Roadside Geology of Wyoming

Introduction

Above all else, Wyoming is a geological state. Wyoming may be known as the "Cowboy State," and the license plates display a cowboy on a bucking bronco, but to our minds, Wyoming is first and foremost geological! In every corner of every mountain range and basin within this big state one can find a geological story recorded in the rocks. In some places the story reads clear, in others whole chapters are missing, but that is the nature of geology. Geologists piece together incomplete puzzles about the history of the Earth. Our purpose in writing this book is to convey the overall story of Wyoming's geology and history based on the clues left in her rocks.

For both authors, Wyoming represents the essence of Rocky Mountain geology. As young geologists we "cut our teeth" on Wyoming's geology and our professional careers have been entwined with Wyoming ever since. For us, Wyoming is a "feeling," unique to this part of the Rocky Mountains. It is the feeling of broad, sage-covered basins extending to the horizon, and being able to see for 100 miles in any direction without a house, farm, road, or tree to obstruct the view. It is the feeling of wind, always present, gathering speed through the open basins and funneling around the mountains. It is the feeling of early evening in Jackson Hole when the Tetons cast long shadows across the valley floor. It is the feeling of antelope grazing on spring grass along the Medicine Bow River.

John Wesley Powell, famous geologist and explorer of the Colorado River drainage, and early director of the U.S. Geological Survey, wrote about the landscape of southwestern Wyoming in 1869 when he started down the Green River on his epic float trip through the Grand Canyon. Powell captured in words the "feeling" of Wyoming better than we are able to:

> Standing on a high point, I can look off in every direction over a vast landscape, with silent rocks and cliffs glittering in the evening sun. Dark shadows are gathering in the valleys and gulches, and the heights are made higher and the depths deeper by the glamour and witchery of light and shade. Away to the south the Uinta Mountains stretch in a long line, —high peaks thrust into the sky, and snow fields glittering like lakes of molten silver, and pine forests in somber green, and rosy clouds playing around the borders of huge, black masses; and heights and clouds and mountains and snow fields and forests and rocklands are blended into one grand view. Now the sun goes down, and I return to camp.

This book was written for those who would like to know more about the geology of Wyoming, including Yellowstone and Grand Teton national parks, but who know little or nothing about geology. We did not write this book for our professional colleagues in geology, although we hope that they, too, will enjoy it. Don't be afraid to plunge into the book; it won't bite! All the technical words have been defined in the text or glossary at the end of the book, and the many illustrations will help you visualize the geology. We believe that your appreciation and enjoyment of this great state will be enhanced by "rubbing elbows" with the rocks and history as you drive through.

HUMAN HISTORY AND GEOLOGY

Human habitation and cultural development are profoundly affected by the landscape and natural resources available, and these are the direct product of geology. Wyoming's history of emigration, settlement, resource and agricultural development have been directly controlled by geological factors.

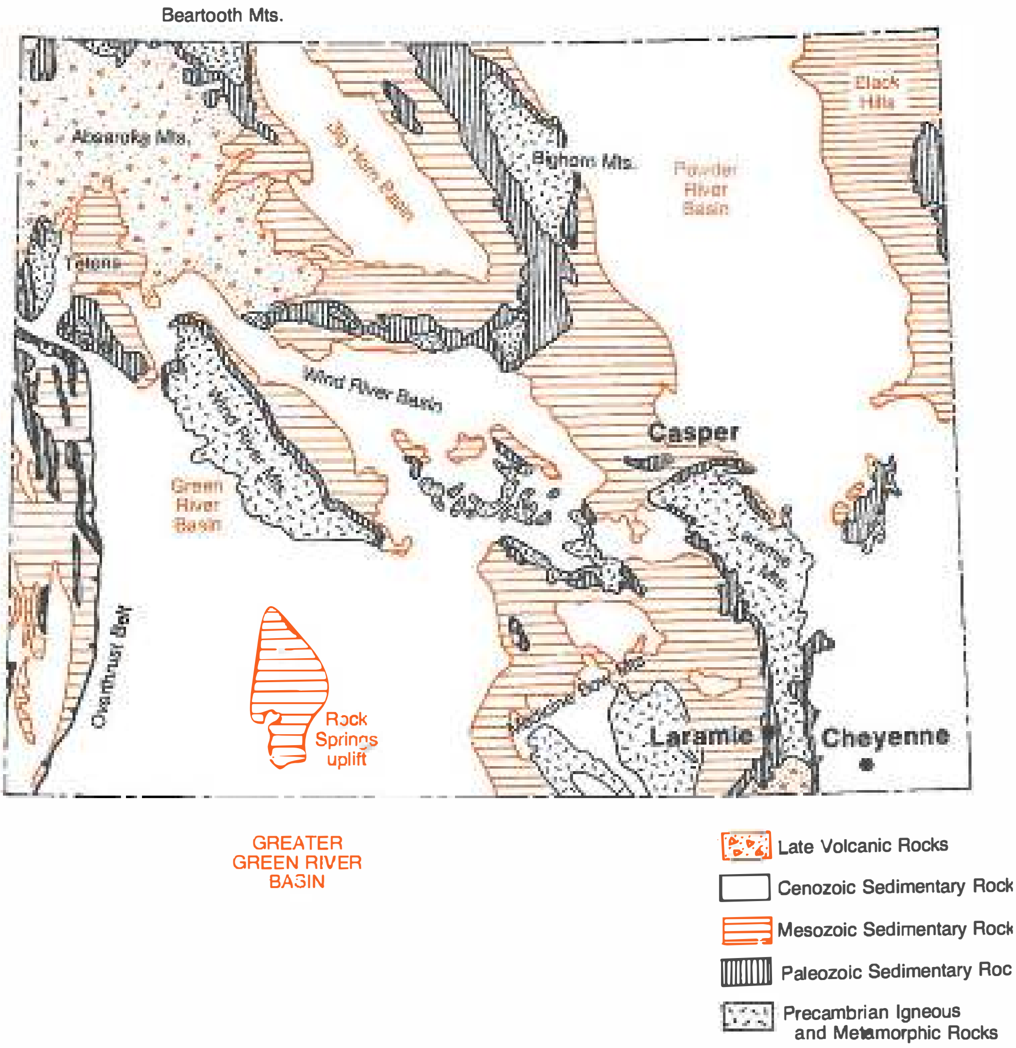
The Indians, of course, were the first natives of Wyoming, although they too migrated to western North America from Asia several thousands of years ago, probably across the Bering Strait. The Indians of Wyoming were nomadic, following the great herds of buffalo, hunting bighorn sheep and elk in the high mountains, and wintering along the banks of the big rivers. Various tribes occupied the region, including the Crow, Shoshone, Sioux and Cheyenne.

The white man came into Wyoming in the early 1800s. The Louisiana Purchase of 1804 gave federal sanction to explorers and fur trappers to open the west for development and settlement. The first expedition to cross Wyoming was the Astorians in 1811-1812. Fur trappers and traders, seeking sleek beaver pelts to be made into fashionable hats for gentlemen, explored every nook and cranny of the state, and Wyoming is rich with their history and namesakes: Jackson's Hole, Colter, Leigh and Jenny lakes, Black's Fork, Smith's Fork, Fontenelle, Sublette, Bonneville, Rendezvous Peak, Bridger, and many others. The mountain men gathered each summer at a predetermined place for a rendezvous to trade furs for supplies, catch-up on old news and, in general, enjoy the comradery of men in a land with no laws! Famous rendezvous sites in Wyoming include the Green River Rendezvous (1833, 1835, 1837, 1839, and 1840) north of Pinedale, the Ham's Fork Rendezvous (1834), and the Wind River Rendezvous (1830 and 1838) near Riverton.

The geological landscape of Wyoming served as a thoroughfare for western migration over the last 150 years—people always passing through but rarely staying. For the tens of thousands of pioneers on the Oregon Trail in the 1840s to 1860s, Wyoming was the means to a better life in the Pacific Northwest, California, or Utah, but it was no place to stop. To the south lay the impenetrable walls of the Colorado Rockies, to the north lay equally forbidding mountains in Montana and Idaho. The "Wyoming Basin" provided a natural pass for the Conestoga wagons across the imposing backbone of the Rocky Mountains.

When the Transcontinental Railroad was built in the 1860s, Wyoming was again the natural choice for crossing the Rockies. Hence, the railroad was built across southern Wyoming, climbing west from Cheyenne on "The Gangplank" of Tertiary sediments that lapped onto the Laramie Range, then across the Laramie basin and around the north end of the Medicine Bow Mountains, across the rocky desert of southwest Wyoming and into northeast Utah. Interstate 80 follows much the same route today.

Wyoming boomed during the railroad building days, boomed during the various gold rushes in the mountains, boomed with



Geologic map of Wyoming.

the tide of oil strikes, boomed with the heyday of uranium mining, and boomed first with underground coal mining and later with surface coal mining. As you can see, the production of natural resources, chiefly energy resources, has been the economic trigger. Wyoming has always had a history of boom followed by bust, followed again by boom. Transient workers came and went with each boom-bust cycle, giving Wyoming the distinctive flavor of a very small permanent population. Indeed, the population today is only about half a million people in a state of 100,000 square miles! There are more antelope than people in Wyoming—that's the way it should be! Wyoming will undoubtedly continue to be driven by boom-and-bust cycles in the future, as the price of natural resources fluctuates on the world market.

Rocks

It is very easy to get "bogged down" in a swamp of technical geological jargon, especially when it comes to names of rocks. Scientists have a tendency to name things, often using lots of complex, Latin-derived words. Our purpose here is to provide a basic introduction to the different kinds of rocks so that you will be equipped to handle the roadside descriptions.

Basically, there are only three groups of rocks that you need to know: 1) igneous rocks, 2) sedimentary rocks, and 3) metamorphic rocks.

Igneous rocks crystallize from magma (molten rock) by cooling. They can either cool within the Earth (intrusive) or on the surface of the Earth (extrusive—lavas and volcanoes). In addition, they are generally classified according to the amount of silica they contain: high-silica igneous rocks are called granite (intrusive) or rhyolite (extrusive); those with intermediate silica are called diorite (intrusive) or andesite (extrusive); and low-silica igneous rocks with about 50 percent silica are called gabbro (intrusive) or basalt (extrusive).

Igneous rocks dominate the landscape in the Absaroka Mountains and Yellowstone National Park of northwestern Wyoming. They also exist in other areas, like the Sweetwater Hills in central Wyoming (where Independence Rock is made of solid granite) and Devils Tower in the northeast corner of Wyoming (the neck of an ancient volcano).

Sedimentary rocks are preserved in Wyoming's large basins, and crop out as tilted layers on the flanks of mountain ranges. Sedimentary rocks are derived from pre-existing rocks through weathering and erosion, followed by deposition in streams, lakes, or the ocean. These rocks form layers and are referred to as "stratified." Sedimentary rocks are generally classified according to the size of fragment that was deposited. From largest to smallest, the size range is: conglomerate (gravel), sandstone (sand-sized), siltstone (silt-sized), and shale (fine mud). In addition, limestone is composed of calcium carbonate derived from shelly organisms (clams, corals, etc.) that lived in clear, warm seas. Lastly, chemical sedimentary rocks are those in arid regions like salt or gypsum that precipitated from water.

Metamorphic rocks are derived from pre-existing rocks through "metamorphosis," caused by extreme heat and pressure. A metamorphic rock has formed new minerals, without melting, that are stable at certain temperatures and pressures. For example, marble is derived from limestone through thermal metamorphism. Likewise, slate is derived from shale through recrystallization at high temperatures and pressures. Schist and gneiss (pronounced "nice") are very common metamorphic rocks, and are found in the cores of Wyoming's mountain ranges. Schist is composed largely of the mineral mica, whereas gneiss is a coarse-grained metamorphic rock with alternating bands of light (quartz and feldspar) and dark (biotite and hornblende) minerals. Schists and gneisses in Wyoming include some of the oldest rocks in North America, over 3 billion years in age!

GEOLOGIC STRUCTURES

Wyoming is a classic region for studying how the crust of the Earth has deformed. The very landscape is the direct result of bending and fracturing of the Earth's crust. We will review the basic types of structures here, and then discuss their origin in the section on geologic history.

Geologic structures may be classified into two basic categories: folds and faults. Folds usually form in relatively ductile (soft) rocks that bend slowly over long periods of geological time, whereas faults occur in more brittle rocks that are rapidly stressed. Therefore, both the relative hardness of the rock and the rate at which it is deformed determine whether a fold or fault will form.

The two most common types of folds are anticlines, in which the limbs dip away from each other, and synclines in which the limbs dip towards each other. The Rawlins uplift and Rock Springs uplift in southwest Wyoming are good examples of anticlines. All of Wyoming's broad, sage-covered basins are synclines. Folds, in general, are the result of compressional (shortening) deformation.

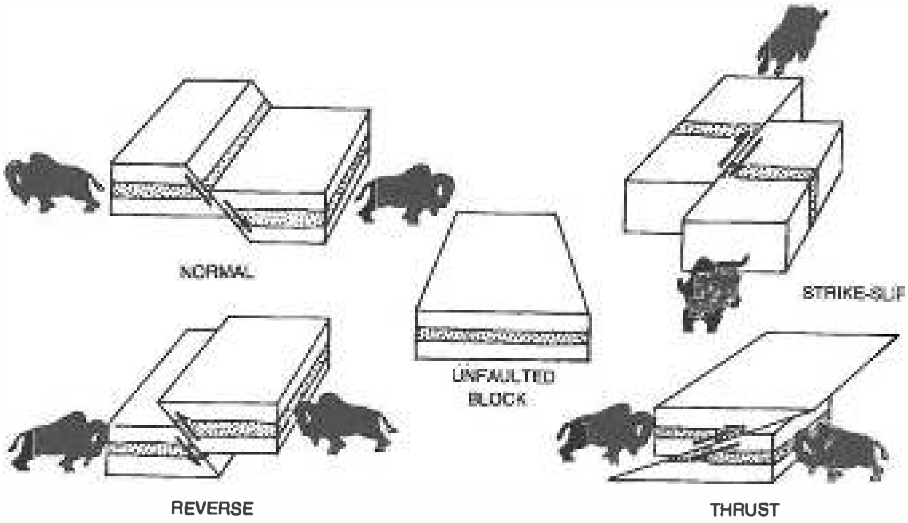
Faults are classified according to whether they extend the crust or shorten the crust. Faults that extend the crust, like the Teton fault, are called normal faults; these faults usually are the result of tension in the crust. Faults that shorten the crust, like the Wind River fault, are called reverse or thrust faults; these are usually the result of crustal compression. A third type of fault, called strike-slip or wrench fault, is the result of shear; the rocks slide past each other. The San Andreas fault in California is a spectacular example of this type of fault. The strike-slip faults scattered around Wyoming are much smaller than the San Andreas!

WYOMING'S EARTH RESOURCES

Wyoming has traditionally been a major producer of energy resources and industrial minerals, and it may play an even bigger role in the future. Wyoming seems to have it all: enormous fields of oil and gas, a seemingly endless supply of low-sulfur coal, large uranium deposits, oil shale, trona, bentonite, gypsum, iron ore, and perhaps most important, clean water.

Wyoming is a leading producer of oil and gas in the Rocky Mountain region. Most is produced from sedimentary rocks buried deeply in the large basins throughout the state, such as the Powder River, Bighorn, Wind River and Green River basins. Refer to the Bighorn Basin chapter for more information on how oil and gas is generated and trapped.

Wyoming contains an incredible amount of coal. Forty thousand square miles, or about 41 percent of the state, is underlain by coal, most of which is close to the surface! This translates into 24 percent of our nation's total coal reserves!



Types of faults: bison push/pulls show how forces act to produce the different types of faults.

Wyoming's coal is in rocks deposited during the Cretaceous period (65 to 140 million years ago) and the early part of the Cenozoic Era (38 to 65 million years ago). During these times, the climate was periodically favorable for dense, swampy vegetation, which formed peat. This peat was then transformed into the almost trillion tons of coal that underlies the sage covered basins of Wyoming.

In the past century, gold was mined to some degree in almost every mountain range in the state, spawning boom towns like South Pass City and Centennial. The town of Encampment sprang up at the base of the Sierra Madre range around the turn of the century as a result of copper mining in that range, and copper mining in the rugged Absaroka Mountains also had its heyday at that time. Although base metal and precious metal production have been historically important, there is no doubt that the production of energy resources has dominated the state's economy.

GEOLOGIC TIME

Time makes geology tick. Not time measured on a watch or in terms of human history, but time measured in millions and billions of years. Time is the essence of geology.

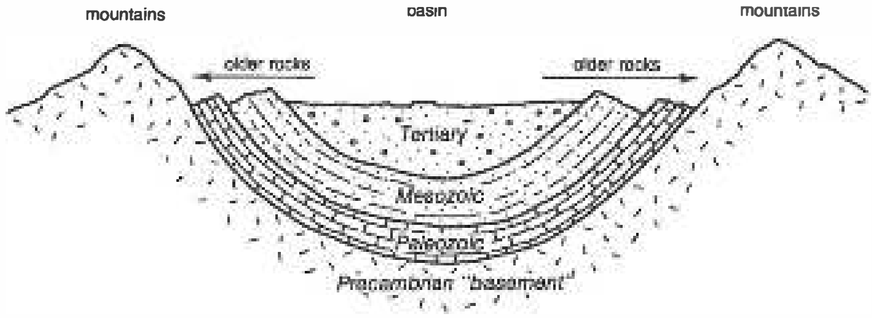


Diagram of stratigraphy in Wyoming's basins and mountain ranges. Note how older rocks are encountered toward the basin edges. This simple diagram shows how the basic structure of Wyoming's foreland province is achieved by upwarping of ranges and downwarping of basins – though in reality more complicated by faults.

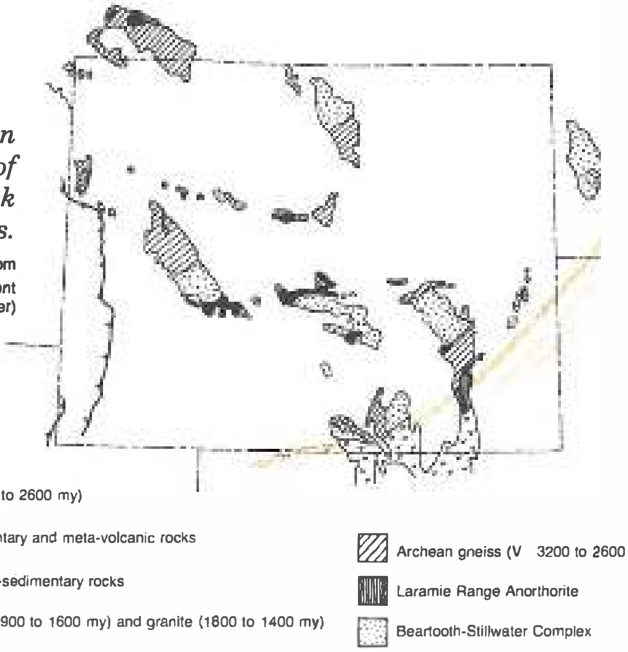
Geologists can date rocks and events in Earth history in two fundamental ways: 1) by relative dating techniques, and 2) absolute dating using radioactivity in rocks. Relative dating tells us the relative age of a rock with respect to neighbor rocks, but does not tell us the rock's absolute age in years. For example, if a rock is cut by a vein of quartz, the vein is obviously younger than the rock it cuts—the principle of cross-cutting relations. Also, rock layers at the bottom of a sequence of sedimentary rocks are obviously older than those on top—principle of superposition. However, we must turn to radioactivity to determine the age of a rock in absolute years. Certain igneous and metamorphic rocks contain minerals with radioactive isotopes that decompose at a constant rate. By measuring the amounts of certain isotopes in rocks, geologists can determine the exact age of a rock, plus or minus a small laboratory error.

The geological time calendar is a convenient, man-made scheme for subdividing Earth history based on relative dating, absolute dating, and paleontology. The Earth is estimated to be 4.6 billion years old, although the oldest rocks thus far dated are a little over 4 billion years old (in Australia). The date of 4.6 billion years is based on radioactive dates of meteorites and lunar rocks, which we assume formed at about the same time as the Earth.

All of Earth history, from 4.6 billion years ago to the present, has been subdivided into 4 main "Eras:" 1) the Precambrian, from 4.6 billion years ago to 570 million years ago; 2) the Paleozoic ("ancient life"), from 470 to 230 million years ago; 3) the Mesozoic ("middle life"), from 230 to 65 million years ago; and 4) the Cenozoic ("recent life"), from 65 million years ago to the present. Each of these Eras is, in turn, subdivided into smaller Periods and Epochs. A geologic time scale showing each division, as well as the major events in each, is located on pages viii and ix.

Precambrian rocks of Wyoming – rock types and ages.

—Adapted from Karlstrom and Houston (1979, front cover)



GEOLOGIC HISTORY OF WYOMING

The Beginning—Precambrian Era

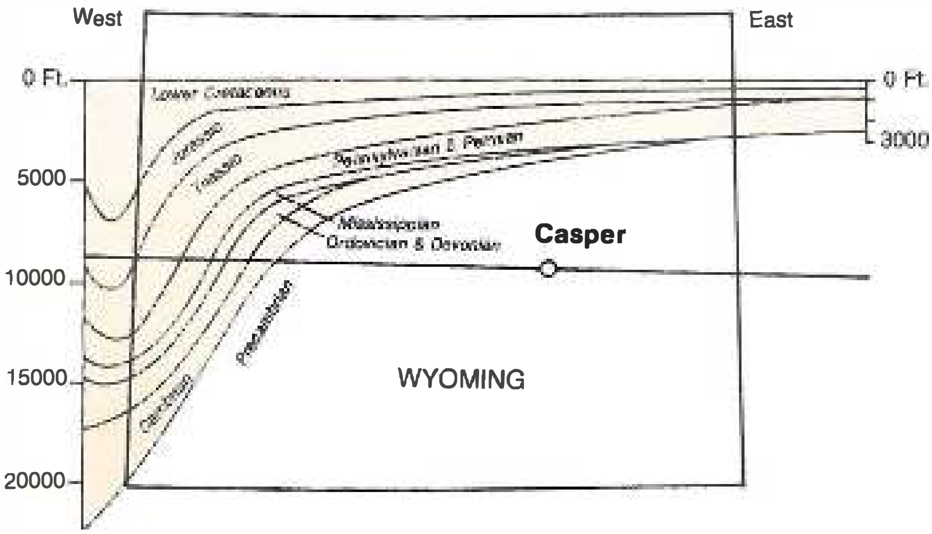
The Precambrian history of Wyoming is recorded in the big mountain ranges. Their cores contain schist and gneiss; basement rocks, that are around 3 billion years old, over half the age of the Earth! These are the oldest basement rocks in the western United States. They are referred to as the "Wyoming Province" rocks.

The south margin of the Wyoming Province is faulted against much younger Precambrian basement rocks (1.7 billion years old) that form the high mountains of Colorado, like the Front range and Park range. This fault zone is called the Mullen Creek - Nash Fork fault zone, and it extends northeast through the Sierra Madre and Medicine Bow mountains to the south end of the Black Hills. Because of their antiquity, little is known about the origin of these rocks. These basement terranes probably represent early micro-continents that gathered together during Precambrian time to form the central nucleus of North America, the "craton."

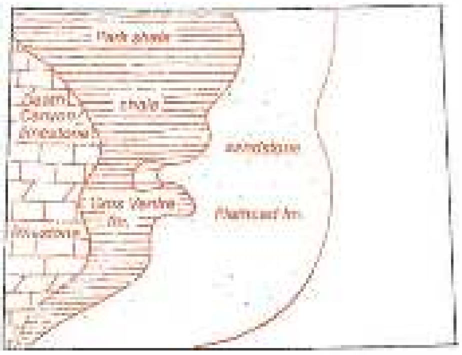
Tropical Seas and Early Life —Paleozoic Era

The Paleozoic history of Wyoming was dominated by warm, shallow, tropical, marine seas. Layers of limestone and shale accumulated on the sea floor to build the Paleozoic sedimentary sequence.

The Rocky Mountain states were part of a broad, submerged, shallow continental shelf that extended along the western margin of North America to the Yukon. Wyoming's portion of the shelf was near the Equator. Land was exposed only in the central part of the North American continent. Marine waters periodically transgressd over the western shelf, depositing sandstone, shale and limestone with each incursion of the sea. The Cambrian Gros Ventre formation of limestone and shale,

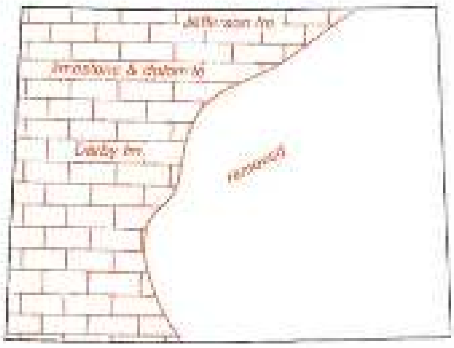


The thickness of the sedimentary rock pile in Wyoming increases dramatically to the west. A shallow platform in the east and an ever-deepening basin to the west existed throughout most of Paleozoic time.

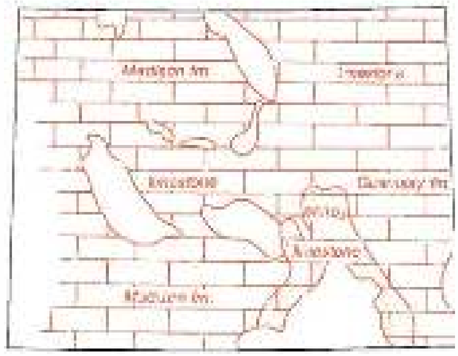


Cambrian rock types and formations in Wyoming.

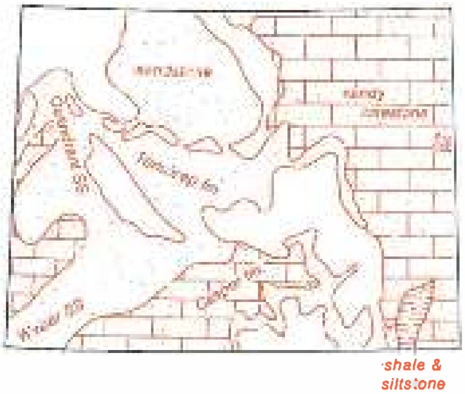
Ordovician rock types and forr tions in Wyoming.



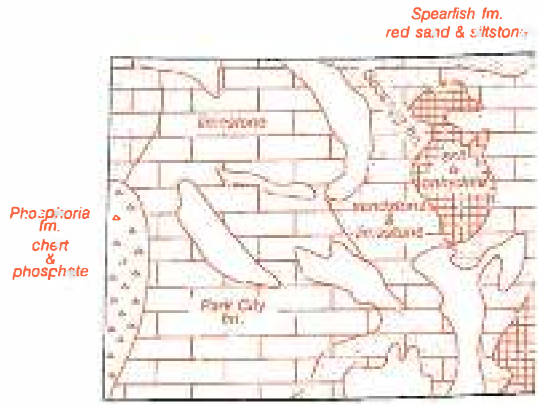
Devonian rock types and formations in Wyoming.



Mississippian rock types and formations in Wyoming.



Pennsylvanian rock types and formations in Wyoming.

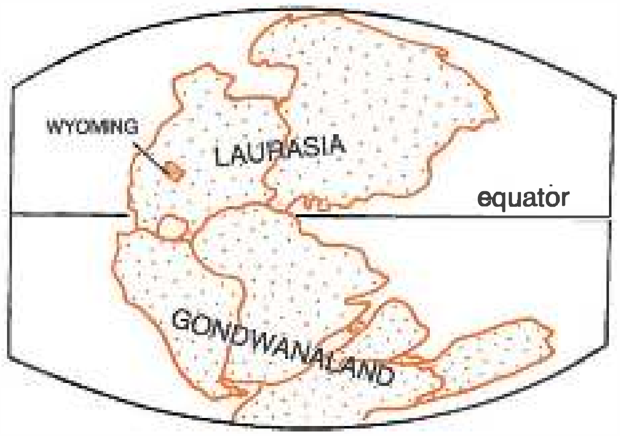


Permian rock types and formations in Wyoming.

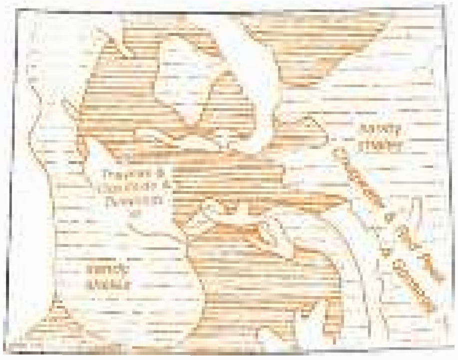
–Adapted from R.M.A.G. *Geologic Altas* (1972) the Ordovician Bighorn dolomite, and the famous Mississippian Madison limestone are examples of the marine sediments deposited on the Wyoming shelf during Paleozoic time. The Wyoming shelf was basically stable during this time, although minor up-and-down movement of the crust caused either erosion or nondeposition of sediments, producing unconformities in the stratigraphic record.

In Pennsylvanian time, the ancestral Rocky Mountains of Colorado were uplifted, perhaps in response to the collision of North America and North Africa. A northern prong of the ancestral Rockies extended into southeast Wyoming from Colorado, called the Pathfinder uplift, but basically the Wyoming shelf was the site of sand deposition (Tensleep sandstone) during the Pennsylvanian.

On a global scale, the close of Paleozoic time witnessed the collision and accretion of all the world's continental land masses to form a supercontinent called Pangaea. The northern part of Pangaea, Laurasia, was made of North America and Europe; the south part, Gondwanaland, was made of South America, Africa, Antarctica, India and Australia. Since this time, the continents have moved to their present positions by a process called "plate tectonics."

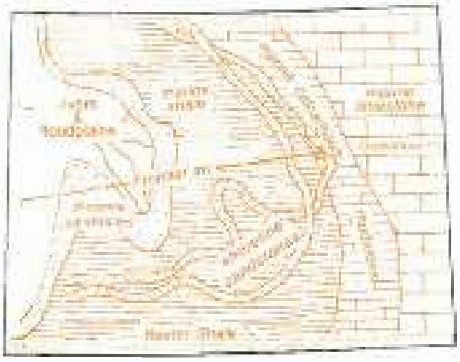


Continental reconstruction at the end of the Paleozoic Era, showing the Supercontinent of Pangaea, composed of Laurasia and Gondwanaland.



Triassic rock types and formations. Most are bright red rocks in Wyoming.

Jurassic rocks of the Morrison formation in Wyoming.



–Adapted from R.M.A.G. *Geologic Altas* (1972)

Cretaceous rock types and formations in Wyoming.

Redbeds and Dinosaurs —Mesozoic Era

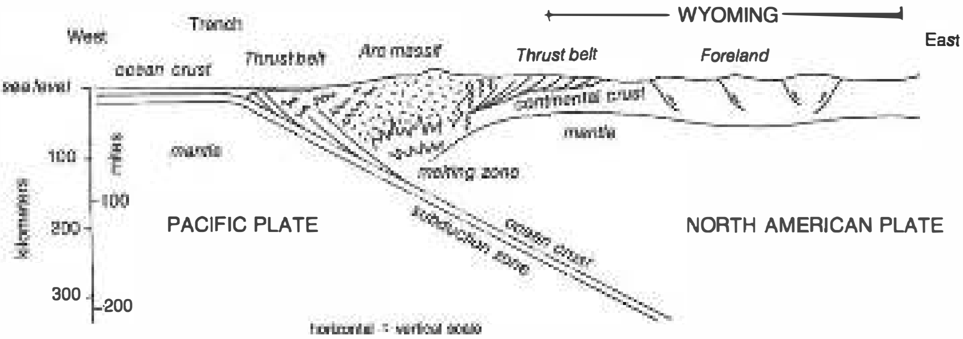
Mesozoic time was a period of transition for the Rocky Mountain region. Bright red Triassic sandstones and shales, the Chugwater formation, were deposited across Wyoming, in sharp contrast to the gray Paleozoic marine limestones. The red and green, dinosaur-bearing mudstones of the Jurassic Morrison formation were deposited on floodplains of rivers, again in contrast to earlier marine shelf sediments.

Marine conditions returned to Wyoming during Cretaceous time, but this time as an inland seaway that extended from the Gulf Coast to the Arctic Ocean, and bordered to the west and east by land. The Rocky Mountain states were largely covered by this seaway, and received thick deposits of sandstones and black, organic-rich shale, such as the Thermopolis, Mowry and Cody shales. These black shales have been the source rocks for much of the region's oil.

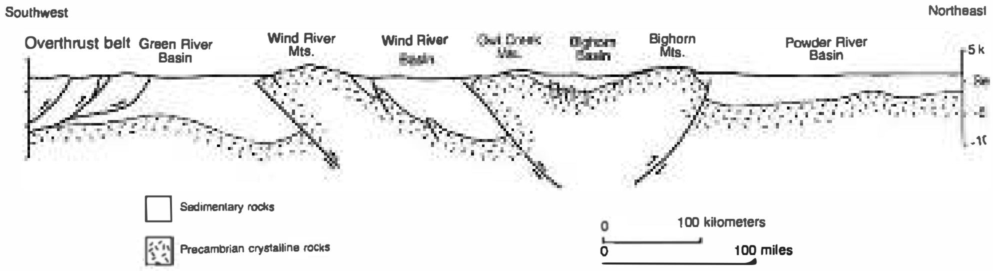
Mountain Building and Mammals —Cenozoic Era

Cenozoic time was a period of mountain building and continental sedimentation. Marine waters never returned to the Rocky Mountain region after Cretaceous time.

The Rocky Mountains were uplifted during an event called the Laramide orogeny—orogeny means mountain building. This event started in late Cretaceous time and continued into early Eocene time. The Rocky Mountain region was compressed as a result of subduction of oceanic crust along the western

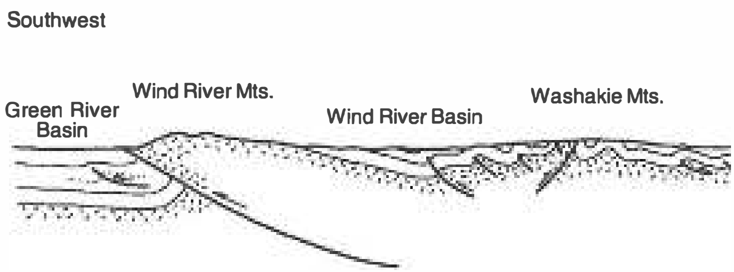


Tectonic framework of western North America during the Laramide orogeny. –Adapted from Grose (1972, p.44)



A profile from northeast to southwest across Wyoming.

margin of the continent. This same process is occurring today along the west coast of South America, and is producing a mountain belt on the east flank of the Andes volcanic chain that is very similar to the Laramide Rocky Mountains of North America. When the crust is squeezed or compressed, it shortens by faulting along reverse or thrust faults. Laramide thrust faults abound in Wyoming and define many of the Precambrian-cored uplifts like the Wind River Range, Bighorn Range, and Laramie Range. Because the sedimentary rocks above the Precambrian basement are more ductile, they were folded over the top and sides of the thrusted basement blocks. This style of deformation, sometimes called foreland style, is spectacularly demonstrated at the Clarks Fork Canyon on the south end of the Beartooth Range near Cody, Shell Canyon in the western Bighorn Range near Greybull, and along the southwest flank of the Gros Ventre Range south of Jackson.

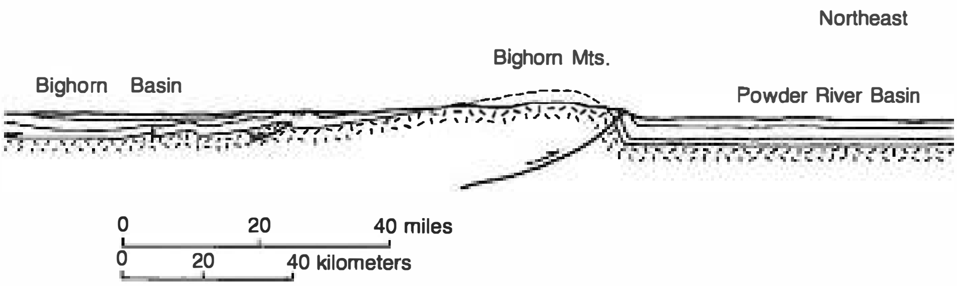


Cross section of Wyoming from

Wyoming yielded to compressive stresses in another way. The far western part of the state is called the overthrust belt for the distinctive style of deformation displayed there. The overthrust belt is a more or less continuous zone of thrust faults and folds that extend along the "backbone" of North America from the Brooks range in Alaska, through the Rocky Mountains of Canada, and down through western Montana, western Wyoming and central Utah. The overthrust belt is characterized by an array of west-dipping, low-angle thrust faults and associated folds that, in general, do not directly involve crustal basement rocks. In other words, the thrusted sheets of rock lay like shingles on a roof, and the thrust faults do not cut into the roof. This region became a major oil producing province in southwest Wyoming and adjacent Utah in the mid-1970s when enormous amounts of oil and gas were found in faulted anticlines.

Highlands created by the Laramide orogeny were slowly worn down by weathering and erosion, with the eroded debris filling adjacent basins. Paleocene time was more humid and wet than our present climate and thick, swampy deciduous forests grew across the state. Their accumulated debris formed the great coal beds of the Fort Union formation; some of those beds are more than 100 feet thick!

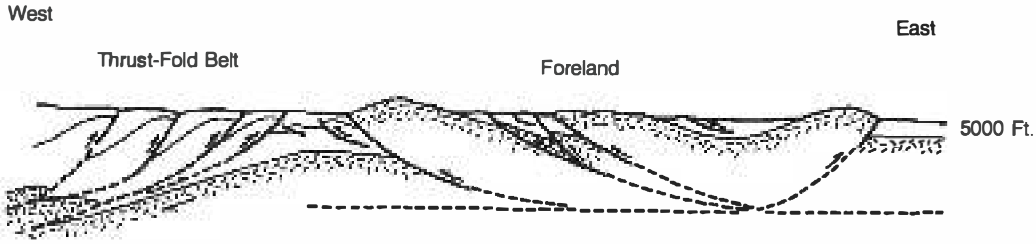
Eocene time is most noted for the accumulation of oil shale beds in southwest Wyoming and adjacent parts of Utah and Colorado. These organic-rich shales, called the Green River formation, accumulated in large, shallow, playa lakes called Lake Gosiute and Lake Uinta. Countless fish skeletons, delicately preserved in the laminated shales of the Green River formation, can be seen at Fossil Butte National Monument west of Kemmerer, Wyoming.



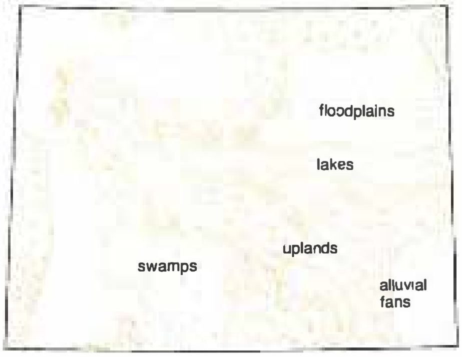
Green River Basin to Powder River Basin

Wyoming sits on the very eastern edge of the North American Thrust Belt.

Oligocene, Miocene and Pliocene time saw continued erosion in the mountains and deposition of the sediments in the basins. Large volcanic eruptions of rhyolite ash occurred to the west in the Basin and Range province of Nevada and Utah during this time, and the ash was carried east by the prevailing winds. This ash is largely responsible for the stark white color of the Oligocene Wind River formation as seen, for example, in the Shirley Basin south of Casper. Miocene and Pliocene rocks have been uniquely preserved in the Sweetwater Hills (also called Granite Mountains) in central Wyoming; this area has been down-faulted since Pliocene time, thus preserving these young Cenozoic strata.

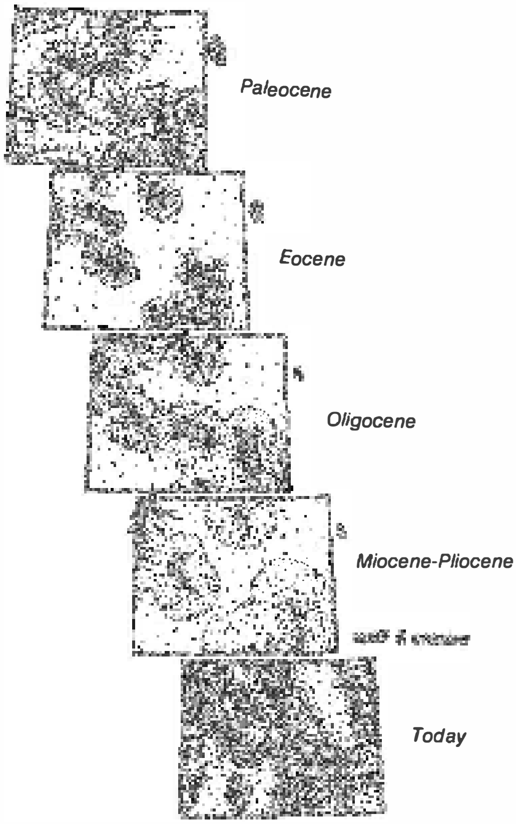


Cross section of Wyoming Thrust and Foreland structure. –Adapted from Lowell (1983, p. 2)

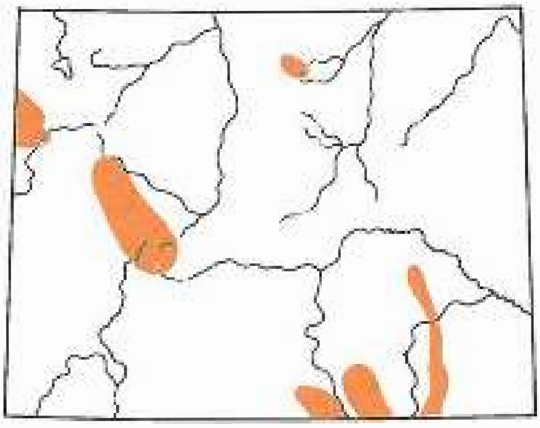


Paleocene rocks and formations

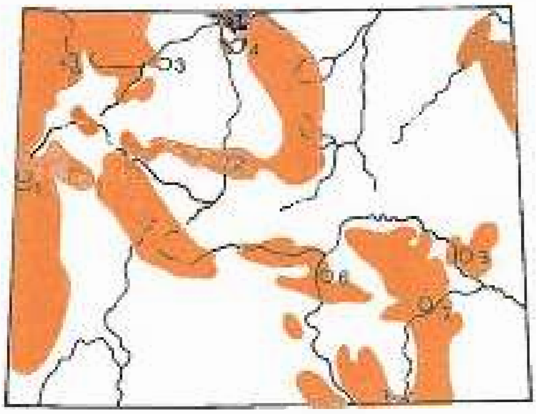
Eocene facies and formations



A sequence of time maps of Wyoming showing the history of "fill-up" of the state's basins throughout the Tertiary. Uplift in Miocene-Pliocene time caused stream cutting and exposure of once-buried mountain ranges, as seen today. –Adapted from R.M.A.G. *Geologic Atlas* (1972)



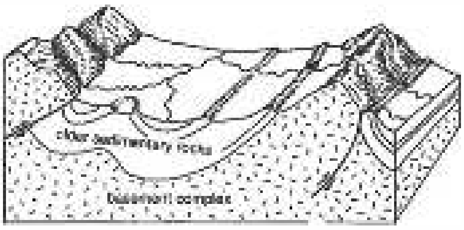
Present-day streams superimposed on Miocene-Pliocene topography. The predecessors to today's streams probably did not vary too much from today's stream locations. –Adapted from R.M.A.G. *Geologic Atlas* (1972)



1 - Snake River Canyon—through the Thrust Belt Ranges
2 - Wind River Canyon—cuts across Owl Creek Mountains
3 - Shoshone River Canyon—slices Rattlesnake/Cedar Mountains
4 - Bighorn River—cuts Sheep Mountain
5 - Bighorn River Canyon—goes through Bighorn Mountains
6 - Fremont Canyon—North Platte River cuts through Seminoe Mountains
7 - Laramie River—flows through Laramie Range
8 - Platte River—flows through canyon at Guernsey State Park across the Hartsville uplift
9 - Belle Fourche River—cuts across the structure at the north end of the Black Hills

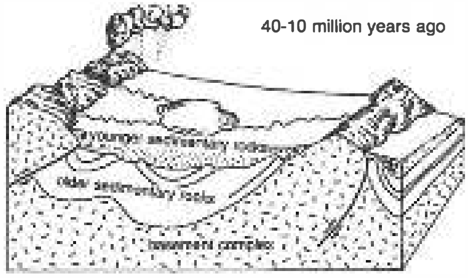
After Miocene-Pliocene uplift, streams began to cut down and erode. As they did so, they cut into buried mountain ranges and entrapped themselves into canyons we see today. The circles show where rivers cut right across ranges in patterns that seem senseless until this story of sediment fill-up, uplift, erosion and entrenchment is understood. –Adapted from R.M.A.G. *Geologic Atlas* (1972)

70-40 million years ago



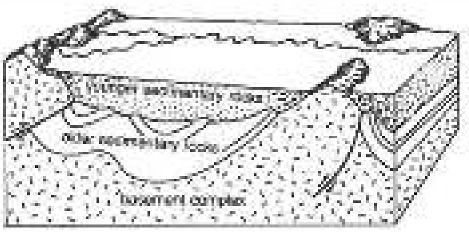
1 *Mountains and basins are formed by folding and faulting. Extensive erosion begins.*

40-10 million years ago



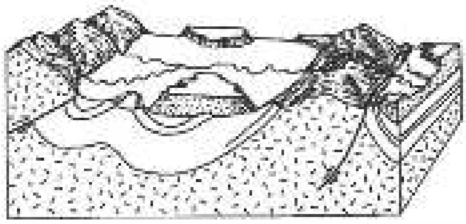
2 *Basins are partly filled by sediments eroding from mountain. Volcanoes add to the fill.*

10-5 million years ago



3 *Basins fill to overflowing. Master streams course through low places over buried ranges.*

5 million years ago to Present



4 *Regional uplift causes new cycle of extensive erosion and downcutting by streams. Canyons are cut across ranges & mountains are exhumed.*

–Adapted from a drawing by S.H. Knight, University of Wyoming

In the last 2 million years, Quaternary time, several dramatic things have significantly changed the Wyoming landscape. First, Yellowstone came into existence through several, enormous volcanic explosions of rhyolite ash apparently due to eastward movement of the Snake River plain; this is discussed in the section on Yellowstone Park. Secondly, the Teton Range rose as Jackson Hole dropped, both movements the result of tensional stresses that are pulling the crust of the western U.S. apart. Lastly, on a far grander scale than either Yellowstone or the Tetons, the entire intermountain region and Basin and Range province have been arched upwards causing rivers to down-cut their channels, resulting in accelerated erosion over the entire western U.S. The cause of this uplift may be related to high heat flow from the mantle which is causing crustal extension and normal faulting. In Wyoming, the result is that the old Laramide ranges and basins are being exhumed, or dug out, as modern rivers cut their way downward. This is why you will see rivers like the Wind River cutting across the Owl Creek and Bighorn mountains, instead of flowing around them. John Wesley Powell, early explorer and western geologist, called this process "superposition" of streams.

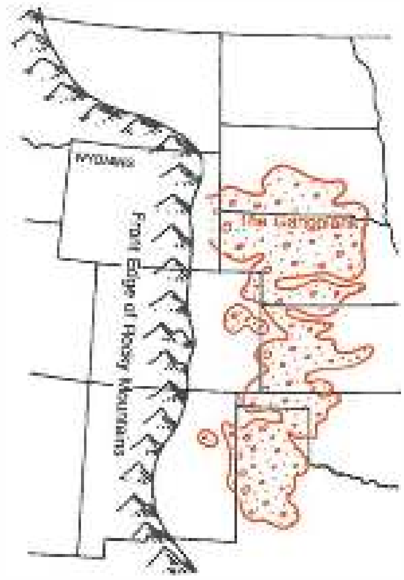
In conclusion, you can see that Wyoming has had a long and complex geological history. The story has been greatly simplified for our purpose here, but it is nevertheless based entirely on what the rocks tell us. Our ideas and interpretations may change with time as more is learned, but the basic facts recorded in the rocks remain true. As geologists, we are constantly striving to better understand the history of the Earth as recorded in the rocks.

I
Southeastern Wyoming

INTRODUCTION

Southeastern Wyoming is a zone of transition from the High Plains to the Rocky Mountains. It is a land that contains elements of both the plains and mountains, for here the north end of the rugged Colorado Rockies project into an otherwise flat region. For more than 150 years, herds of pronghorn antelope have curiously watched a steady caravan of passing humanity. Southeastern Wyoming was the corridor through the Rockies for early explorers, fur trappers, west-bound emigrants, and the Union Pacific Railroad. Today, it remains a thoroughfare for millions of travellers who, like the early pioneers, pass through but seldom stop.

To the south, the northern Colorado Rockies are composed of two great mountain uplifts, the Front Range on the east and the Park Range on the west. The Front Range rapidly looses elevation northward from the 14,000 foot summit of Longs Peak, Colorado, and splits into the Laramie and Medicine Bow ranges in southeastern Wyoming. Similarly, the Park Range plunges north into Wyoming, becoming the Sierra Madre Range. The landscape of southeastern Wyoming is dominated by these three prongs or extensions of the Colorado Rockies. In addition, a small arch called the Hartville uplift connects the northern Laramie Range with the south end of the Black Hills in South Dakota.



Extent of the high plains east of the Rocky Mountain front. The Gangplank is part of a remnant apron of early Tertiary-aged sediments that spread east from the eroding Rocky Mountains.

MOUNTAINS OF SOUTHEASTERN WYOMING

Laramie Range

The Laramie Range is a mere prong of the northern Colorado Front Range, but it is this range, out of all others in the Rockies, that gave the great mountain building episode called the Laramide orogeny its name. The Laramide orogeny was the birth of the entire Rocky Mountain system, occurring in early Cenozoic time, around 50-65 million years ago. It was caused by subduction of oceanic crust along the western margin of the continent; this in turn compressed and uplifted the continental crust to form the Rockies.

By Rocky Mountain standards, the Laramie Range is a low, flat, subdued uplift. It barely resembles the mass and height of its Colorado cousin to the south. Because the Laramie Range was not so formidable, western emigration moved through this part of the country in the 1800s. The highest point is Laramie Peak, 10,274 feet, at the north end of the range. Laramie Peak is visible for more than 100 miles and was the pioneer's first glimpse of the Rocky Mountains. The emigrants followed the North Platte River, skirting the north end of the range to Fort Caspar. Later, in the late 1860s, the Union Pacific Railroad