37

There were no significant generalized displacements from the rock walls and only some incremental displacements in the debris zone (regions E, G, and H) throughout Q37 (Table 5 and Table 6).

Table 5. LiSAmobile generalized displacement in regions of interest from June 20, 2014, to the end of Q37 on September 20, 2023 (3879 days), Turtle Mountain, southwestern Alberta.

Region	Location Description	Displacement (mm)	Approximate Region Area (m^2)
A	Close to North Peak	≤64.0	3405
B	Between North and South peaks	≤6.6	3034
C	Close to South Peak	≤80.6	8031
D	Below South Peak	≤78.7	10030
E	Debris area toe of North Peak rock wall	≤13.2	12928
F	Mid to lower vegetated rock wall	-	2865
G	Debris zone runout area	≤150.8	11494
H	Elongated channel (right) to the valley	≤326.3	17718
I	Elongated channel (left) to the valley	≤241.0	8684

Table 6. LiSAmobile measured displacement at POIs from June 20, 2014, to September 20, 2023 (3879 days), with observations specific to Q37, Turtle Mountain, southwestern Alberta.

Region	Point of Interest (POI)	Displacement (mm)	Displacement Description Specific to Q37
A	P_1 to P_4	40.6 to 235.6	Generalized stability in Q37.
B	P_5	≤22.6	Generalized stability in Q37.
C	P_6 and P_7	17.7 to 154.7	Generalized stability in Q37.
D	P_8, P_21 to P_23	52.2 to 70.7	Generalized stability in Q37.
E	P_9, P_10, and P_17	≤208.6	Generalized stability in Q37.
F	P_11	-	Data are omitted due to errors introduced by atmospheric moisture within the line of sight or presence of vegetation.
G	P_12	≤142.1	Generalized stability in Q37.
H	P_18	≤414.5	Negative displacement caused by debris movement in Q37.
I	P_20	≤226.4	Generalized stability in Q37.

Annual analyses since 2014 have identified an area with a very slow rate of displacement below region C, between South and Third peaks. In 2016, Ellegi determined that this area consists of two different blocks moving with similar behaviours. In 2018, Ellegi identified a third area with a very slow rate of displacement over a larger area near region A, close to North Peak. Ellegi was able to evaluate the displacement rates within region A, identifying small-scale movements over a larger area (large block movements). In 2019, both upper and lower blocks near region C continued to exhibit a slow rate of displacement, whereas the third area near region A was moving slower than in 2017–2018.

Analyses of these areas have a one-year time frame, comparing the results from September of one year to those from September of the previous year. Ellegi states results are highly influenced by local effects, the size of the area chosen (large versus small), and whether pixel values are precisely measured or averaged.

In addition, snow accumulation from late fall to early spring introduces noise in the readings, producing fluctuations in the time series. Filtering algorithms are applied to reduce the noise but can not eliminate it completely.

In 2023, an analysis of regions A and C was completed for the period from September 20, 2022, to September 20, 2023 (Figure 6). There was overall stability in region A with only a small area on the southern flank of North Peak reaching an average displacement of -1.0 mm and a peak of -5.0 mm. No appreciable displacement was observed in region C. In addition, there was no significant displacement on the peak except for a few isolated areas where localized displacements peaked at -3 and -5 mm. Region G, the debris zone, experienced relatively rapid movements whereas the remaining regions of the mountain were stable.

The monitoring data continue to indicate that overall large-block movements are minimal. It provides assurance that the LiSAmobile system has the capability to identify and record data points for both large block movement and smaller natural rockfalls. Ellegi will complete another investigative study on these areas after collecting and compiling data for another year.

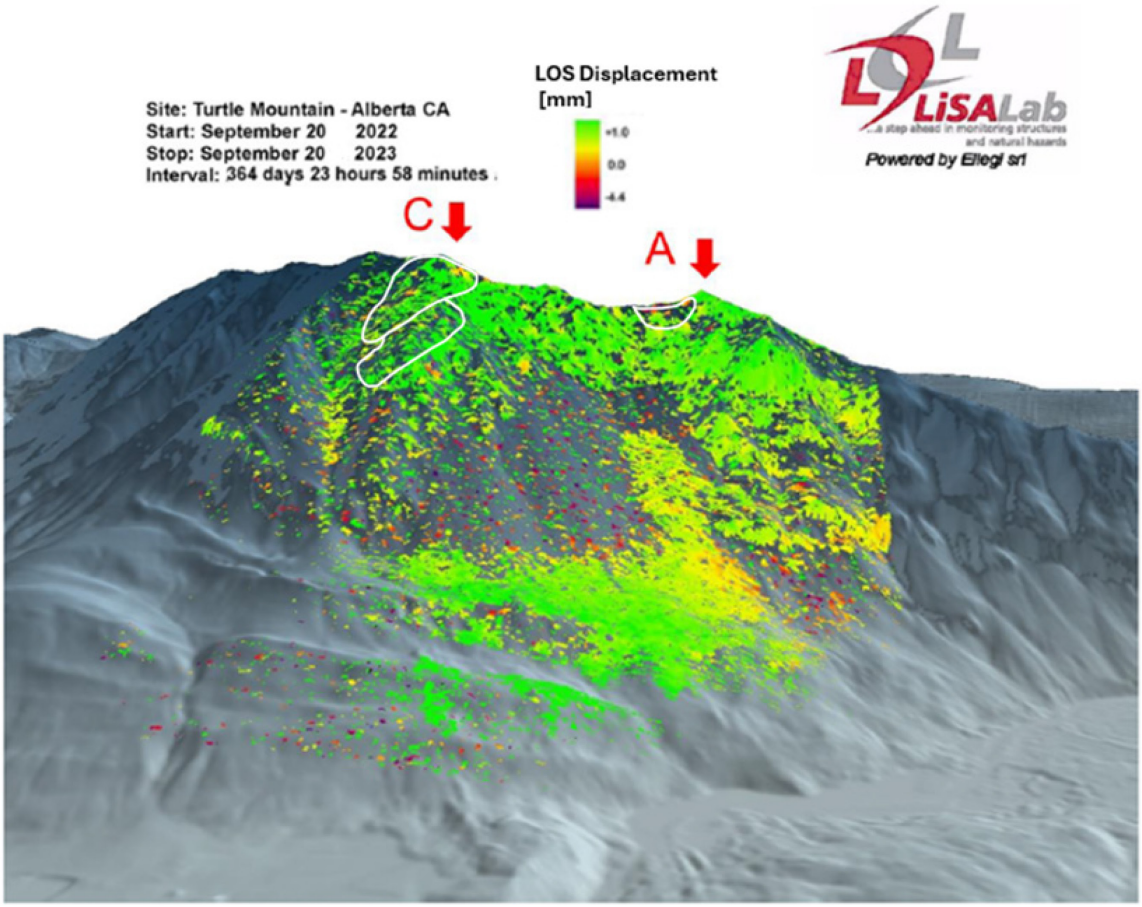


Figure 6. The line-of-sight (LOS) three-dimensional (3D) displacement map of Turtle Mountain, southwestern Alberta, shows the annual analysis of areas of large block movements (outlined in white) near regions A and C, from September 20, 2022, to September 20, 2023. White outlines added by authors. Abbreviation: CA, Canada.

4.2.4 Report to the End of Q38

The overall general displacements in Q38 were attributed to snow accumulation and there was no sign of anomalous accelerations on the ridge (Table 7). Regions A and B were stable during this quarter

(Table 8). During the winter months, the Crowsnest Pass area is known for large amounts of snow accumulation that impact the data. The cumulative displacement map (2014 to 2023; Figure 4) shows the largest part of the deformation occurred in the debris zone and elongated channels.

Table 7. LiSAmobile generalized displacement in regions of interest from June 20, 2014, to the end of Q38 on December 20, 2023 (3470 days), Turtle Mountain, southwestern Alberta.

Region	Location Description	Displacement (mm)	Approximate Region Area (m^2)
A	Close to North Peak	≤62.0	3405
B	Between North and South peaks	≤9.6	3034
C	Close to South Peak	≤83.9	8031
D	Below South Peak	≤80.1	10030
E	Debris area toe of North Peak rock wall	≤12.5	12928
F	Mid to lower vegetated rock wall	-	2865
G	Debris zone runout area	≤151.5	11494
H	Elongated channel (right) to the valley	≤333.1	17718
I	Elongated channel (left) to the valley	≤236.4	8684

Table 8. LiSAmobile measured displacement at POIs from June 20, 2014, to December 20, 2023 (3470 days), with observations specific to Q38, Turtle Mountain, southwestern Alberta.

Region	Point of Interest (POI)	Displacement (mm)	Displacement Description Specific to Q38
A	P_1 to P_4	40.8 to 235.9	Generalized stability in Q38.
B	P_5	≤24.3	Generalized stability with minor fluctuations in Q38.
C	P_6 and P_7	15.3 to 156.0	Negative displacement at P_6 influenced by snow cover in Q38.
D	P_8, P_21 to P_23	50.5 to 74.6	Generalized stability with minor fluctuations in Q38.
E	P_9, P_10, and P_17	≤201.3	Generalized stability with minor fluctuations in Q38.
F	P_11	-	Data are omitted due to errors introduced by atmospheric moisture within the line of sight or presence of vegetation.
G	P_12	≤144.4	Generalized stability in Q38.
H	P_18	≤426.5	Displacement caused by snow movement in Q38.
I	P_20	≤229.8	Generalized stability in Q38.

5 Supporting Studies and Research

During 2023, no secondary monitoring campaign was selected for supporting studies and research. The AGS selects secondary campaigns based on monitoring frequency and supplementary monitoring is predetermined on an annual basis.

6 Turtle Mountain Year-in-Review

Two time-lapse videos were produced by the AER showing a 12-month cycle of video clips taken daily at noon from the Bellevue and South Peak webcam video streams. These videos were created for educational purposes, to display the data collected from the tertiary monitoring system (web cameras), and to illustrate the daily changes on Turtle Mountain throughout the year. Links to the 2023 annual videos are available for download on the AGS website (https://ags.aer.ca/research-initiatives/turtle-

mountain-webcams). In addition, both videos are available for streaming on YouTube: at Bellevue (https://www.youtube.com/watch?v=qXfXiGFV70o) and at South Peak (https://www.youtube.com/watch?v=6XlwAS8N364).

7 Conclusions

Recent application of monitoring and modelling technologies has greatly increased the understanding of the existing rock-slope hazard at Turtle Mountain. The rate of displacement for large blocks is low and has remained relatively constant over the last decade of monitoring.

The Alberta Geological Survey will continue to work with Ellegi for maintenance and upgrades to LiSAmobile. At the end of each year, an internal review of LiSAmobile and its data is conducted and the TMMP's monitoring needs for the next year are assessed. This assessment will help with planning for the next year. Different forms of monitoring systems continue to be investigated.

Communication of the monitoring effort is also ongoing. The Alberta Geological Survey publishes the results in annual reports (e.g., Chao, 2022, 2023, 2024) and continues to collaborate with the Municipality of Crowsnest Pass council members and staff to provide information on the TMMP. Updates are also available on the 'Turtle Mountain Monitoring Program' page of the AGS website (https://ags.aer.ca/research-initiatives/turtle-mountain-webcams).

8 References

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