

The Gothic Dome: Kilometer-scale Miocene Exhumation in Colorado’s Elk and West Elk Mountains

Lon Abbott¹, Rebecca Flowers², James Metcalf², Coleman Hiett³, Robert Kelleher⁴, Hector Camm⁵, Mitchell Ramba⁶, Noah McCorkel⁷, and Edward Riccio¹

¹University of Colorado at Boulder

²Univ of Colorado at Boulder

³Utah State University

⁴University of Colorado

⁵University College London

⁶Sibanye-Stillwater

⁷Y2 Consultants

November 22, 2022

Abstract

The Colorado Rockies were initially raised during the Laramide Orogeny ca. 70-45 Ma. But consensus exists that the range experienced a second, post-Laramide episode of surface uplift; the timing and cause of that post-Laramide surface uplift event remains enigmatic. Low-temperature thermochronologic studies conducted by us and others using apatite (U-Th)/He (AHe), apatite fission track (AFT), and zircon (U-Th)/He (ZHe) techniques reveal that a dome of kilometer-scale exhumation occurred in Colorado’s Elk and West Elk mountains between ca. 18-6 Ma. We call this feature the “Gothic Dome” because it is centered on Gothic Mountain, near the town of Crested Butte. We suggest the ~100-km-diameter Gothic Dome likely experienced Miocene surface uplift, which triggered the dome-shaped exhumation pattern documented by the low-temperature thermochronometry. The exhumation magnitude exceeds 4 km in the center of the dome (as revealed by a 16 Ma ZHe date on an Oligocene pluton) and diminishes toward its perimeter. This diminution of exhumation magnitude toward the perimeter is revealed by progressively older AHe, AFT, and ZHe dates in all directions away from Gothic Mountain. AHe dates for samples that lie outside the perimeter are Laramide-age or older, further documenting the dome-shaped nature of this Miocene exhumation event and illustrating the low magnitude of Miocene to recent exhumation outside the dome’s perimeter. Outcrops of ca. 11 Ma basalt surround the Gothic Dome to the north, west, and south, requiring that Miocene exhumation outside the dome’s perimeter was minimal. A suite of alkaline, low-volume, felsic plutons and ultramafic lamprophyres intruded the Gothic Dome between ca. 18-12 Ma. This alkalic magmatism began either immediately prior to or contemporaneous with the onset of Gothic Dome exhumation, hinting that the same root cause might be responsible for both. Workers elsewhere, including Tibet, the Altiplano, and California’s Sierra Nevada mountains, have attributed small-volume alkalic magmatism, surface uplift, and exhumation to the activity of lithospheric drips. We offer that Miocene activity of such a drip beneath Colorado’s Elk and West Elk mountains is an appealing mechanism to explain the near simultaneity of those same phenomena here.

Please Review Your Abstract Submission. If The Abstract Is Final, Click "Submit Abstract" To Complete Your Submission.

- You May Review Or Modify Your Submission Until The Deadline Of 4 August 2021 23:59 EDT/03:59 +1 GMT. After This Date, No Further Edits Will Be Made To The Submission.
- You Must Click "Submit Abstract" Below Or The Abstract Will Not Be Considered For Review Unless Fully Submitted By The Deadline.

Submit Abstract

The Gothic Dome: Kilometer-scale Miocene Exhumation in Colorado's Elk and West Elk Mountains

Lon D Abbott¹, Rebecca Marie Flowers², James Metcalf², Coleman Hiatt³, Robert Kelleher⁴, Hector Camm⁵, Mitchell Ramba⁶, Noah McCorkel⁷ and Edward Riccio⁸, (1)University of Colorado at Boulder, Boulder, CO, United States, (2)Univ of Colorado at Boulder, Department of Geological Sciences, Boulder, CO, United States, (3)Utah State University, Department of Geosciences, Logan, UT, United States, (4)University of Colorado, INSTAAR, Boulder, CO, United States, (5)University College London, Energy Systems and Data Analytics, London, United Kingdom, (6)Sibanye-Stillwater, Columbus, MT, United States, (7)Y2 Consultants, Jackson, United States, (8)University of Colorado at Boulder, Geological Sciences, Boulder, CO, United States

Abstract Text:

The Colorado Rockies were initially raised during the Laramide Orogeny ca. 70-45 Ma. But consensus exists that the range experienced a second, post-Laramide episode of surface uplift; the timing and cause of that post-Laramide surface uplift event remains enigmatic. Low-temperature thermochronologic studies conducted by us and others using apatite (U-Th)/He (AHe), apatite fission track (AFT), and zircon (U-Th)/He (ZHe) techniques reveal that a dome of kilometer-scale exhumation occurred in Colorado's Elk and West Elk mountains between ca. 18-6 Ma. We call this feature the "Gothic Dome" because it is centered on Gothic Mountain, near the town of Crested Butte. We suggest the ~100-km-diameter Gothic Dome likely experienced Miocene surface uplift, which triggered the dome-shaped exhumation pattern documented by the low-temperature thermochronometry. The exhumation magnitude exceeds 4 km in the center of the dome (as revealed by a 16 Ma ZHe date on an Oligocene pluton) and diminishes toward its perimeter. This diminution of exhumation magnitude toward the perimeter is revealed by progressively older AHe, AFT, and ZHe dates in all directions away from Gothic Mountain. AHe dates for samples that lie outside the perimeter are Laramide-age or older, further documenting the dome-shaped nature of this Miocene exhumation event and illustrating the low magnitude of Miocene to recent exhumation outside the dome's perimeter. Outcrops of ca. 11 Ma basalt surround the Gothic Dome to the north, west, and south, requiring that Miocene exhumation outside the dome's perimeter was minimal. A suite of alkaline, low-volume, felsic plutons and ultramafic lamprophyres intruded the Gothic Dome between ca. 18-12 Ma. This alkalic magmatism began either immediately prior to or contemporaneous with the onset of Gothic Dome exhumation, hinting that the same root cause might be responsible for both. Workers elsewhere, including Tibet, the Altiplano, and California's Sierra Nevada mountains, have attributed small-volume alkalic magmatism, surface uplift, and exhumation to the activity of lithospheric drips. We offer that Miocene activity of such a drip beneath Colorado's Elk and West Elk

mountains is an appealing mechanism to explain the near simultaneity of those same phenomena here.

Plain-Language Summary:

When and how the Colorado Rockies were uplifted to their present height remains unknown. We present data on the range's erosion history that provides one clue to help solve that mystery

Session Selection:

EP031. Reconstructing mountain belts tectonics and climate

Submitter's E-mail Address:

lon.abbott@colorado.edu

Abstract Title:

The Gothic Dome: Kilometer-scale Miocene Exhumation in Colorado's Elk and West Elk Mountains

Requested Presentation Type:

Assigned by Program Committee (oral, eLightning or poster discussion session)

Previously Published?:

No

Abstract Payment:

Paid (agu-fm21-1002048-6776-1766-3576-1911)

I do not want to be involved in the OSPA program as a judge (students will be able to opt-into the OSPA program in October).

First Presenting Author***Presenting Author***

Lon D Abbott

Primary Email: lon.abbott@colorado.edu

Affiliation(s):

University of Colorado at Boulder

Boulder CO 80309-0399 (United States)

Second Author

Rebecca Marie Flowers

Primary Email: rebecca.flowers@colorado.edu

Affiliation(s):

Univ of Colorado at Boulder

Department of Geological Sciences

Boulder CO 80309-0000 (United States)

Third Author

James Metcalf

Primary Email: james.metcalf@colorado.edu

Affiliation(s):

Univ of Colorado at Boulder

Department of Geological Sciences

Boulder CO (United States)

Fourth Author

Coleman Hiett

Primary Email: coleman.hiett@gmail.com

Affiliation(s):

Utah State University

Department of Geosciences

Logan UT 84322 (United States)

Fifth Author

Robert Kelleher

Primary Email: Robert.Kelleher@colorado.edu

Affiliation(s):

University of Colorado

INSTAAR

Boulder CO 80309-0450 (United States)

Sixth Author

Hector Camm

Primary Email: hector.camm@colorado.edu

Affiliation(s):

University College London

Energy Systems and Data Analytics

London (United Kingdom)

Seventh Author

Mitchell Ramba

Primary Email: Mitchell.Ramba@colorado.edu

Affiliation(s):

Sibanye-Stillwater
Columbus MT 59019 (United States)

Eighth Author

Noah McCorkel
Primary Email: noah@y2consultants.com

Affiliation(s):

Y2 Consultants
Jackson 83001 (United States)

Ninth Author

Edward Riccio
Primary Email: Edward.Riccio@colorado.edu

Affiliation(s):

University of Colorado at Boulder
Geological Sciences
Boulder CO 80309 (United States)

FINAL STEPS

1. **Check spelling and contact information.**
2. **Make necessary corrections:**
 - Select the step in the Abstract Control Panel that you wish to edit (e.g., Authors, Abstract Details)
 - Edit the information and click the submit button.
3. **Click [here](#) to print this page now.**