Thermal controls on the development of fractures in dolostones of the Niagara Escarpment, Hamilton, Ontario, Canada

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INTRODUCTION

The Niagara escarpment is a Paleozoic sedimentary landform composed of dolostones, shales, and sandstones (Fig 1) which spans temperate Southern Ontario and the northeastern United States (Fig. 2). Little work has been conducted to clarify the mechanism, extent, or factors involved in fracturing of the escarpment. We sought to assess whether weathering mechanisms such as freeze-thaw weathering and thermal stress contribute to fracturing on the escarpment in Hamilton, Ontario, as has been observed in numerous cold climates (Hall and Thorn 2013; Matsuoka 2019).

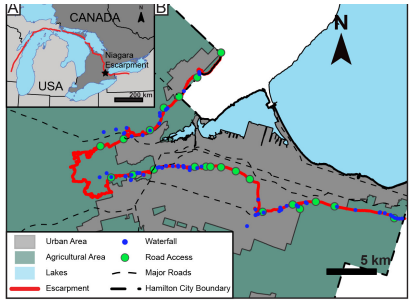


Fig. 1

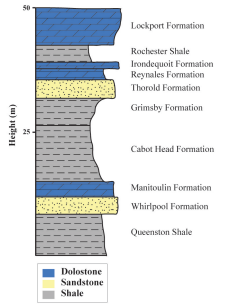


Fig. 2

METHODS

- We installed HOBO MX-2303 dual-thermistor data loggers to measure rock surface and fracture temperature *in* situ at exposures on the escarpment (*Fig. 3a, 3b*) and in dolostone blocks under controlled outdoor conditions *(Fig. 3c*)
- Temperature was recorded in 1-minute intervals to examine short-scale thermal stress and long-term freeze-thaw cycles.

Fig. 3a



Fig. 3b



Fig. 3c



RESULTS

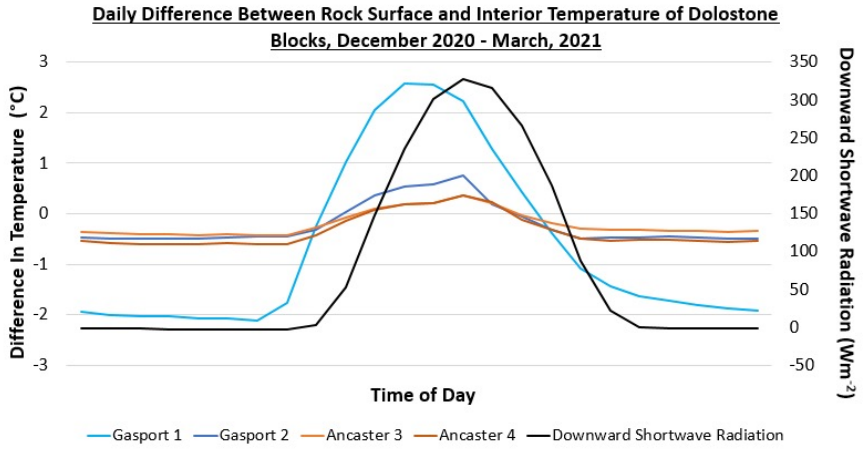


Fig. 4

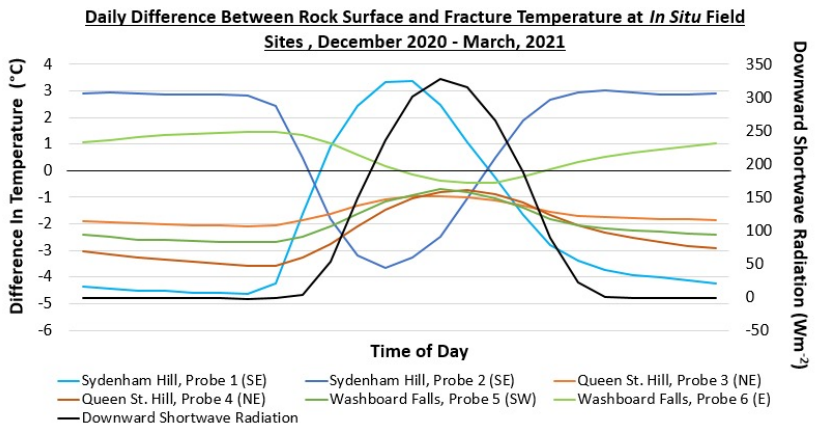


Fig. 5

RESULTS

Figure 4:

- Rock surface and interior temperature follow diurnal trends in radiation in magnitude and timing
- The temperature gradient is relatively small in most of the dolostone blocks

Figure 5:

- Rock surface and fracture temperature follow diurnal trends in radiation in magnitude and timing with a **lag time**
- The temperature gradient is larger between surface and fracture at southeasterly aspects

DISCUSSION

- Field data from in-situ sites shows a clear relationship between **aspect**, fracture and rock surface temperature
- The difference in temperature observed between the interior of experimental blocks and pre-existing fractures in the field illustrates that **fracture structure influences temperature** rather than simply depth into the rock
- We observed few instances with a temperature gradient of 1°C/min or greater, suggesting that **thermal stress is unlikely** the mechanism of weathering
- Further research will elucidate the features of fractures which control the temperature gradient from the surface

REFERENCES

Hall, K., & Thorn, C. E. (2014). Thermal fatigue and thermal shock in bedrock: An attempt to unravel the geomorphic processes and products. Geomorphology, 206, 1–13. https://doi.org/10.1016/j.geomorph.2013.09.022
Matsuoka, N. (2019). A multi-method monitoring of timing, magnitude and origin of rockfall activity in the Japanese Alps. Geomorphology, 336, 65–76. https://doi.org/10.1016/j.geomorph.2019.03.023

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