Friends Board Members

Patty Glatfelter
Leadership Team

Wayne Johnston
Web Master

Linda Laverty
Rick Wilson
Membership

Sally McCracken
Leadership Team

Jerry McLain

Bev Harms
Secretary

Michelle Speck
Newsletter Editing

Cheryl Petersen
Jan Beals
Treasurer / Leadership Team

Jean Rodeck
Member Emeritus

John Schwabe
Project Coordinator

Wendie Warner
Technology Coordinator

Gary Censoplano

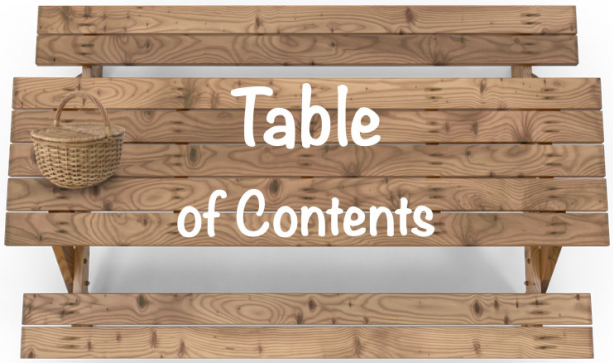
Therese Johnson

Team Contributors
Newsletter

The staff and volunteers of the Florissant Fossil Beds would like to extend a sincere thank you to each member of the Friends of the Fossil Beds. Your interest and support of our local National Monument help ensure continued public enjoyment and accessibility to the wonders of nature and the unique natural history to be found within the Florissant Fossil Beds.

"Again,we have such a choice to make and an opportunity to preserve for ourselves and our posterity the scenic beauty, the recreational resources and, perhaps most important, the distinctly unique and irreplaceable remnants of an era of a million years ago."

(Statement by Greg Chancellor during 1969 Hearing to establish the Florissant Fossil Beds as a National Monument)



TOC at bottom of each page returns to this page

The Newsletter staff encourages submission of articles related to the Fossil Beds.

Our next publication date is June 20, 2024.

Please contact us here.

Estella Leopold
1927 - 2024
A Life Well Lived
A Lasting Legacy

Estella Bergere Leopold, paleoecologist and conservationist, passed away late on February 25th, 2024 at the age of 97. Estella combined a distinguished scientific career with a lifelong commitment to the land ethic philosophy of her father, renowned ecologist and writer Aldo Leopold. Her work led her to leadership roles in the establishment of Florissant Fossil Beds and Mount St. Helens national monuments. Elected in 1974 to the National Academy of Sciences, she was honored in 2010 in Osaka, Japan, with the International Cosmos Prize.

Read full article and obituary here

Estella with guitar in 1936

Estella with Poco in 1938

Estella Jr with IES students in Shack 1970

Estella at the Shack Campaign in 2005

Images from Aldo Leopold Foundation Website

Meet A NPS Staff Member
Jeffrey Wilson / Facility Manager

I grew up in a small town in northern Arizona called Page, which is close to the Utah border. The two states share a National Park unit called Glen Canyon National Recreation Area (GLCA) and that is where I started in the National Park Service (NPS) in 2007. Before the NPS I was in the U.S. Army, stationed at Fort Campbell Kentucky as an infantryman with the 2nd 502 infantry Regiment. After the military I learned the electrical trade in Phoenix, AZ, Flagstaff, AZ, and then back to Page where I got a job working for Glen Canyon NRA as their electrician.

While at Glen Canyon I went through the NPS Structure Fire training program and became a member of the Glen Canyon Structure Fire Brigade as a firefighter. I also went through the NPS Dive training program and became a NAUI certified master diver for the NPS where I helped in recovery, scientific and maintenance diving at GLCA and other parks as needed. In 2013-14 I enrolled in the GOAL program, this is a year long leadership development program that took me to many NPS sites including Grand Canyon, San Francisco Maritime, Independence National Historical park in Philadelphia, and Washington, D.C.

In 2014 my wife who also works for the NPS, our 4 children and I moved across the country to Philadelphia/South New Jersey to work at Independence National Historical Park as the electrician and a Facility Manager detail. In 2016-17 I enrolled in the Facility Managers Leadership Program (FMLP), this is exactly what it sounds like as a yearlong training program through the NPS and Indiana University to strengthen facility-management skills. While in Philadelphia we enjoyed being emersed in the history of the country while being surrounded by more people than we had ever before. This gave us all great life experiences living in a very historical and diverse area with the opportunity to learn and grow. The museums, cultural aspects and just about any type of food you can think of was amazing. While on detail I had the opportunity to serve as the grounds, custodial and MVO Facility Manager during the Pope's visit to Independence Hall and the grounds of the Independence Mall among many, many other special events held every year at that park. My favorite ones were the 4th of July in the place where it all started.

In 2018 I decided to use my leadership and Facility Management training to become a Facility Manager, although we enjoyed the experience and knowledge of the East Coast, we were ready to get a little closer to home. I was lucky enough to have been given the opportunity to become the Facility Manager here at Florissant Fossil Beds N.M. I had always wanted to live in Colorado going back to when I would visit my grandfather at his home in Rico, CO, when I was a child. This has been a great opportunity for me and my family.

I will continue to improve this park and team as much as I can until the next door opens in our journey and appreciate the time and experiences we have had in each unique stop along the way.

Visitor Center

Florissant Fossil Beds National Monument

The visitor center exists to provide a variety of services to visitors of the Florissant Fossil Beds National Monument.

The visitor center is staffed with National Park Service professionals, program and student interns, and knowledgeable volunteers. Each staff member is well-equipped to provide visitors with Monument historical and scientific information and to recommend current daily programs, expository ranger walks, and hiking information that accommodates distance and difficulty levels for specific visitor interest and physical abilities.

The visitor center, in addition to the staff services mentioned above, offers:

- An information counter managed by individuals with Fossil Beds fluency.
- Detailed site trail and topography maps.
- A bookstore filled with Monument and nature-relevant titles and souvenir items.
- A site museum that details the geologic history of the Fossil Beds and offers examples of fossils found on site.
- Restroom facilities

We encourage our visitors to take advantage of all the service offerings, daily educational programs and personnel expertise available at the visitor center.

Our reason for being is in our building name.

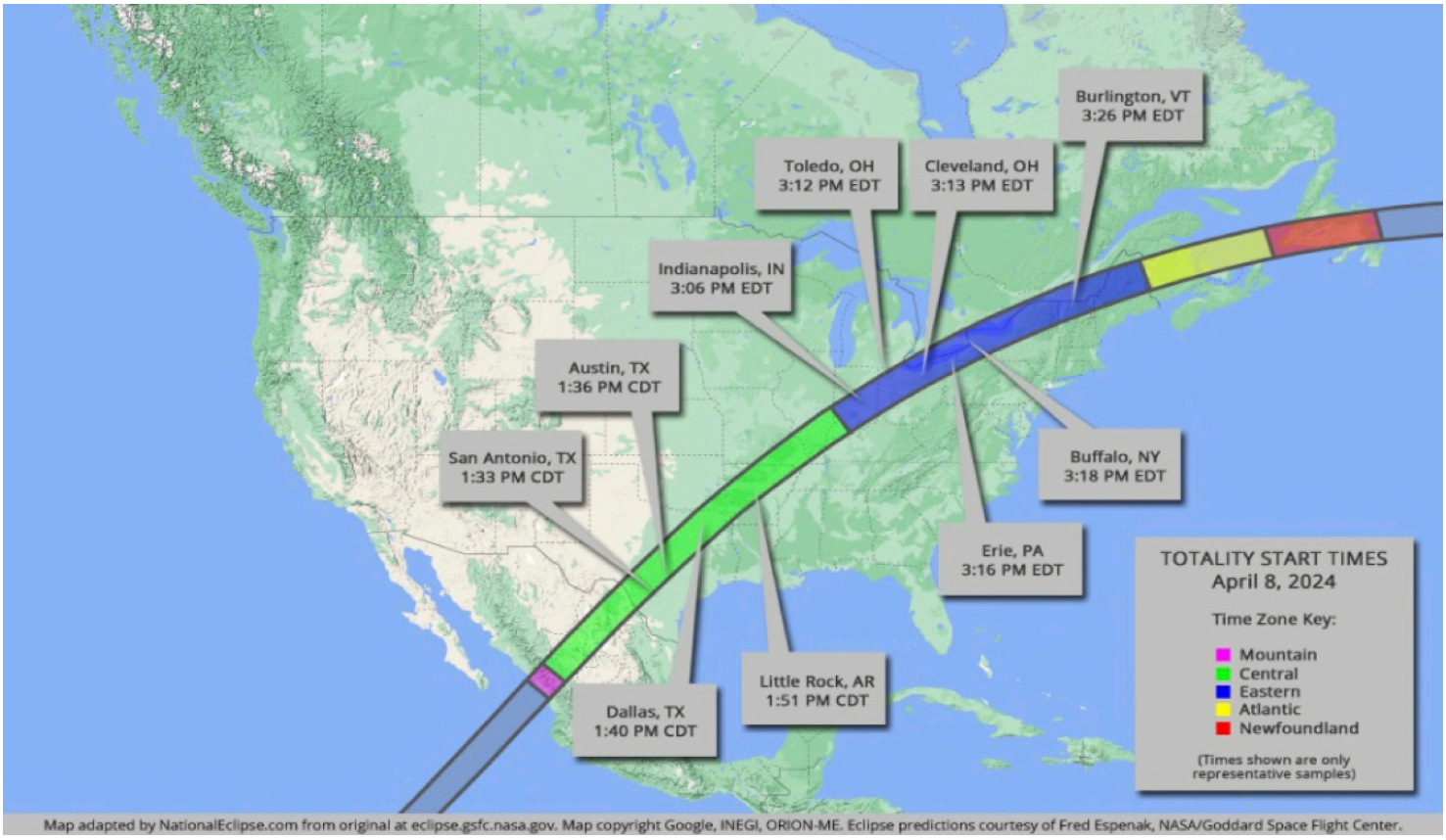
Spring Astronomy - Florissant Fossil Beds Night Sky

Mark Harter, FLFO Volunteer Ranger, Astronomy Lead
March 2024

Goodbye / Hello! A popular Beatles song says, "You say goodbye, and I say hello". As we say farewell to the spectacularly clear winter constellations on those cold winter nights, we welcome the spring constellations which promise warmer weather, and it can't come soon enough! We've had a real winter here in Florissant with plenty of snow and cold temperatures. For stargazers, the new spring season brings changes in the night sky as the famous winter constellations of Auriga, Taurus, Orion, Canis Major, and Gemini progress westward out of view. In their departure, we greet new spring constellations including Ursa Major (Big Dipper), Cancer, Leo, Virgo, Hydra, and the Spring Triangle, all of which are rich with interstellar beauty.

Florissant Fossil Beds Astronomy Programs. All of these constellations can be clearly seen at the Florissant Fossil Beds (FLFO) National Monument during our Night Sky Astronomy Programs. We closed out the 2023 FLFO astronomy year with a record number of visitors to our Night Sky Programs, and we're hoping to eclipse that (pun intended) in 2024! However, we're taking a different approach in 2024 due to FLFO Ranger staffing challenges, and limited Colorado Springs Astronomical Society (CSASTRO) astronomers available due to other commitments. Rather than having monthly Night Sky Programs with only 90 minutes of viewing time as in previous years, in 2024 we're focusing on Quarterly / Seasonal Night Sky Programs with 3 hours of viewing time to provide deeper viewing later in to the night of FLFO's international dark skies. We're planning 3 major Night Sky Astronomy Program events for late Spring (May), Summer (August), and Fall (October). Please watch for the announced dates. As usual, we'll be supported by CSASTRO astronomers and telescopes for every event!

Solar Eclipse – April 8. Hopefully you all have your calendars marked for April 8, which is the last total solar eclipse for the next 20 years in the Northern Hemisphere. The next total solar eclipse in North America will be in the year 2044, we'll all be 20 years older and wiser. If you want to see the April 8 solar eclipse in totality (4 minutes of total sun blockage), you'll need to travel to see it (see the map), as the totality path moves from southeast Texas through the central-east part of the U.S. up to Maine. Several of us are making the journey to Texas to witness this event. We'll report back in the next Friends Newsletter on how exciting it was. To wet the public's appetite, on Saturday morning March 16, CSASTRO will have a solar telescope at the FLFO Visitor Center so that people can view the sun (with eye protection of course). Hope you can join us!



FLFO Astronomy Volunteers Needed! Are you interested in astronomy? Would you like to be an important part of the FLFO Volunteer Ranger team? If so, we need YOU! We're looking for 2-3 more volunteers to support our FLFO Night Sky Astronomy Programs. The commitment is minimal – 3-4 times/year helping set up and tear down (cones and light markers), and directing traffic (turning off car lights, pointing people to the Visitor Center). It's so easy even a caveman can do it! If interested, please let Mark Harter or Penny Wagner know and we'll gladly talk with you about it!

Mark Harter is a Florissant resident, and as a FLFO Volunteer Ranger, leads the FLFO astronomy events. He is a retired military Veteran (Air Force), and is an Aerospace Engineer at the United States Space Force.

Anonymous source
...but believed to be
an astrophysicist...

***Not** associated with Mark's submission*

Financial Report for the Friends of the Florissant Fossil Beds: 2023

2023 was another busy year financially for the Friends. Most importantly, we were able to provide critical support to graduate students and interns at the Fossil Beds. We returned to the Farmers' Market in Woodland Park. As we look forward, we are considering a range of new fundraising activities. We provide a summary below.

2023 Highlights:

- ✦ We were able to continue to provide needed support to the Monument.
  - As anticipated in the Financial Report last year, our financial support of graduate students/intern expenses increased substantially in 2023. Based on requests from Penny Wagner, the Monument's Superintendent, and Dr. Herb Meyer, the Monument's retiring paleontologist, we increased this support in 2023 compared to 2022 ($8,157 compared to $1,566 in 2022.) Indeed, we returned to our former levels of support which had been interrupted by COVID and staffing transitions at the Monument.
  - These funds supported project expenses for two graduate students (Ariana Miranda and Stephanie Tkacik) and conference travel for three interns (Hillary Cepress-McLean, Ashley Martinovich, and Paityn Schlosser).

As in 2022, our 2023 income was almost $10,000.

- The donation box in the Visitors Center continues to provide critical support: $4,155 in 2023. Donations, mostly from members of the Friends, yielded another $2,960. **THANK YOU!**

The Friends expenses in 2023 were like those of 2022.

- The details of these expenses vary year-to-year. In 2023, our website subscription, billed every 3 years, came due (~$500) and we caught up on past expenses for our Zoom account (~$700). Finally, we helped with expenses for Dr. Meyer's retirement party.
- This past summer, we returned to having a booth at the Woodland Park Farmer's Market ($225). This provides an opportunity for Fossil Beds staff, interns, and Friends volunteers to interact with a wide range of local residents and visitors to the area.

2023 Financial Summary, as reported to the leadership of the Florissant Fossil Beds National Monument and the National Park Service:

Income:	$ 9,674.01
Expenses:	-$11,852.79
TOTAL:	-$ 2,178.77

- Ideally, we would avoid a deficit, of course, but an analysis determined that this deficit was due to the intern expenses supported. Still, this situation increased our commitment to fundraising.

Plans for 2024:

- Financial Support of the Monument
  a. We plan to continue discussions with Superintendent Wagner about the levels of intern support the Friends will provide in 2024. After all, this is a major mission of the Friends.
  b. As the A-Frame renovation concludes, it is likely the Friends will be asked for supply monies for goods difficult to obtain under NPS funding rules. This might include kitchen supplies, small furniture, and so on.
  c. Funds of up to $5,000 per year are available to the Superintendent to be allocated at her discretion. In the past, these monies have been used for supplies for the Night Sky Program; shale from the Fossil Quarry; pencils for the Junior Ranger program; first aid courses for staff and volunteers; and a myriad of other, generally small expenses not easily paid for by federal funds. We will assist Superintendent Wagner as she makes strategic use of these funds.

Finally, we are discussing exciting new possible fundraising opportunities. Stay tuned!

A final note of thanks to everyone: donors, members, and Board members, who make the Friends' monetary support possible.

Jan Beals

THE GREAT BACKYARD BIRD COUNT

Submitted by Sally McCracken

It was six degrees when I pulled into the parking lot of the Florissant Fossil Beds NM at 9:15 on Saturday, February 17, 2024. The Great Backyard Bird Count event was about to begin with everyone dressed for a cold winter day. The Friends of the Fossil Beds have held this citizen science event every February for many years. This was the 25th year for this international event.

By 10 a.m., the temperature had risen into the high 30's with bright sun and no wind. By the end of the event, which ran from 9 AM to 1 PM, we had 2 groups go out for the bird count. Ten different species and 76 individual birds were counted. A good time was had by all. We are very happy to have very qualified people to lead our hikes and the count. We usually have at least one volunteer from the Aiken Chapter of Audubon which is based in Colorado Springs.

The official count for The Great Backyard Bird Count event this year won't be available until early April 2024. You can find that data when available on ebird.org. Here are the statistics for 2023 to give you an idea of the size of this citizen science event:

555,291 participants from 202 countries around the world joined the count. 7,538 species of birds were counted which is 2/3 of the known species alive in the world. More than 125,000 pictures were submitted. 394,652 checklists were submitted. All of this data will help scientists around the world following changing migrating habits, the health of many bird species and the effect of climate change on many different bird species. It will be interesting to match last year's count with the 2024 count. Every year, the numbers go up. Check the results out in April.

Text of the Public Law that created the Florissant Fossil Beds National Monument.

Public Law 91-60
An Act

To provide for the establishment of the Florissant Fossil Beds National Monument In the state of Colorado.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, in order to preserve and interpret for the benefit and enjoyment of present and future generations the excellently preserved insect and leaf fossils and related geologic sites and objects at the Florissant lake beds, the Secretary of the Interior may acquire by donation, purchase, with donated or appropriated funds, or exchange such land and interests in land in Teller County, Colorado, as he may designate from the lands shown on the map entitled, "Proposed Florissant Fossil Beds Nation Monument", numbered NM-FFB-7100, and dated March 1967, and more particularly described by metes and bounds in an attachment to that map, not exceeding, however six thousand acres thereof, for the purpose establishing the Florissant Fossil Beds National Monument.

Sec 2. The Secretary of the Interior shall administer the property acquired pursuant to section 1 of this Act as the Florissant Fossil Beds National Monument in accordance with act entitled "An Act to establish a Nation Park Service, and for other purposes," approved August 25, 1916 (39 Stat. 535; 16 U.S.C 1 et seq.), as amended and supplemented.

Sec. 3. There are authorized to be appropriated such sums, but not more than 3,727,000, as may be necessary for the acquisition of lands and interest in land for the Florissant Fossil Beds National Monument and for necessary development expenses in connection therewith.

Approved August 20, 1969.

National Monument and the Anitiquities Act

Summary

"The Antiquities Act of 1906 (54 U.S.C. §§320301-320303) authorizes the President to proclaim national monuments on federal lands that contain historic landmarks, historic and prehistoric structures, or other objects of historic or scientific interest. The President is to reserve "the smallest area compatible with the proper care and management of the objects to be protected." The act was designed to protect federal lands and resources quickly. Presidents have proclaimed a total of have enlarged, diminished, and changed the terms of monuments previously proclaimed by Presidents[sic]. Congress has modified many of these proclamations, converted some monuments to different designations, and abolished some monuments. Congress also has created monuments under its own authority". - https://sgp.fas.org/crs/misc/R41330.pdf

This block of text describes the essence of the Antiquities Act of 1906 that has resulted in the identification and preservation of lands and landmarks that have a significant scientific and/or historic value. The lands designated as a National Monument enjoy a federal guarantee of proper management and, where appropriate, public access.

The value in such preservation and allowance for access is educational, recreational, and enlightening. Lands of scientific and/or environmental interest are protected from development and commercial use. They are restricted in the most positive sense. They are left in their natural state with only carefully selected improvements designed to augment the level of protection and public accessibility without serious degradation of the scientific and/or natural gifts and artifacts found within the Monument boundaries.

They reflect the true spirit of America and the foresight and intelligence of the American people. They belong to all of us and are shared and respected accordingly.

Read the actual text of §320301 here.

Florissant Fossil Beds National Monument

JUNIOR RANGER DAY

Saturday, April 27, 2024

10AM– 2PM

- Earn your Junior Ranger badges!
- Hands-on activities for kids of all ages
- Tour the historic 1878 homestead
- Take a guided-walk with a ranger

Park Entrance Fees Apply

For More Information

Please call (719) 748-3253

or visit our website www.nps.gov/flfo

A Webinar presented by Ariana Miranda

April 10, 2024
6:30 p.m. MST

Underneath the Roots of the *Sequoias*: Paleosols of the Florissant Fossil Beds National Monument

Paleosols are preserved soils that have become rock in the geologic record. They hold important clues to Earth's past climate including ways of estimating temperature, precipitation and elevation based on geochemistry. My study delves into what the past climate of Florissant was at the end of the Eocene by looking at the soils that developed along the surface of the *Sequoia* stump forest before the lahar buried them.

April 27, 2024
10 a.m. - 2 p.m.

Junior Ranger Day

Earn your Junior Ranger badges
Hands-on activities
Tour the historic 1978 homestead
Take a guided-walk with a Ranger

Park entrance fees apply

Coming Events

Spring & Summer 2024

Early May 2024

Steve Veatch will do a webinar entitled "Through The Lens: The Story of Three Photographers From the Cripple Creek Mining District." All of them lived in the late 1800's and early 1900's. They played a crucial role in documenting the history and culture of the Cripple Creek Mining District.

The date and time to be determined.

August 24, 2024

Join us as we celebrate the 55th Anniversary of the establishment of the Florissant Fossil Beds. We hope to have some great afternoon activities ending the day with a fabulous banquet at The Nature Place in Florissant. Dinner reservations will be limited, so watch for information coming out to make your reservations.

Donation Corner

July 1 through December 31

2023

To our Donors:
We are thankful for your generosity and support for our mission.
Much of what we do, would not be possible without you.

John	Wright	Denver	CO
Peter	Scanlon	Woodland Park	CO
Sara	Miner	Colorado Springs	CO
David and Carolyn	Hibner	Florissant	CO
Outdoor Adventures		Woodland Park	CO
Deborah	Woodcock	Lexington	VA
Thomas & Pamela	Wylie	Centennial	CO

SPRING

Florissant Fossil Beds

is one of the best

seasons to visit the

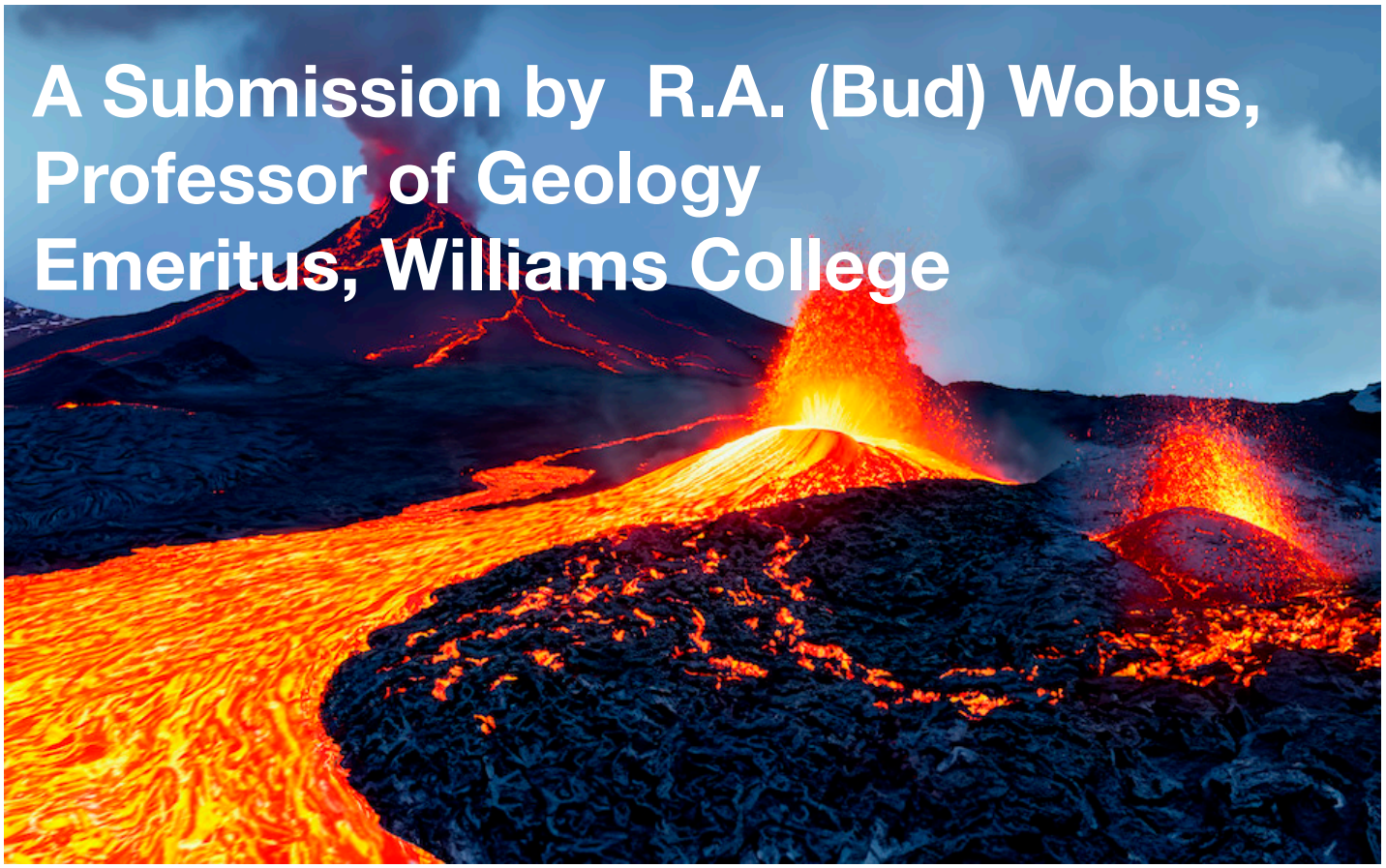
Images from NPS Website

Please Visit Soon.

Spring
Is one
Of Mother Nature's
Annual gifts
Wrapped in
Ribbons of renewal
with
The promise of beginnings
And
Fragile blossoms of hope
All carefully placed within
-fg-

Enjoy Your Gift!


...and now for
the
Geologists
among us...


A Submission by R.A. (Bud) Wobus,
Professor of Geology
Emeritus, Williams College

GREAT BLASTS FROM THE PAST…
THE WALL MOUNTAIN TUFF IN CENTRAL COLORADO
by R.A. (Bud) Wobus, Professor of Geology, Emeritus, Williams College, MA

One day about 36.7 million years ago…maybe it was a Wednesday….all hell broke loose in central Colorado! A shallow magma chamber near the present location of Mt. Princeton and Buena Vista exploded with a magnitude many times greater than the maximum ever observed by humans, spewing incandescent clouds of molten volcanic droplets, solid fragments, and gas which travelled across the state with the velocity of an express train. These pyroclastic flows travelled as far as Castle Rock, 90 miles to the east, in a couple of hours. Also known as "glowing avalanches" for their ground-hugging cloud-like form and high temperature (more than 1000 degrees F.), they followed and filled stream valleys and overtopped drainage divides along the way. The erosional remnants of these flows have been named the Wall Mountain Tuff, a crucial geologic age datum in central Colorado.

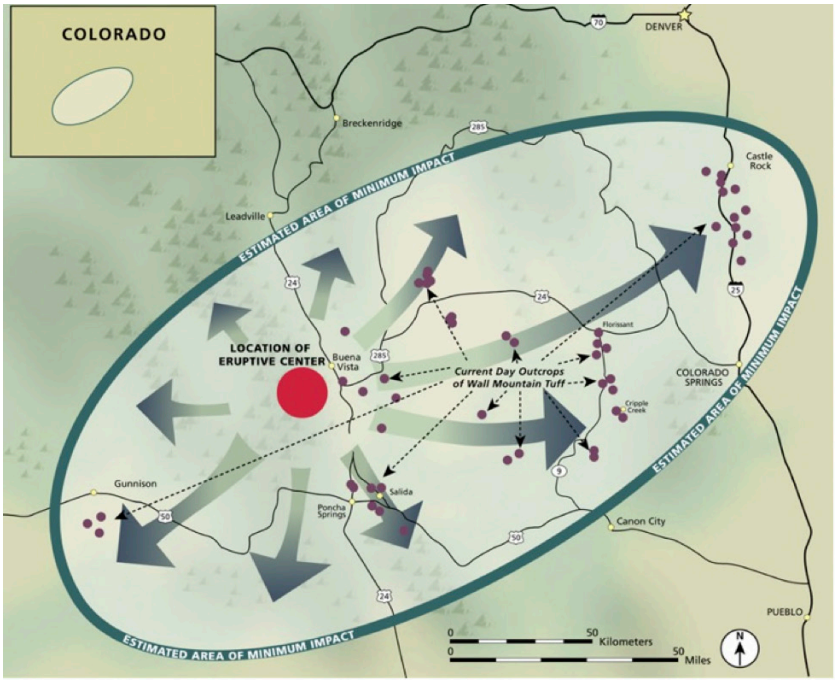
Pyroclastic flow on Mt. St. Helens, 1980. Photo by Peter Lipman, U.S. Geological Survey.

In his book BASIN AND RANGE, John McPhee describes this phenomenon as "….a violently expanding, exploding mixture of steam and rhyolite glass " which "…in enormous incandescent clouds heavier than air, scudded across the landscape like a dust storm." In a spatially restricted sense this is the ultimate geologic hazard, not as widespread as an earthquake or hurricane but virtually impossible to escape if in the line of travel.

A pyroclastic flow from Mt. Pelee on the Caribbean island of Martinique in 1902 instantly obliterated the town of St. Pierre and its 29,000 inhabitants, and similar explosions have taken tens of thousands of lives over the years. in Indonesia, the Philippines (especially Pinatubo, in 1991), Japan and in the Mediterranean region. (Mt. Vesuvius devastated Pompeii in 79 A.D.).

Volcanologists have developed a “Volcanic Explosivity Index”, or VEI, akin to the Richter scale in seismology, to compare the size of these eruptions. The VEI is based on the estimated volume of pyroclastic material (tephra) ejected during an eruption using a logarithmic scale, with each higher number representing a ten-fold increase. Non-explosive Hawaiian lava flows have a VEI of 0-1, while the largest eruptions known (like Yellowstone 2.1 million years ago or Taupo, New Zealand, at about 26,500 years) have each produced more than 1,000 cubic kilometers of ejected debris and are assigned the maximum VEI of 8. The integrated volume of remnants of the central Colorado eruption 36.7 million years ago would put it in the highest category (VEI=8). For comparison, Mt. St. Helens in 1980 had a VEI of 5, as did Vesuvius in 79 A.D.; Pinatubo in the Philippines in 1991 was a 6.

The outflow from the Wall Mountain Tuff eruption is indicated by erosional remnants of the pyroclastic flows across the central part of the state. Often these remnants are within former stream valleys which the flows followed and filled. The volcanic rock in the valleys, being much harder than the erodible sides, now forms a ridge or butte, marking a total reversal of the former topography.



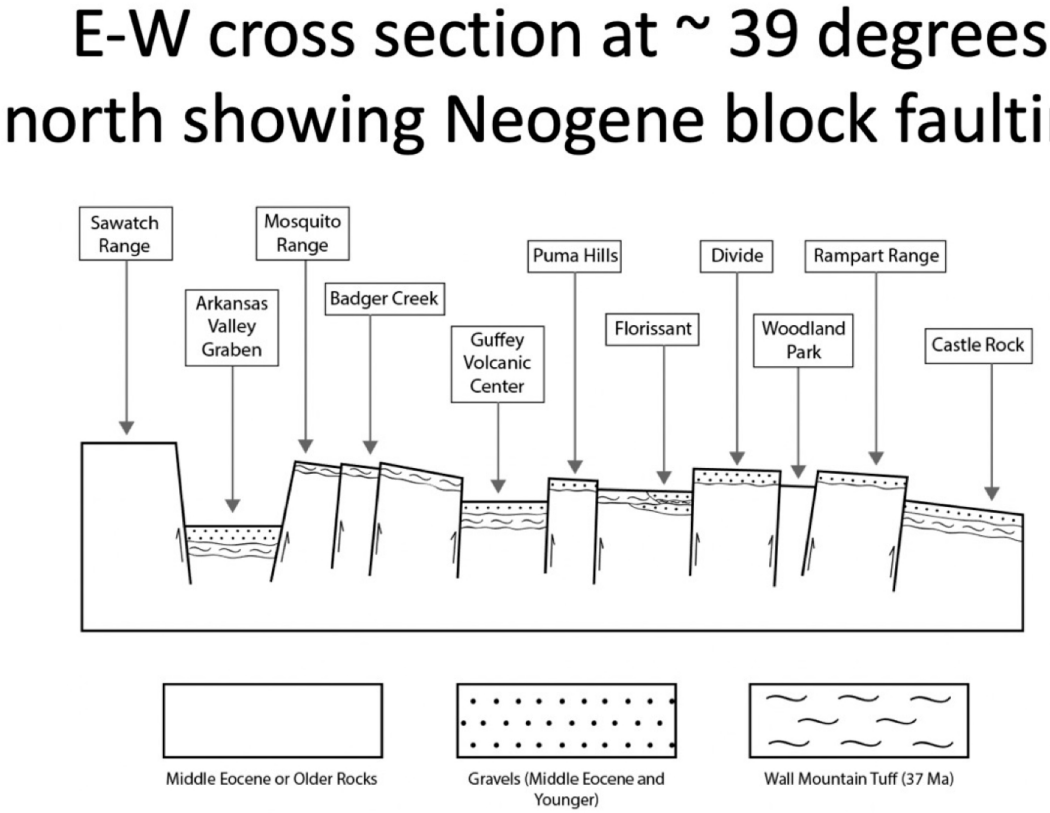
Outflow map of the Wall Mountain Tuff in central Colorado. Map by Larry Scott, Colorado Geological Survey

Erosional remnant of Wall Mountain Tuff in former stream valley in South Park

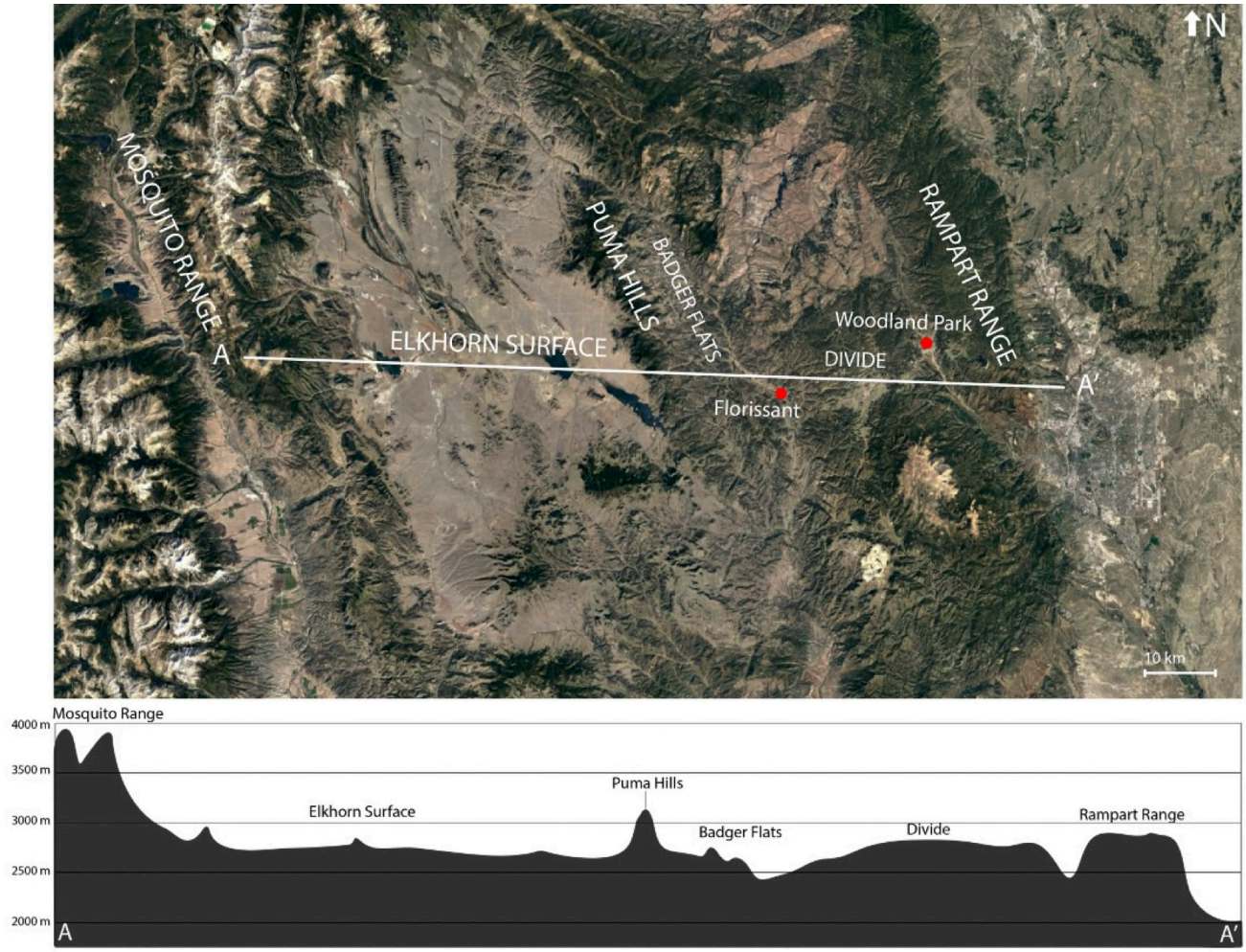
The Wall Mountain Tuff was extruded across the almost flat topography of central Colorado at that time. Known as the Late Eocene Erosion Surface (LEES) or "The Big Flat", broad remnants of this surface still exist across South Park and the Front Range at elevations from 8500 to 9500 feet (Wobus, 2022).

"The Big Flat", remnants of the Late Eocene Erosion Surface at an elevation of 9000 feet. View to northeast from south of Florissant.

At the time of eruption there were few topographic impediments that would have blocked or ponded the flows as they moved to the east across the Front Range and on to Castle Rock, but subsequent faulting has segmented the surface as shown below:



Generalized east-west cross-section from the Sawatch Range (source of the Wall Mountain Tuff) to Castle Rock at the mountain front. From Epis and Chapin, 1975, modified by Olson, 2019.



Google Earth image and topographic cross section of an E-W transect parallel to the previous figure from just east of the Sawatch Range, to Colorado Springs, showing labelled remnants of the erosion surface and younger topographic impediments like the Puma Hills, which form the eastern rim of South Park.

THE WALL MOUNTAIN TUFF…A CLOSER LOOK

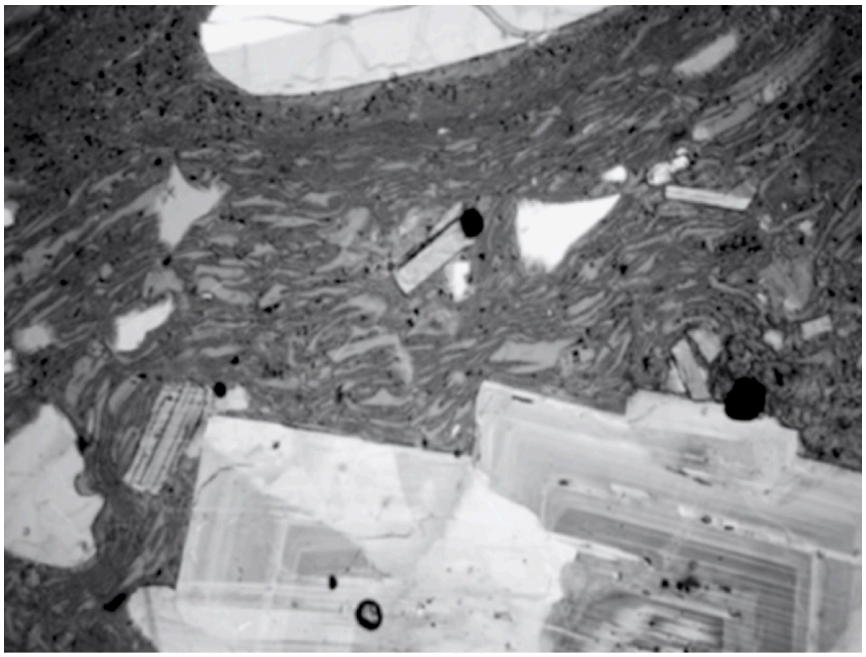
Curiously, the type locality of the Wall Mountain Tuff is nowhere near the source of the pyroclastic flows which produced it. It was named for an isolated exposure at the south end of Wall Mountain near the center of the Black Mountain 15-minute quadrangle (about 8 miles south-southwest of the town of Guffey), where it forms cliffs 80 feet high (Epis and Chapin, 1974). The name was proposed to incorporate several previously mapped pyroclastic flow units, those which had been informally called “ash flows -1, -2, and -4 ,“ and the Agate Creek Tuff. It was several more years before the unit was correlated with a source at or near Mt. Princeton.

The rock varies in texture and color depending on the distance from its source and the depth within a given exposure. When pyroclastic flows lose their forward momentum and begin to settle out and consolidate, the material deposited from the flow incudes crystals formed before eruption, broken fragments of rock and pumice (porous volcanic glass), and shards of glass which had not yet begun to crystallize.

All of this steaming mass is compacted, flattened, and welded together from the weight of the overlying material as temperature falls, yielding the signature rock of a pyroclastic flow, a welded tuff or ignimbrite. This rock is highly resistant to weathering and erosion, hence the prominence and longevity of many of its outcrops. Its characteristic compacted fabric with flattened pieces of former pumice or obsidian can be retained for well over a billion years.

Moderately welded outcrop of Wall Mountain Tuff south of Florissant.

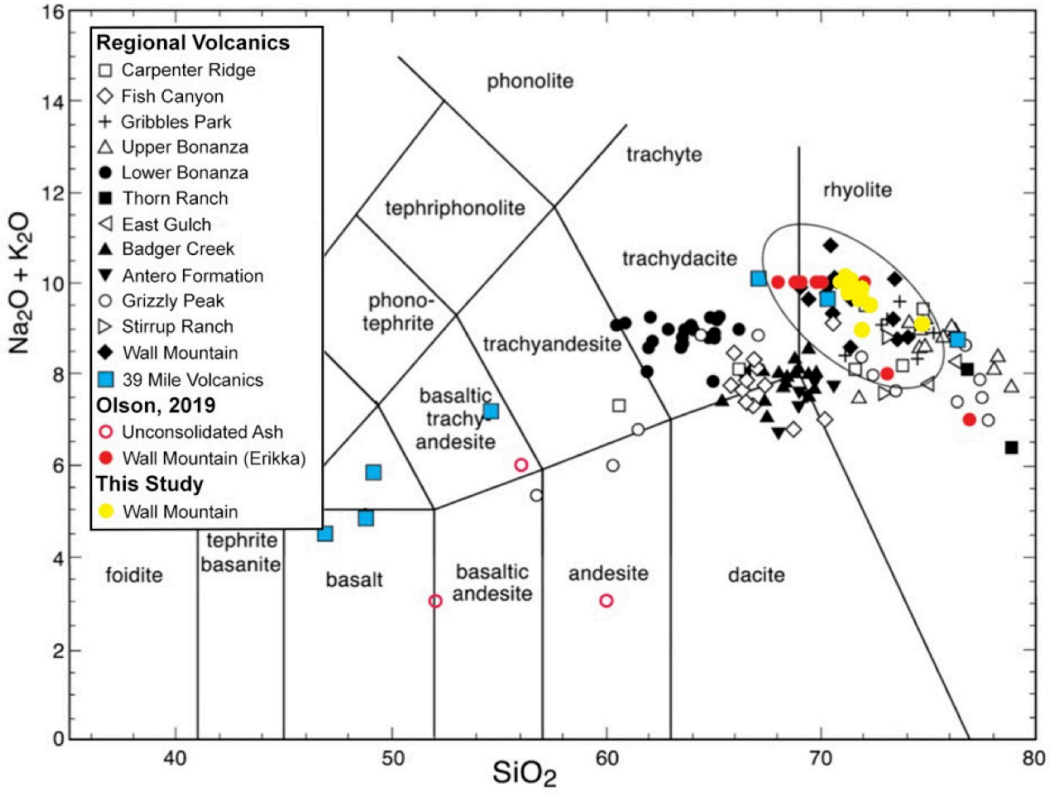
Densely welded Wall Mountain Tuff with flattened fragments of black obsidian (volcanic glass)



Thin section of Wall Mountain Tuff viewed under crossed polars in a petrographic microscope. Crystals of feldspar (plagioclase and sanidine) in a groundmass of compressed glass shards. Field of view about ¼ inch across.

The presence of sanidine, a form of potassium feldspar, allows the radiometric dating of the Wall Mountain Tuff using the decay of an isotope of potassium to argon. This provides an approximation of the time of its eruption: 36.69 +/- 0.09 million years (McIntosh and Chapin, 2004). Because of the widespread distribution of erosional remnants of the tuff, it is the age-datum for much of central Colorado. In the Front Range it rests directly on billion-year-old granite, and it underlies noteworthy features like the world-famous fossiliferous lake beds of the Florissant Formation at the Florissant Fossil Beds National Monument.

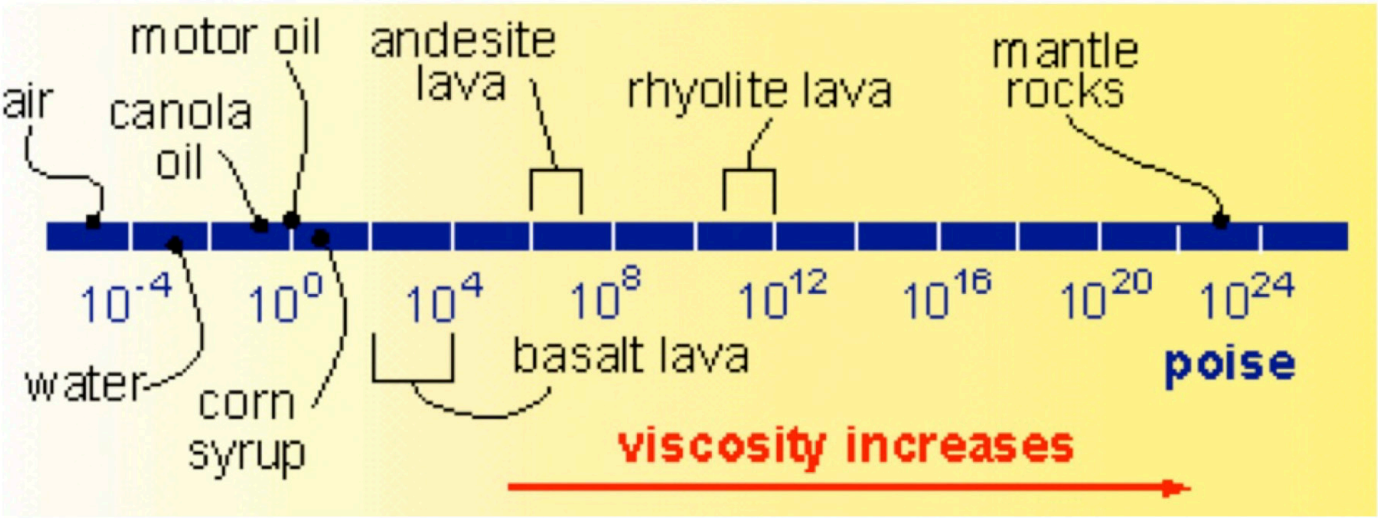
The mineralogy of the Wall Mountain Tuff is due to its chemical composition, and together the two classify it as a rhyolite or rhyodacite. It has the same composition as many granites, which contain larger crystals due to the slow cooling of magma deep underground. Chemically it is especially enriched in silica and the alkalies (potassium and sodium), a feature which has permitted the geochemical correlation of its undated exposures in the Front Range with radiometrically dated outliers to the west in South Park.



Geochemical correlation of Wall Mountain Tuff in the Front Range (solid red and yellow circles) with radiometrically dated samples in South Park (solid black diamonds). (Lockwood and others, 2021, after McIntosh and Chapin, 2004).)

The high silica content is, in fact, the determining factor that led to the explosive nature of the eruption of the Wall Mountain Tuff. Silicon and oxygen, the two most common elements in the Earth's crust, have a very strong chemical affinity for one another and form among the tightest bonds of all common elements. This strong bonding begins to become established even while magma is just beginning to solidify, and along with the relatively low temperature of granitic or rhyolitic melts, it accounts for the high viscosity ("stickiness") of the magma.

The explosiveness of a volcanic eruption is to a large extent dependent on magma viscosity, a term which can be defined as "resistance to flow" due to the internal friction of the molecules involved. Quantified by a unit known as "poise", it has a wide range of values among fluid materials, as shown in the graph with a logarithmic scale below:

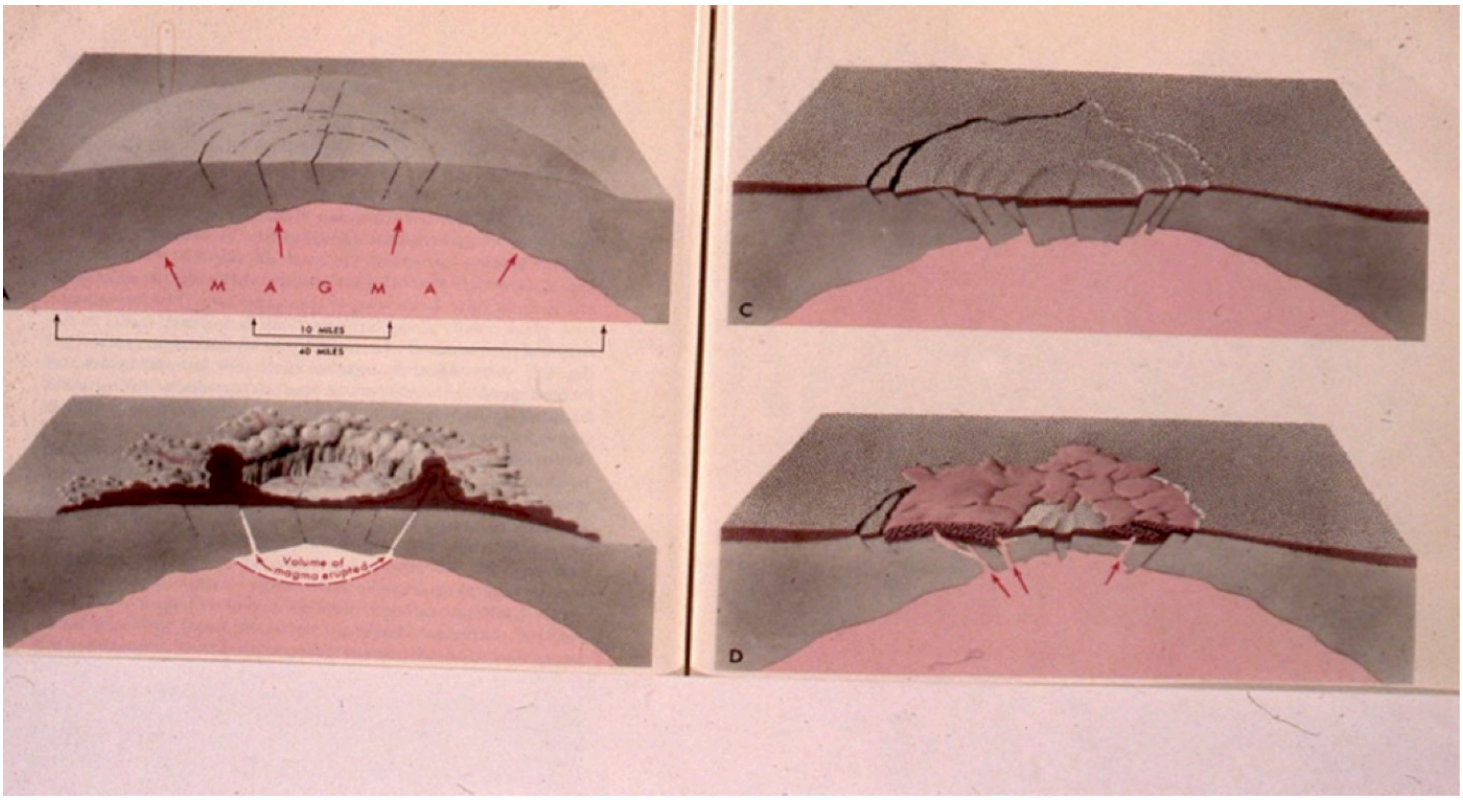


Scale of viscosity (fluidity vs. stickiness) of volcanic flows compared with common non-geologic substances.

As the scale indicates, basalt, the most common type of lava, is eight orders of magnitude more fluid than rhyolite and actually forms rivers of flowing lava, as observed in Hawaii and Iceland. Its low viscosity is due to its higher temperature and lower silica content, the latter only about 50% as compared with 70% and higher for rhyolite. Since magma always has a content of dissolved gases (principally water vapor) trying to escape, the amount of these gases and the ease of their escape becomes the dominant factor in determining the style of an eruption. As confined magma underground rises into lower pressure regions near the surface, the gases are released and form bubbles. Bubbles in basalt magma, with both a lower gas content and higher fluidity, can easily effervesce and escape from the erupting lava. But those in rhyolite magma are confined due to its high viscosity; visualize rising bubbles in a corked bottle of warm champagne.

Eventually the pressure of the gases to escape becomes greater than the confining pressure of the overlying rock to hold them in. The rising magma bulges and breaks the rock layers until fractures reach the upper gas-charged top of the magma chamber, resulting in the sudden explosive release of the underground contents.

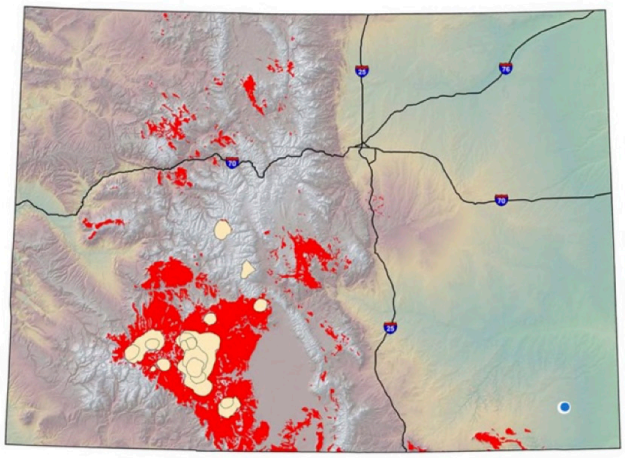
At this stage pyroclastic flows are formed from gas clouds that rise high above the eruption site and collapse gravitationally under the weight of their included molten droplets, rock and pumice fragments, and gas, forming density currents that sweep across the landscape, as described earlier. This scenario is well portrayed in a series of block diagrams prepared by the U.S. Geological Survey to illustrate the eruption of the Yellowstone volcanic center in three successive gigantic eruptions beginning 2.1 million years ago, with the most recent about 600 million years ago:



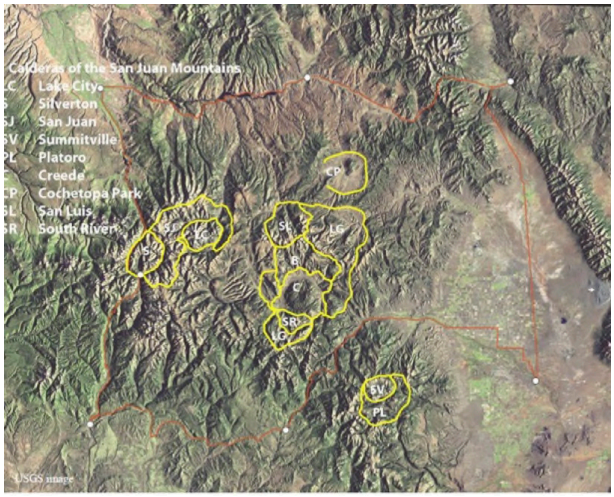
Stages of a Yellowstone-style eruption, counter-clockwise from upper left: A) rise of gas-charged magma domes and fractures the overlying rock; B) fractures penetrate to the pressurized gas-rich top of the chamber, causing an explosive eruption; C) collapse of the drained magma chamber, forming a giant caldera; D) later rise of small blobs of viscous magma form small steep-sided domes in the floor of the caldera.

While an explosion caldera is the best indication of a violent volcanic eruption, none has been found at the presumed source of the Wall Mountain Tuff. For many years the large granite pluton at Mt. Princeton was suggested as a remnant of the source magma chamber which had been exposed by subsidence of the Upper Arkansas/Rio Grande rift immediately adjacent to the east. However, more recent radiometric dating of that granite has shown that it is 2 million years younger than the Wall Mountain Tuff (McIntosh and Chapin, 2004).

The eruption of the Wall Mountain Tuff was an early prelude to what has become known as the Great Ignimbrite Flare-Up in Colorado and adjacent states which produced 30 caldera-associated ignimbrite sheets in the San Juan volcanic field from about 32-23 million years ago
(Lipman, 2012). Many of these caldera centers resulted in caldera collapse and later mineralization to create some of the major mining districts of the Colorado Mineral Belt, as indicated by caldera names like Silverton, Platoro, and Bonanza. The largest caldera, the La Garita, produced what might be the world's record volume of pyroclastics about 28 million years ago, the Fish Canyon Tuff with a volume greater than 5000 cubic kilometers!

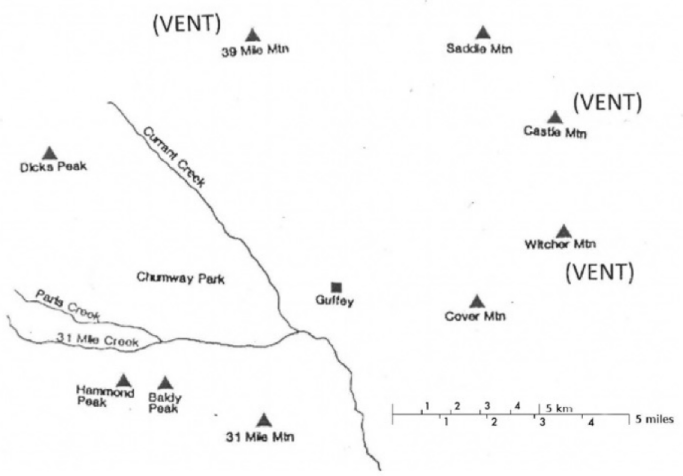


Map of Colorado volcanic fields, with the largest, the San Juan field, perforated by calderas.



A few of the calderas of the San Juan field west of the broad open San Luis Valley /Rio Grande Rift.

A younger caldera-shaped feature within the outflow area of the Wall Mountain Tuff was once thought to be the remnant of an exploded and collapsed volcano the size of Mt. Ranier, but is now considered to be an erosional feature incorporating several adjacent smaller volcanoes. The Guffey volcanic center of the Thirtynine Mile Volcanic field (second largest in Colorado) was the source not of rhyolitic pyroclastic flows but of lower-silica andesite lavas and voluminous mudflows (Wobus, 2022).



Mountains surrounding the Guffey volcanic center and positions of vents that fed several small volcanoes peripheral to the center. This is NOT an explosion caldera of the type previously described.

Google Earth view of Guffey volcanic center.

Although the Wall Mountain Tuff lacks a source caldera with economic mineralization, it serves an important geologic function by providing a unique and widespread age datum. Deposited as a virtually instantaneous veneer across an extensive swath of central Colorado, it marks a datable boundary between the Late Eocene Erosion Surface and younger overlying units, and it is the first radiometrically datable horizon above the billion-year-old granites it overlies.

References

Epis, R.C. and Chapin, C.E., 1975, Geomorphic and tectonic implications of the post-Laramide, Late Eocene erosion surface in the Southern Rocky Mountains, in Curtis, B.F. (ed.) Cenozoic history of the Southern Rocky Mountains: Geological Society of America Memoir 144, pp.45-74.

Epis, R.C. and Chapin, C.E., 1974, Stratigraphic nomenclature of the Thirtynine Mile volcanic field, central Colorado: U.S. Geological Survey Bulletin 1395-C, 23 pp.

Lipman, Peter W., 2012, Geologic map of the Cochetopa Park and North Pass calderas, northeastern San Juan Mountains, Colorado: U.S. Geological Survey Scientific Investigations Map 3123, 48 pp.

Lockwood, C.A., Wobus, R.A., and Olson, E.R., 2021, Geochemical verification and tectonic implications of the 36.7 Ma Wall Mountain Tuff in the Florissant region, Southern Front Range, Colorado: Geological Society of America Abstracts with Programs, v.53, no. 6, doi. 10.1130 /abs/2021 AM-366742.

McIntosh, W.C. and Chapin, C.E., 2004, Geochronology of the central Colorado volcanic field:
New Mexico Bureau of Geology and Mineral Resources Bulletin 160, p.205-237.

Olson, E.R., and Wobus, R.A., 2019, Geomorphology and tectonism in Colorado's Southern Front Range: Implications of boulder and volcanic deposits on the Late Eocene Erosion Surface: Geological Society of America Abstracts with Programs, v.51, no.5, doi. 10.1130 /abs/2019 AM-331776.

Wobus, R.A., 2022, The Big Flat: A geological and personal traverse from Colorado Springs to South Park across Colorado's subalpine erosion surface: Florissant, CO: Colorado Outdoor Education Center, 75 pp.

CODA

National Park Service Public Domain