Fracture-controlled erodibility, great rock climbing

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Matthes Crest, just south of Tuolumne Meadows, is a famous climbing locality. The ridge owes its prominence to the glacial erosion of tabular fracture clusters lying on either side of it. Credit: Frank Klein.

Tuolumne Meadows in Yosemite National Park is an iconic American landscape: It is a sub-alpine meadow surrounded by glacially sculpted

granitic outcrops in the Sierra Nevada Mountains. Because of its accessibility and aesthetic appeal, it is a focal point for both vacationers (up to 4,200 people per day) and geoscientists. It also has historical significance: The idea for a Yosemite National Park came to John Muir and Robert Underwood Johnson over a campfire there.

As the largest sub-alpine meadow in the Sierra Nevada, Tuolumne Meadows is also a geomorphic anomaly: The presence of broad and open topography is commonly associated with bedrock erodibility. In contrast, the nearby vertical rock walls—including Cathedral Peak, Matthes Crest, and Lembert Dome—suggest bedrock durability. Despite these geomorphic differences, the entire region is underlain by the same lithology, the Cathedral Peak Granodiorite.

In this new study published in the November 2014 issue of GSA Today, authors Richard A. Becker, Basil Tikoff, Paul R. Riley, and Neal R. Iverson present evidence that this anomalous landscape is the result of preferential glacial erosion of highly fractured bedrock. In particular, tabular fracture clusters (TFCs) are common in the Cathedral Peak Granodiorite in the Tuolumne Meadows area. TFCs are dense networks of sub-parallel opening-mode fractures that are clustered into discrete, tabular (book-like) zones.

The authors conclude that Tuolumne Meadows resulted from ice flowing perpendicularly to high TFC concentrations. In contrast, ice flowing parallel to variable TFC concentrations formed the vertical rock walls. Thus, the exceptional rock climbing around Tuolumne Meadows is a direct result of fracture-controlled variations in erodibility—on the 10 meter to 100 meter scale—within a single lithology. This finding supports the contention that landscape evolution is strongly controlled by bedrock fracturing and that tectonic processes that result in fracturing may generally exert a fundamental and underappreciated role in geomorphology.

More information: "Preexisting fractures and the formation of an iconic American landscape: Tuolumne Meadows, Yosemite National Park, USA." *GSA Today*. DOI: 10.1130/GSATG203A.1

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