

## THE CENOZOIC UPLIFT HISTORY OF THE TETON RANGE: CALIBRATION AND APPLICATION OF FISSION-TRACK GEOTHERMOMETRY

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### Objectives

The Teton Range has experienced at least two pulses of uplift during the Cenozoic era. The earliest uplift, around 50–60 Myr ago, was associated with the Laramide Orogeny, and it produced an unknown amount of uplift of the ancestral Teton–Gros Ventre Range. The more recent uplift is a Plio–Pleistocene phenomena, in which several thousand meters of uplift can be documented through offsets of isochronous strata. During these pulses of uplift, the range has been differentially warped, such that the center of the range has been uplifted to a greater extent than the northern and southern terminations of the range. This differential uplift can be easily delineated by tracing the Precambrian–Cambrian unconformity along the axis of the range as it ascends from either end towards its highest point in the center.

This geologic framework provides an excellent setting in which to use fission-track dating to evaluate the thermal and uplift history of the range. In addition, because of the good control on the amount of differential uplift of the central portion of the range versus its northern and southern ends, this setting provides an opportunity to evaluate the accuracy of the fission-track method as a tool for assessing uplift. The objectives of this research are, therefore, two-fold. First, fission-track dating of apatite and zircon separates will be used to assess the thermal and uplift history of the range. Second, the fission-track results will be used to assess the reliability of the method in discriminating differential amounts of uplift within a relatively restricted area.

### Methods

Apatite has an annealing temperature of approximately 100–200°C, whereas zircon has an annealing temperature of approximately 200°C. At temperatures below these limits, these minerals will retain their fission-tracks for geologically long periods of time. When a mountain mass is uplifted and cooled, first the zircon and later the apatite cool through these temperature thresholds and begin to retain their fission-tracks. Therefore, dates on these minerals reveal when they passed through these annealing temperatures. Given certain assumptions about the local geothermal gradient, these dates of annealing can yield data on uplift rates.

Two methods are commonly used. In the first, zircons and apatites are separated

from individual rock samples collected along the length of the range. Dates on these provide a thermal history which can then be interpreted in terms of uplift. A more direct assessment of uplift can be obtained by using "relief sections". In this method, samples are collected as to yield large vertical elevation differences between the adjacent samples. Following dating, ages associated with various heights can be directly translated into an uplift history. Both approaches were used in this study.

### Results

During the summer of 1985, approximately 250 kilograms of samples were collected from 25 sites. The majority of these were collected within several hundred meters of the valley bottom in a traverse running from the base of Mt. Moran in the north to Phillips Canyon in the south. Two relief sections were collected. One traversed the southeast face of Buck Mountain and provided a relief section of about 1500 m. The second was along the east face of Mt. Moran and provides a vertical relief of approximately 1700 m. In addition, samples were collected from bedrock exposures in easily accessible portions of the Gros Ventre Range. Because it was not known which rock types would yield the most suitable apatite and zircon for this study, granites, gneisses, and diabases were collected at numerous different sites. In addition, where the Precambrian-Cambrian of conformity was encountered, samples were collected from the Flathead Sandstone. Although this rock contains detrital minerals, if it has been heated sufficiently (above the annealing temperatures), it could also yield useful age information. These samples are presently in the process of being crushed, separated, mounted, polished, etched, and irradiated. Age determinations will not be available from them until Spring, 1986. We anticipate that these initial results will enable us to identify those lithologies which are best suited for fission-track studies and will allow us to focus our future collecting efforts on areas likely to yield the most useful data. It is our intent to expand the grid of sampling both farther north along the range front and to the west into the interior of the range.

### Conclusions

A study has been initiated to assess the Cenozoic uplift history of the outrange. This history will be based on annealing dates for zircon and apatite minerals collected along the length, breadth, and height of the range. The anticipated results should aid us not only in interpreting the deformational history of the range, but also should permit an assessment of the resolution of the fission-track method in a well controlled geological context.