

A photograph of a natural rock arch made of layered sandstone, with a view of a valley and mountains through the opening. The sky is blue with some clouds. The text "GEOLOGY OF WYOMING (/)" is overlaid in the center.

# **GEOLOGY OF WYOMING (/)**

## **THE GREAT UNCONFORMITY**





Image from: © Greg L. Jones, Shoshone Canyon Unconformity,  
<https://www.flickr.com/photos/wyojones/> (<https://www.flickr.com/photos/wyojones/>)

**Wow Factor** *(1 out of 5 stars):*



**Geologist Factor** *(5 out of 5 stars):*



## Attraction

Place your hand on The Great Unconformity! The contact between the Precambrian igneous/metamorphic crystalline rock (2.6 to 2.8 billion years old) and overlying Cambrian Flathead Sandstone (520 million years old) is a 2 billion year gap in the rock record. Optional very scenic walk or bike ride up Shoshone Canyon.



# Geology of The Great Unconformity

The Great Unconformity was first recognized by John Wesley Powell during his 1869 exploration of the Grand Canyon. In the Grand Canyon, sedimentary 525 million year old Tapeats Sandstone lies on metamorphic 1.740 billion year Vishnu Schist, a time gap of over 1.2 billion years. Powell understood that this surface represented an immense period of time, but lacked the tools to obtain accurate ages.



**Grand Canyon north view from Moran Point. Unconformity shown by white dashed line.**

Image from: [https://www.sciencebase.gov/catalog/file/get/51dd8a11e4b0f72b4471c22e?](https://www.sciencebase.gov/catalog/file/get/51dd8a11e4b0f72b4471c22e?f=__disk__a4%2Ffe%2Fed%2Fa4feede5fc924a29e222953ecfb7ac0703daa326&width=3413&height=2287)

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[f=\\_\\_disk\\_\\_a4%2Ffe%2Fed%2Fa4feede5fc924a29e222953ecfb7ac0703daa326&width=3413&heigh](https://www.sciencebase.gov/catalog/file/get/51dd8a11e4b0f72b4471c22e?f=__disk__a4%2Ffe%2Fed%2Fa4feede5fc924a29e222953ecfb7ac0703daa326&width=3413&height=2287)  
[t=2287](https://www.sciencebase.gov/catalog/file/get/51dd8a11e4b0f72b4471c22e?f=__disk__a4%2Ffe%2Fed%2Fa4feede5fc924a29e222953ecfb7ac0703daa326&width=3413&height=2287))

This “missing time” between the ancient earth and the Phanerozoic Eon (< 542 million years ago) is found worldwide. In Shoshone Canyon it can best be observed just before Tunnel #1 (the first one when heading west) on U.S. 14-16-20. Cross bedded Cambrian Flathead



Sandstone (520 million years) rests on Precambrian igneous (2.65-2.6 billion years) and metamorphic crystalline rock (2.80-2.75 billion years). The time gap of from 2.08 to 2.28 billion years is about twice as long as that seen in the Grand Canyon and almost half the age of the earth.

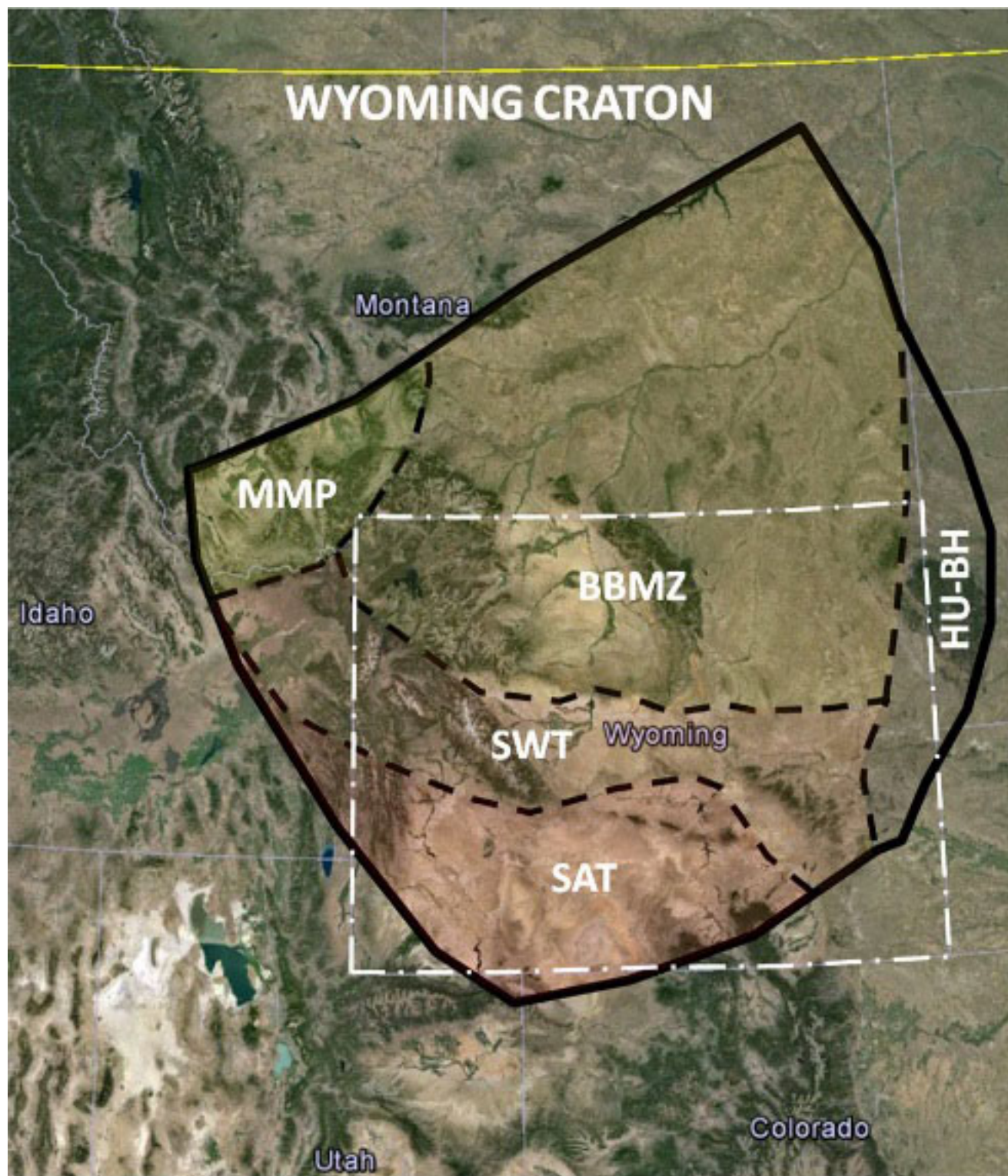


**Shoshone Canyon west view at Tunnel #1. Unconformity shown by white dashed line.**

*Image from: Fisher, M.P., 2016, Shoshone Canyon*

The reason for this “greater” Great Unconformity is that the basement rock of Wyoming represents the oldest continental crust in the Rocky Mountain Region and some of the first to crystallize as the molten earth cooled. The crystalline rock in Shoshone Canyon is part of the Archean Wyoming craton, an ancient land mass that underlies most of Wyoming and parts of the adjacent states. The Wyoming cratonic core segments MMP, BBM, SWT assembled through collision driven by plate tectonics in the middle Archean (3.2-2.8 billion years). They joined with the other subprovince bits HU-BH and SAT to create a micro-continent 2.65 billion years ago. It remained an independent “micro-continent” for at least 750 million years.





**Wyoming Craton shown in solid black line. Subdivisions are displayed by black dashed lines: BBMZ = Beartooth-Bighorn Magmatic Zone, HU-BH = Hartville Uplift-Black Hills, MMP = Montana Metasedimentary Province, SWT = Sweetwater Terrain, SAT = Southern Accreted Terrain.**

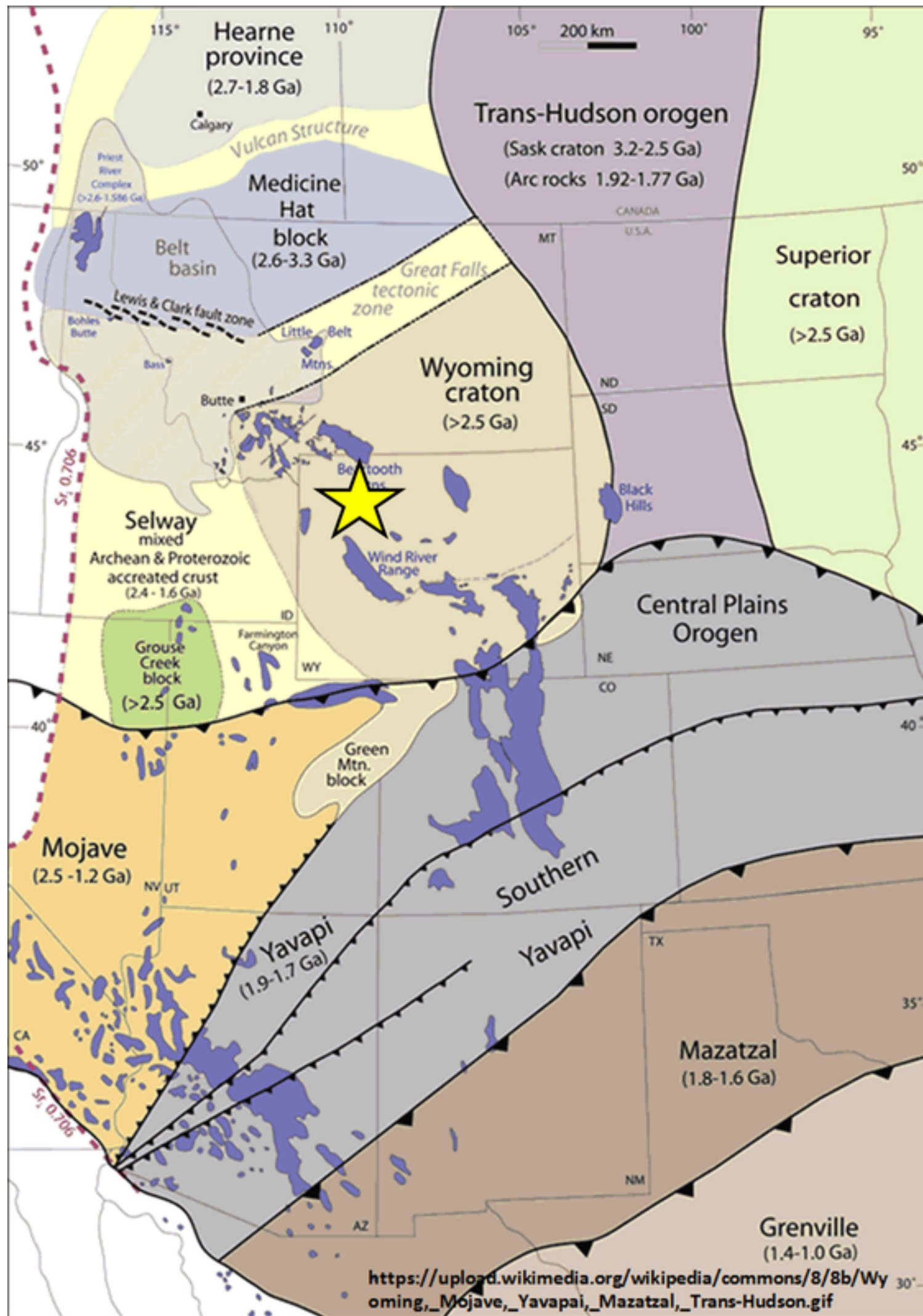
*Image from: Base: Google Earth Image; Overlay Data:*

[http://www.supercontinent.org/gallery2/gallery/v/New\\_Results\\_From\\_Wyoming\\_Craton/WY+subp+map+w-2\\_69+dikes.jpg.html](http://www.supercontinent.org/gallery2/gallery/v/New_Results_From_Wyoming_Craton/WY+subp+map+w-2_69+dikes.jpg.html)

([http://www.supercontinent.org/gallery2/gallery/v/New\\_Results\\_From\\_Wyoming\\_Craton/WY+subp+map+w-2\\_69+dikes.jpg.html](http://www.supercontinent.org/gallery2/gallery/v/New_Results_From_Wyoming_Craton/WY+subp+map+w-2_69+dikes.jpg.html))

A fingertip can span the Archean-Phanerozoic unconformity, a time gap when amazing things occurred in earth's crustal evolution. Beginning about 1.9 billion years ago, Wyoming amalgamated with other Archean crustal blocks to establish the core of the North American continent (aka. "Laurentia" or the "United Plates of America").



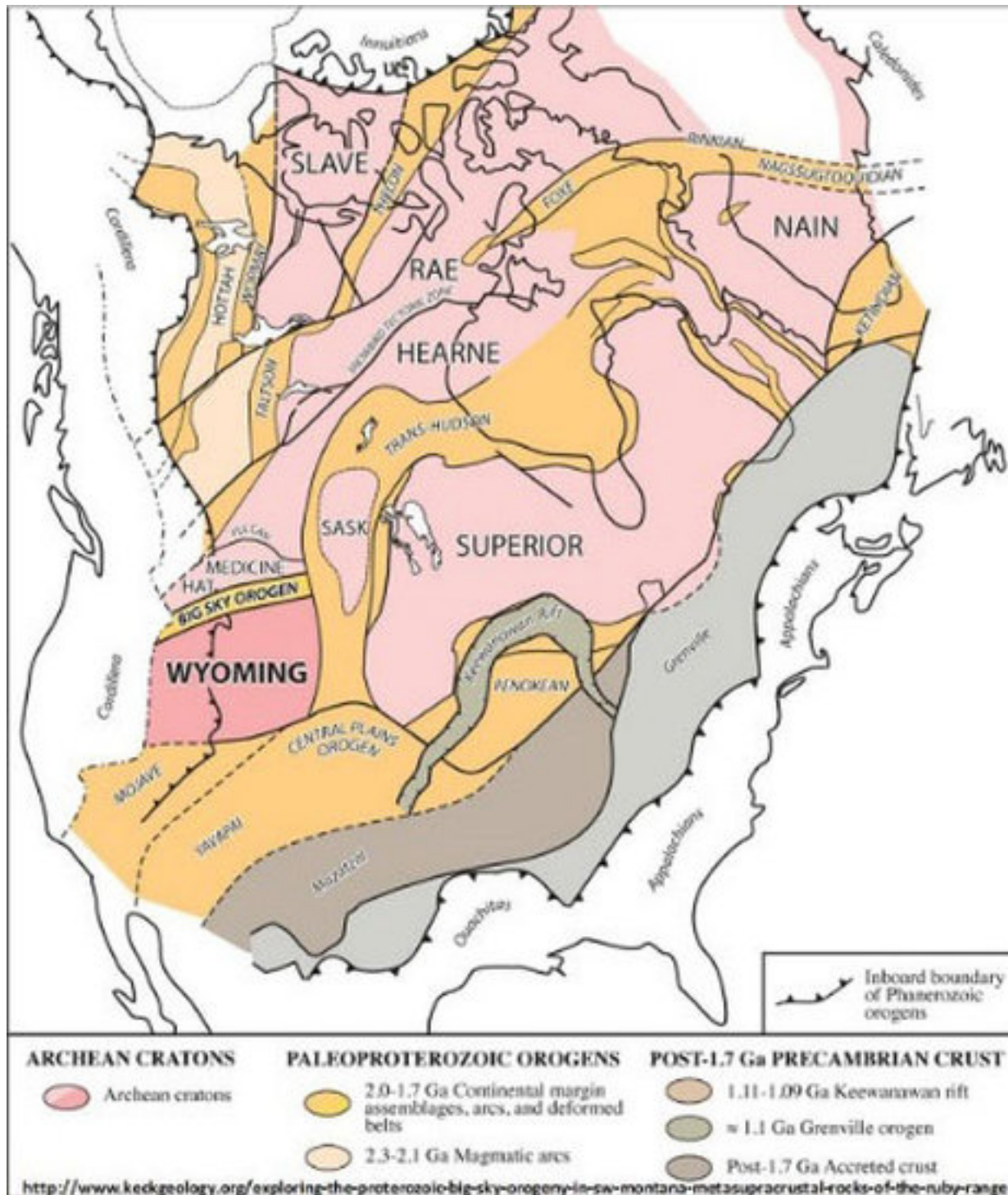


**Wyoming craton orogenic sutures with adjacent Archean blocks, Shoshone Canyon location shown by yellow star.**

Image

from: [https://upload.wikimedia.org/wikipedia/commons/8/8b/Wyoming%2C\\_Mojave%2C\\_Yavapai%2C\\_](https://upload.wikimedia.org/wikipedia/commons/8/8b/Wyoming%2C_Mojave%2C_Yavapai%2C_)





**Wyoming at southwestern margin of North American craton. Image**

**from:** <http://www.keckgeology.org/exploring-the-proterozoic-big-sky-orogeny-in-sw-montana-metasupracrustal-rocks-of-the-ruby-range> (<http://www.keckgeology.org/exploring-the-proterozoic-big-sky-orogeny-in-sw-montana-metasupracrustal-rocks-of-the-ruby-range>)

The Grenville Orogeny occurred 1.3 billion years ago, when the Eurasian and African continents collided with North America to form the Appalachian Mountains and the first “super continent” Rodinia (Russian for “Motherland”). Wyoming was located at the center of the resulting land mass that stretched pole to pole. Several significant events in earth evolution occurred during the existence of Rodinia:

1. The first evidence of a continent scale mountain building episode (Grenville Orogeny)



2. Cyanobacteria flourished, building stromatolites that produced oxygen through photosynthesis (cyanobacteria are ancient organisms that still exist)
3. Bacteria combined in symbiotic relationships, that evolved into Eukaryotes (cells with nuclei; quantum leap in complexity)
4. The first sexual reproduction of organisms as cells developed nuclei (quantum leap in diversity)
5. The dramatic increase in atmospheric oxygen (from our great, great ancestors the stromatolites)
6. The initial breakup of Rodinia led to “Snowball Earth” (ocean and continents covered by glacial ice)
7. Significant changes in ocean chemistry as ice melted, subsea volcanoes (spreading ridges) increasing atmospheric carbon dioxide and increased chemical weathering of rocks.

The breakup of Rodinia, beginning about 750 million years ago, left the Wyoming craton on the southwestern edge of North America at a tectonically passive margin. A shallow sea encroached across this margin onto the Wyoming craton 230 million years later depositing the cross-bedded Cambrian Flathead Sandstone (520 million years) that rests on the Precambrian rocks in the Shoshone Canyon. (<http://images.summitpost.org/original/597478.gif>)





**Cambrian Flathead Sandstone deposited on Archean crystalline basement rock. Unconformity shown by white dashed line.**

*Image from: Fisher, M.P., 2016, Shoshone Canyon Unconformity*

## **What you will see at The Great Unconformity**

Coarsely crystalline pink granite and black gneiss below the contact and buff to tan colored coarse grained sandstone above the contact. When the Cambrian seas flooded the exposed granite and deposited sands in a beach to shallow marine setting, there were no land plants or land animals. Life only existed in the ocean. The shoreline was stark and desolate without vegetation. Study of the Precambrian-Cambrian contact in Sunlight Basin 20 miles to the northwest suggests the Precambrian surface had some relief with the likely existence of granite islands along that rocky coast.

## **Directions to The Great Unconformity**



Starting at the intersection of US 14-16-20 (Sheridan Ave) and US 14A (16th St) in downtown Cody, head west toward Yellowstone on US 14-16-20. Travel through town, 0.8 miles Buffalo Bill Center of the West, 2.8 miles Old Trail Town, 3.2 miles Rodeo Grounds – Stampede Park, 5.1 miles Hayden Bridge – Bureau of Reclamation Road (walk - see below), 5.7 miles bridge over Shoshone, **6.4 miles pull-off and park on right side of highway** just before the first short tunnel, cross highway to south side and touch The Great Unconformity.

## Shoshone Canyon Walk

Certainly the most scenic walk or bike ride close to Cody is on the Bureau of Reclamation road up the Shoshone Canyon toward the dam. Starting at the Hayden Bridge parking area, it is an out and back four mile total walk that will take about 1-1/2 hours to complete. Elevation gain is only about 200 feet. You are adjacent to the Shoshone River and on pavement the whole way. For some unknown reason, you will only see a handful of people enjoying this gem at any one time. For rock climbers, there are a number of bolted climbing routes once you reach the granite. (<https://rootsrated.com/cody-and-east-yellowstone-wy/climbing/lower-granite> (<https://rootsrated.com/cody-and-east-yellowstone-wy/climbing/lower-granite>))

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granites. Across the river and behind the power plant is another good exposure of this same Great Unconformity. The scenery gets special as the road continues along the river another mile in Precambrian granites. You will go through the first tunnel at 1.6 miles after which the road forks. The left fork follows along the river for another 0.3 miles until you reach a second tunnel where you can go no further. If you take the right fork after the first tunnel, the road climbs 0.4 miles and 350 vertical feet up toward the dam visitor center. There is no access to the Buffalo Bill Dam Visitor Center from this direction (see geowyo Buffalo Bill Dam website (<http://www.geowyo.com/buffalo-bill-dam--rattlesnake-mtn.html>)).

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