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Alberta Energy Regulator

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# Turtle Mountain Decommission Project, Alberta (NTS 82G): Summary Report and Historical Signs

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## Abstract

The Turtle Mountain Monitoring System (TMMS) is a near-real-time remote monitoring system that provides data from a network of sensors located at Turtle Mountain in the Crowsnest Pass, site of the 1903 Frank Slide. As of April 1, 2005, the Alberta Energy and Utilities Board, now the Alberta Energy Regulator (AER), through the Alberta Geological Survey (AGS), took ownership of this system and manages the Turtle Mountain Monitoring Program (TMMP). In July 2016, the TMMP transitioned from a near-real-time early warning system to a near-real-time remote monitoring system.

The TMMP conducts ongoing monitoring of Turtle Mountain's unstable eastern slopes, including an annual detailed review of the TMMS data stream. To help with this interpretation, the AGS has completed 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 provides information about the AER/AGS's ownership of the TMMS and serves as a historical record regarding the decommissioning of non-operational instrumentation on Turtle Mountain in June 2017. The objectives during the decommissioning of inactive equipment also included the installation of historical signs on South Peak, with the aim of educating hikers on the legacy of the TMMS from more than a decade of monitoring.

# 1 Project Summary

The purpose of the Turtle Mountain Decommission Project (TMDP) was to remove non-operational instrumentation and equipment located on Turtle Mountain. The addition of historical signs on South Peak provides public outreach to commemorate the historical monitoring (2003 to 2015) by the Turtle Mountain Monitoring System (TMMS). Lastly, the TMMS transitioned the ground-based InSAR (GB-InSAR), LiSAmobile, to the primary monitoring sensor in 2016. Additional documentation of the inoperable sensors and Turtle Mountain monitoring transition plan is provided in Wood et al. (2016, 2017a, b).

## 1.1 Background

In 2005, the AGS assumed responsibility for the long-term monitoring and study of a potentially large, slowly moving rockslide at Turtle Mountain. The initial priority of this program was to provide an early warning to the residents of the Crowsnest Pass in the event of a second catastrophic rock avalanche originating from South Peak. In July 2016, the TMMP transitioned from a near-real-time early warning system to a near-real-time remote monitoring system.

During the past decade, the AGS has been studying Turtle Mountain and providing on-call staff 24 hours a day. In July 2013, a one-day workshop about Turtle Mountain was held in Waterton, Alberta to review the previous decade of monitoring. Following the workshop, an independent panel of international experts prepared a report (Wood et al., 2016, Appendix 3) for the AGS providing recommendations for the current and future TMMP. The report outlines the characteristics and hazard assessment of the mountain site, reviews the early warning system practices, and makes recommendations for the future of the program. The panel found the risk of a large-scale rockslide to be very low. The transition to a near-real-time remote monitoring system will eliminate the requirement that staff be on call 24 hours a day and will allow the AGS to withdraw some non-operational monitoring equipment. More information on non-operational equipment previously identified by the AGS is provided by Wood et al. (2016, 2017a). The AGS is still responsible for long-term monitoring and retains the capacity for early warning if necessary.

In June 2014, the AGS leased a GB-InSAR system known as LiSAmobile (Figure 1) for a one-year probationary period, giving us time to review the equipment and monitoring system. During this period, monthly data updates and monitoring reports were produced on a quarterly basis. This one-year pilot period allowed the AGS to verify that the services and equipment provided by Ellegi Srl. were optimal for monitoring surface displacements and had the ability to withstand weather extremes in the Crowsnest Pass (for detailed information on the operation and data collected, see Wood et al., 2016, 2017a). LiSAmobile continues to collect high-quality data with limited interruptions since installation. In 2016, the AGS transitioned to using the LiSAmobile system as the primary monitoring system for the TMMS, with secondary monitoring campaigns selected by the AGS on an annual basis (Wood et al., 2017b). The AGS will continue to evaluate LiSAmobile and investigate newer forms of monitoring systems for the Turtle Mountain Field Laboratory (TMFL).

## 1.2 Goals

The primary goal was to remove non-operational and abandoned instruments and equipment from Turtle Mountain because of their inoperable state or generation of poor-quality data. Some non-operational instrumentation may have been collecting sporadic data, but such data are no longer used by the TMFL. Non-operational instruments were inventoried in 2016 and subsequently decommissioned and removed in June 2017. All instruments and equipment removed from the mountain were awaiting surplus admission in the fall of 2017. Remaining items that have no capital asset value will be disposed at a local eco-station.


**Figure 1. LiSAmobile, overlooking South Peak of Turtle Mountain, Crowsnest Pass, Alberta.**

The secondary goal was to work with the Government of Alberta, Frank Slide Interpretive Centre (FSIC) to create historical signs for members of the public who visit South Peak on Turtle Mountain. These signs provide information on the historical monitoring program and transition to a near-real-time remote monitoring system.

## 1.3 Scope of Work

In-scope work included the removal of low-risk non-operational equipment and restoration of the TMFL on South Peak to its near-original state. Removal of equipment in high-risk areas, as previously identified by the Turtle Mountain team during a reconnaissance visit in 2016 was out of scope.

Project constraints were highly variable due to the possibility of harsh weather conditions on Turtle Mountain. Weather is extremely volatile and difficult to predict. Sudden storms and high winds present the most substantial complications for the project. Weather is deemed favourable in the early morning, but massive storms can suddenly develop by early afternoon. The weather was monitored every hour, and constant communication with the helicopter pilot was mandatory. All field-crew members were prepared for the possibility of an emergency weather evacuation and were prepared to descend the mountain quickly by foot or helicopter. Effective communication on the mountaintop was critical between all members. Flights were determined at the discretion of the pilot for all passenger and slinging flights.

Other constraints included the very loose and brittle rock and unstable terrain found on Turtle Mountain. All field-crew members were required to read the *Turtle Mountain Field Laboratory Safety Manual* (Alberta Geological Survey, 2016) and implement all safety measures while on the mountaintop. Equipment located in areas of easy to moderate accessibility were decommissioned. Stations that required special climbing gear or rappelling systems were not removed.

## 1.4 Project Contributors

Two companies were contracted to provide services and support for the TMDP. NavStar Geomatics Ltd. was contracted to provide decommission support for the differential GPS (dGPS) stations, and general clean-up of NavStar equipment. Ascent Helicopters Ltd. was contracted to provide all passenger and equipment slinging services on the mountain.

# 2 Decommission

## 2.1 Web Camera

One group of two AGS employees was tasked with the replacement of the web camera located at South Peak (Figure 2a). The previous Mobotix M22 camera was replaced with a newer M25 model. The decision to replace the web camera was based on several reoccurring issues with the older M22 model, including:

- poor image quality as a result of low megapixels and outdated technology,
- constant unexplained reboots of the camera, and
- inadequate communication transmissions to the AER network.

Replacement of the web camera installation was straightforward, with the new camera solving the above problems and producing a higher quality video stream (Figure 2b).

## 2.2 Weather Station and Safety Barrels

The second group focused on disassembling the weather station and replenishing the safety supplies in the safety barrel. The weather station is located on the west side of the ridge crest, approximately 3 m below the hiking path connecting South and Third Peaks. As seen in Figure 3a, the weather station is attached to a 3 m high extended tripod that is secured to the rock face with steel cables. It houses instrumentation such as a wind monitor, solar radiation probe (pyranometer), temperature/relative humidity probe, solar panel, batteries, and a plastic enclosure for multiplexors, dataloggers, barometer, and a transmission radio. This instrumentation collected and transmitted data on rainfall, wind direction and speed, temperature, and barometric pressure to complement data collected by other components of the monitoring system on the mountain.

The decommissioning of the weather station began with the detachment of the power supply and removal of the electrical cables that were connecting batteries with the solar panel and instruments. After the electronic equipment was disconnected, batteries were removed from their protective enclosure and transported to the nearest slinging area (Figure 3b). The rock temperature probe could not be safely accessed, so its conduit was cut as close to the source as possible and the probe was left untouched.

Cleanup at the site included removal of a metal tool chest and such smaller items as electrical wiring, nuts, and bolts. Conduit and other long electrical wires were rolled up and taped for safe transportation by helicopter.

The tripod structure for the weather station (including steel tension cables), solar panels, wind monitor, and the empty plastic enclosure were left behind as part of the educational display for the public on the history of the TMMP.

If hikers or visitors become stranded on top of Turtle Mountain as a result of injury, fatigue, or change in weather conditions, they can access a survival kit housed in two blue waterproof plastic safety barrels near the weather station, one of which is shown in Figure 4. The kit includes items such as a utility knife, utensils, broadcast radio, flashlight, batteries, blankets, sleeping bags, waterproof matches, water and purification tablets, wick candles, camp stove with fuel, heat packs, and basic first-aid kit.



**Figure 2. a) Replacement of the South Peak web camera. b) Image from the new South Peak web camera.**

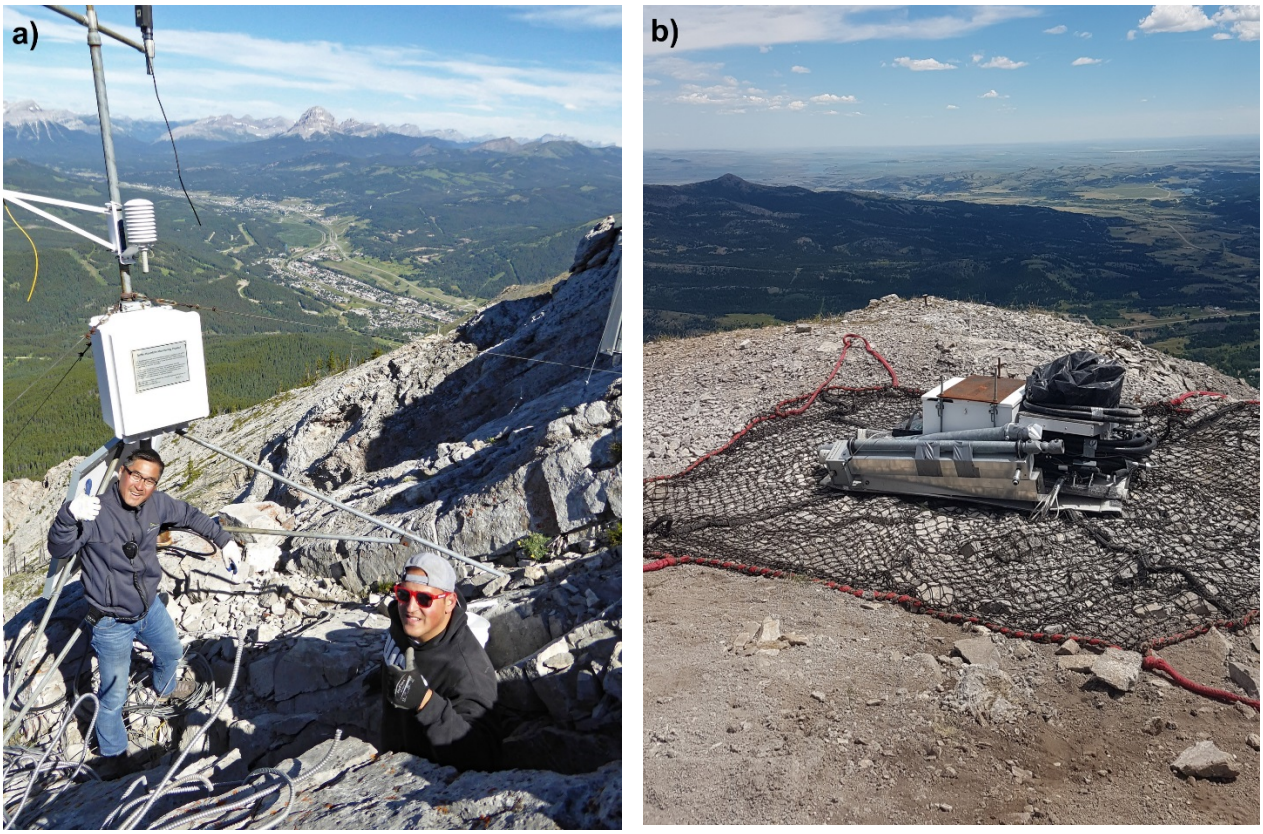


**Figure 3. a) AGS field staff dismantling the weather station electronics and instrumentation. b) Non-operational equipment awaiting removal from Third Peak via helicopter sling.**

**Figure 4. One of the two safety survival barrels located in the cracks near the weather station.**

These survival barrels also contain an approximately 48-hour supply of high-energy food rations for two people (or four people for 24 hours), including instant coffee and soup packages, hot chocolate, mixed nuts, sugar, and granola bars. All consumables are vacuumed sealed, and most of them will not expire until 2020. All expired rations, such as granola bars and mixed nuts, were removed and replaced with a fresh stock. An inventory of the emergency barrels was conducted and the internal inventory was updated to reflect these changes in the *Turtle Mountain Field Laboratory Safety Manual* (Alberta Geological Survey, 2016) in 2017.

## 2.3 Borehole

The third group focused on dismantling the borehole, located approximately 10 m below the South Peak monitoring station. As seen in Figure 5, the borehole station consisted of a solar panel, battery boxes, dataloggers, multiplexors, and a wireless router, which served as the data collection and transmission site for the monitoring sensors: crackmeters, extensometers, and tiltmeters.

To decommission the station, the battery and solar panel were disconnected, followed by all sensor connections. The dataloggers, multiplexors, and the router were left in the enclosure for ease of transport. The conduit housing the wires to each of the external sensors was then disconnected from the metal enclosure. Once all connections were severed, the guy-wires were loosened and the main mast was disconnected. When the mast was free, the enclosure and solar panel were separated from the mast to prepare them for slinging.

## 2.4 Crackmeters, Extensometers, and Tiltmeters

The remaining AGS crew was responsible for dismantling the crackmeters, extensometers, and tiltmeters. All 22 crackmeters remain on the mountain due to their remote and concealed locations. Four surface-wire extensometers and seven tiltmeters were removed from the mountain due to their relative ease of access.

**Figure 5. AGS field crew dismantling the borehole hub and conduit lines leading to multiple monitoring-equipment locations.**

An extensometer consists of a narrow metal enclosure at one end and a plastic head at the other, both of which were cut near the base of the equipment. Tiltmeters consist of a small waterproof enclosure that is attached to the face of the mountain by two screws. Once disassembled, all of the sensors were brought to the closest slinging area where conduit was rolled and taped together for safe transportation. The remaining two extensometers and three tiltmeters remain as part of the educational display for the public on the historical monitoring program. Locations of the monitoring sensors on Turtle Mountain are shown in Figure 6 and the exact co-ordinates of the sensors are provided in Table 1.

### 2.5 Differential GPS

Three employees from NavStar Geomatics Ltd. were responsible for decommissioning the dGPS network of sensors. Each of these stations consists of three parts: a GPS antenna mounted on a concrete pillar, an electronic box containing batteries and telemetry instruments, and a solar panel providing power to the station. Six out of ten stations were disassembled due to their ease of access. Station removal included dismantling the GPS antennas, solar panels, and electronic boxes, and removing all conduit cables from the station, leaving only the concrete pillar in place. The remaining four stations are considered out of scope, due to their locations; therefore, only the battery enclosures, electronics, and conduit were removed. Figure 7a shows a fully assembled dGPS station, while Figure 7b shows a partially dismantled station that was left as part of the educational display for the public on the historical monitoring program.

### 2.6 Clean-up

One of the critical components of the decommission project was the clean-up and transportation of the equipment from the mountaintop to the valley below. Several locations on the mountain were selected as slinging and staging areas. They were chosen according to their relative flatness, ease of access for the helicopter, lack of trees, and general visibility from the surroundings (Figure 8).

Due to the potential risks of the operation, constant communication between the helicopter pilot and the field leaders was mandatory. To further increase everyone's safety, a limited number of employees were allowed to be near the slinging area and responsible for equipment loading. All employees were required to wear safety vests for maximum visibility from the helicopter.

A group of three field-crew members was located at the base of the mountain and responsible for unloading the cargo nets, organizing materials, and packing the trailers according to the *Turtle Mountain Field Laboratory Safety Manual* (Alberta Geological Survey, 2016). Final packing of the trailers is shown in Figure 9.

The remaining field-crew members were responsible for the final clean-up of the mountain, which involved picking up screws and bolts misplaced while the equipment was being dismantling, picking up garbage left by hikers, and cleaning and organizing the equipment awaiting pickup from the helipad.

## 3 Outcomes

### 3.1 Historical Signs

Six historical signs were created in collaboration with the Frank Slide Interpretive Centre (FSIC) that provide information and education to hikers on the historical monitoring equipment that remains in place. The signs were printed on aluminum, weather-resistant material and attached to rocks on South Peak (Figure 10) with weather-resistant bolts. Sign locations were chosen with the FSIC for ease of access to hikers.

### 3.2 Surplus Inventory

All decommissioned items were brought back to the AER/AGS Mineral Core Research Facility (MCRF) for either surplus as capital/noncapital assets or to repurpose for other use at the AGS. Items for surplus

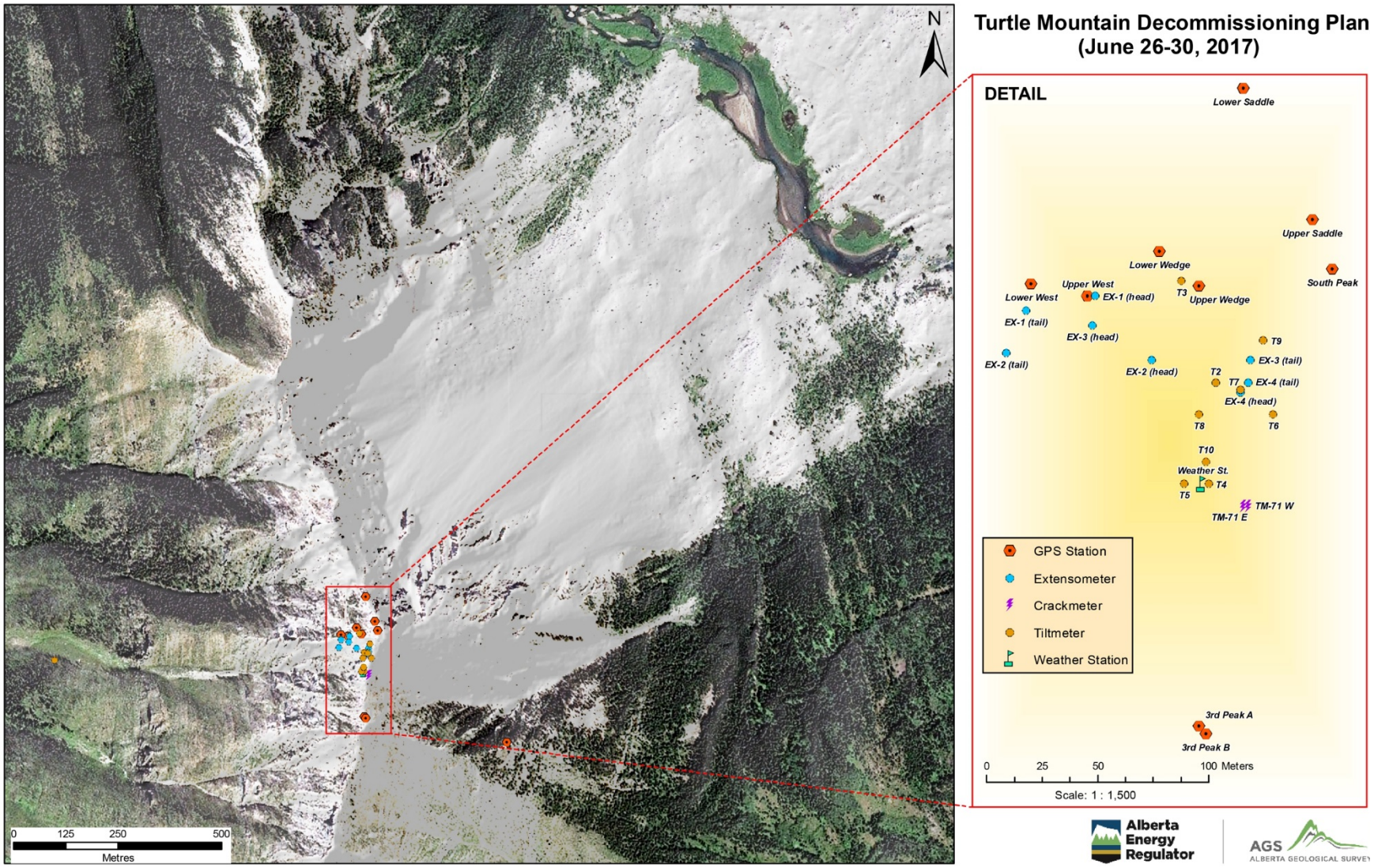


**Figure 6. Locations of monitoring equipment on Turtle Mountain, near South Peak.**

**Table 1. Location and status of the Turtle Mountain monitoring equipment. Decommissioned stations were either partially decommissioned (e.g., dGPS stations), leaving only concrete pillars, or fully disassembled (e.g., extensometers, and tiltmeters). Various pieces of equipment were left as historical examples of monitoring due to their inaccessibility. The weather station was also partially decommissioned, leaving the external structure behind. All of the crackmeters remain on the mountain due to their inaccessibility. Remaining historical stations have had their electronics and batteries removed.**

| Monitoring Network | Station Name | Location | | Station Status |
|---|---|---|---|---|
| | | Latitude | Longitude | |
| Differential GPS | Ridge | 49.57660 | –114.40786 | Historical |
| | Upper Wedge | 49.57904 | –114.41256 | Decommissioned |
| | Lower Wedge | 49.57918 | –114.41272 | Decommissioned |
| | Upper West | 49.57900 | –114.41301 | Decommissioned |
| | Lower West | 49.57905 | –114.41324 | Decommissioned |
| | South Peak | 49.57911 | –114.41202 | Historical |
| | Upper Saddle | 49.57931 | –114.41210 | Historical |
| | Lower Saddle | 49.57984 | –114.41238 | Historical |
| | 3rd Peak A | 49.57726 | –114.41256 | Decommissioned |
| | 3rd Peak B | 49.57723 | –114.41253 | Decommissioned |
| Extensometers | EX-1 (head) | 49.57900 | –114.41298 | Decommissioned |
| | EX-1 (tail) | 49.57894 | –114.41326 | Decommissioned |
| | EX-2 (head) | 49.57874 | –114.41275 | Historical |
| | EX-2 (tail) | 49.57896 | –114.41334 | Historical |
| | EX-3 (head) | 49.57888 | –114.41299 | Decommissioned |
| | EX-3 (tail) | 49.57874 | –114.41235 | Decommissioned |
| | EX-4 (head) | 49.57865 | –114.41236 | Historical |
| | EX-4 (tail) | 49.57861 | –114.41239 | Historical |
| Tiltmeters | T1 | 49.57870 | –114.41278 | Decommissioned |
| | T2 | 49.57865 | –114.41249 | Historical |
| | T3 | 49.57906 | –114.41263 | Decommissioned |
| | T4 | 49.57824 | –114.41252 | Decommissioned |
| | T5 | 49.57824 | –114.41262 | Decommissioned |
| | T6 | 49.57852 | –114.41226 | Decommissioned |
| | T7 | 49.57862 | –114.41239 | Decommissioned |
| | T8 | 49.57852 | –114.41256 | Decommissioned |
| | T9 | 49.57882 | –114.41230 | Historical |
| | T10 | 49.57833 | –114.41253 | Historical |

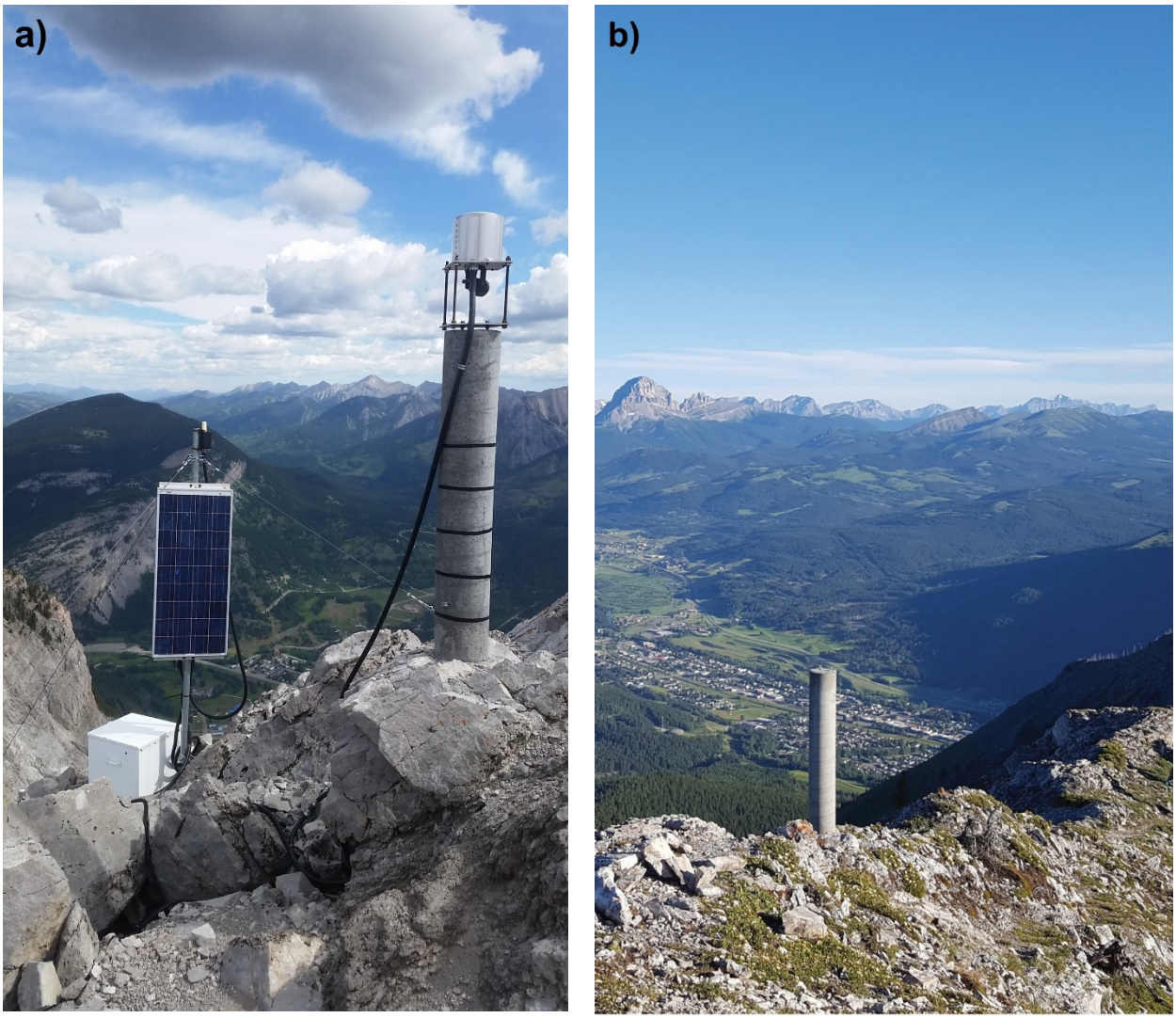


**Figure 7. a) Fully assembled dGPS station in 2016. b) Partially dismantled dGPS station, with only the cement pillar remaining.**

included functioning equipment from the mountain, such as solar panels, batteries, conduit and various sensors. The metal and plastic enclosures that housed the electronics on the mountain were stored at the MCRF, with the intent of being used in future by the AGS.

# 4 Conclusion

Recent application of modern characterization, monitoring, and modelling technologies has dramatically increased our understanding of the existing rock-slope hazard at Turtle Mountain. The successful decommissioning of non-operational instrumentation on Turtle Mountain concludes the transition from a mountain-based early warning system to a remote monitoring system.

The AGS will continue to investigate different forms of monitoring systems for the TMFL and will continue to provide primary, secondary, and tertiary monitoring. This report is written for historical education and is accurate to the best of our knowledge.

**Figure 8. Equipment removal from South Peak by helicopter.**

**Figure 9. Equipment loaded onto trailers for transportation back to Edmonton.**


**Figure 10. Sign installed on South Peak commemorating the Town of Frank, devastated by the Frank Slide of 1903.**

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