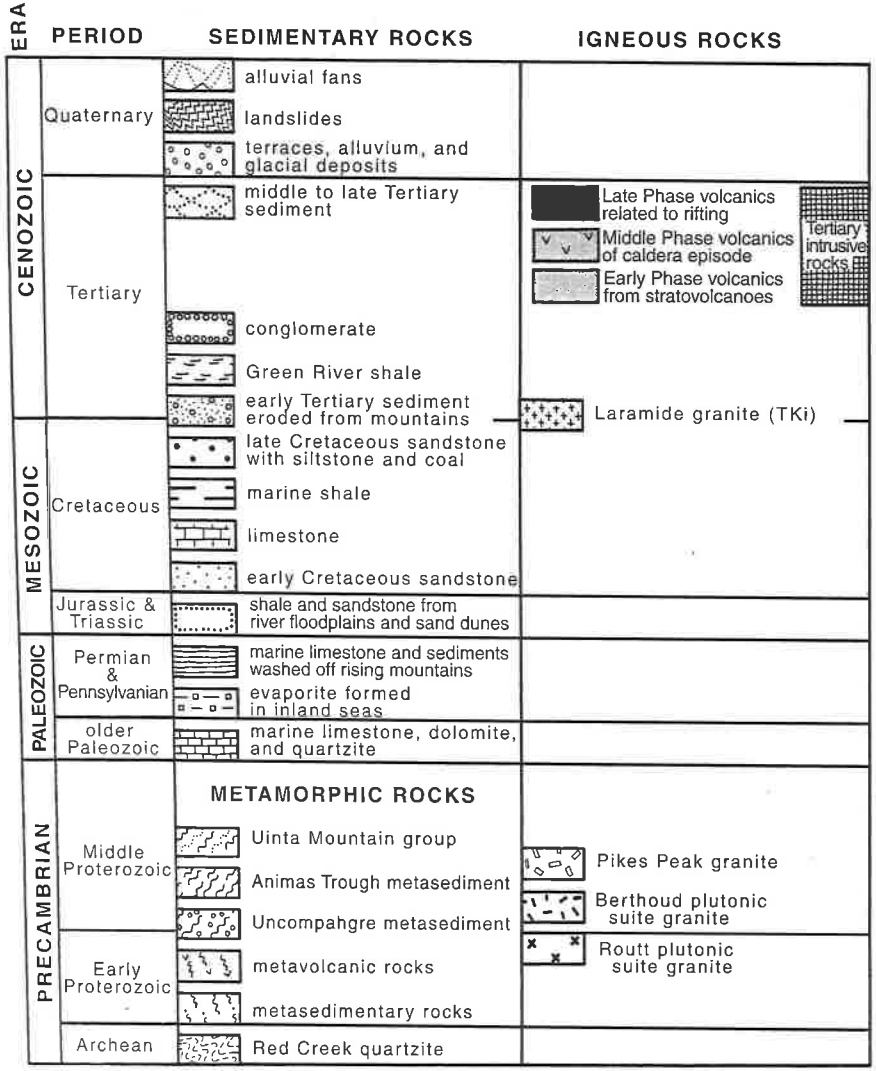
ROCK SYMBOLS USED ON MAPS



ROADSIDE GEOLOGY of COLORADO

SECOND EDITION

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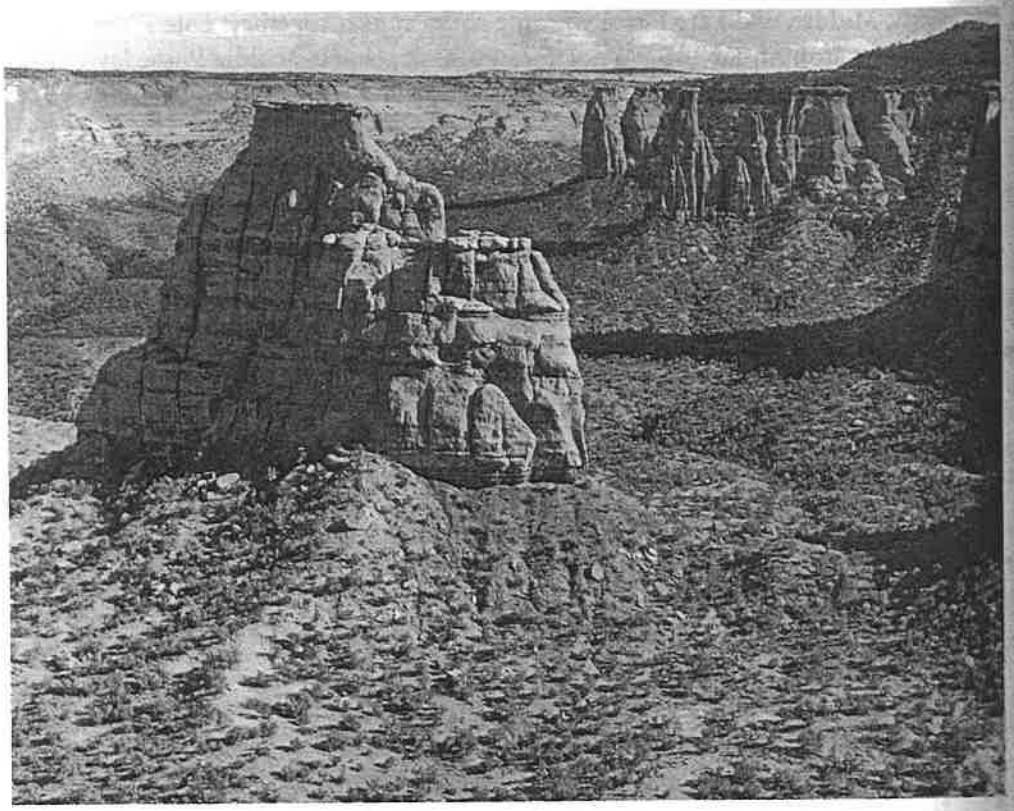


Far western Colorado is sharply carved, with deep canyons and ravines separating flat-topped mesas, buttes, and plateaus. Erosion of horizontal rock layers—some hard, some soft—governs the shape of the land. Independence Rock, Colorado National Monument.
—Ray Strauss photo

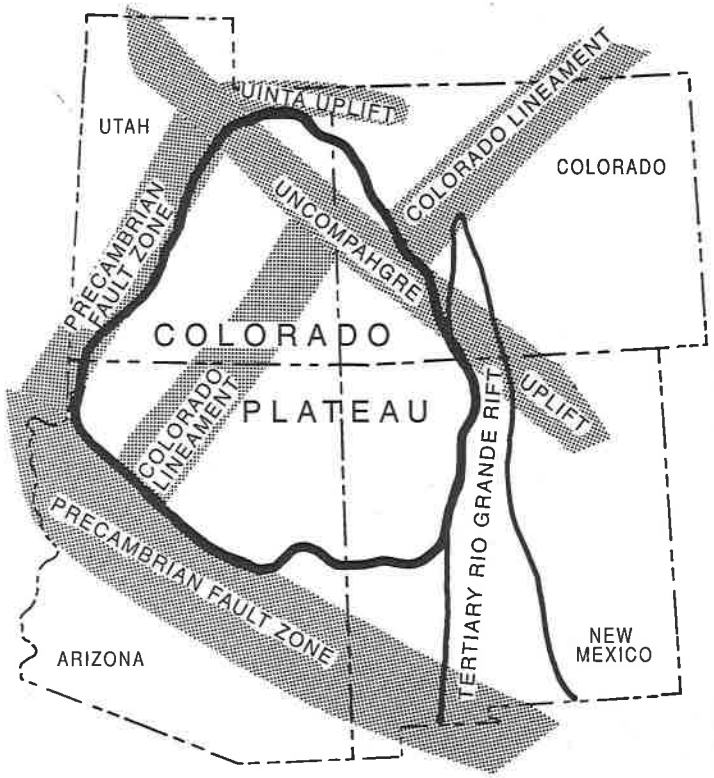
VI
Plateau Country

West of the Rocky Mountains is a region of flat-lying sedimentary rock known as the Colorado Plateau. Named for the great river that runs through it, it extends far into Utah, Arizona, and New Mexico. This region escaped the wave of unrest that swept across western North America when the continent collided with a subcontinent along its western coast. The collision thrust up the Sierra Nevada, the ranges of Nevada and Utah, and then the Rockies. The Colorado Plateau bowed and buckled, it is true, and was rotated a bit and uplifted many thousands of feet, but the sedimentary rock layers remained nearly horizontal.

The entire Colorado Plateau lies within the drainage basin of the Colorado River, whose tributaries carve its innumerable canyons. Simple folds and faults in many places control the drainage, blocking established streams and forcing them to detour or to cut deep into hard, intractable Precambrian rock. These same faults and folds give different elevations to different portions of the Plateau Country. The Uncompahgre Plateau, for instance, reaches 9,000 feet above sea level, Mesa Verde is 7,000 feet, and the Roan Plateau averages 8,000 feet. None of the component plateaus show the intense folding and thrust faulting that characterize the Colorado Rockies.

This is a colorful land in which many of the sedimentary layers, tinted with shades of salmon, pink, or dark rust red, contrast sharply with the blue of high-altitude sky and the soft greens of piñon, juniper, and sage. It is a desert land now, as it has been before, with average annual rainfall below 10 inches. The warm-hued rocks are often bare of soil, and vegetation is usually scanty, making it a scenic and geologic wonderland whose history is more easily read than that in many other parts of the world.

In the Plateau Country, Precambrian rocks are exposed only in the hearts of the deepest canyons and along the margins of a few fault-block uplands. These sparse outcrops, however, are enough to tell us that the western part of Colorado experienced the same Precambrian events as the rest of the state. Let's look a moment at western Colorado's story.



The Colorado Plateau covers parts of Colorado, Utah, Arizona, and New Mexico. Its boundaries are fault zones discernible on maps and satellite images, most of them first activated in Precambrian time.

Precambrian Time

Sedimentary and volcanic rocks deposited along an ancient continental margin some 1.8 billion years ago were folded into the roots of mountains and intruded by granite 1.7 and again 1.4 billion years ago. Each period of mountain building was caused by a collision along the continent's southeastern coastline, first in what is now New Mexico, then in Oklahoma and Texas. Between orogenies, a broad valley sank between deep rift faults in the southwestern corner of the state, seemingly in response to crustal tension. Well after the second orogeny, a similar valley developed in Colorado's northwestern corner.

Paleozoic Time

Cambrian sandstone, now mostly metamorphosed into quartzite, was preserved in the same two corners of western Colorado. Ordovician and Silurian rocks, if they were ever deposited there, were removed by erosion before Devonian and Mississippian limestones accumulated in shallow seas above the Cambrian layers.

Uncompahgria, an isolated range that was part of the Ancestral Rocky Mountains, rose in Pennsylvanian time in southwest Colorado, faulted upward and westward as a result of North America's collision with Africa. West of Uncompahgria, shallow seas repeatedly flooded a nearly landlocked basin and, through repeated evaporation, left behind thick deposits of salt. Erosion gradually removed earlier Paleozoic strata from Uncompahgria, leaving bare the old horizontal surface of the Precambrian rocks.

Mesozoic Time

Triassic rivers spread floodplain and delta sediments across the horizontal surface. From time to time and place to place, dunes drifted across the land.

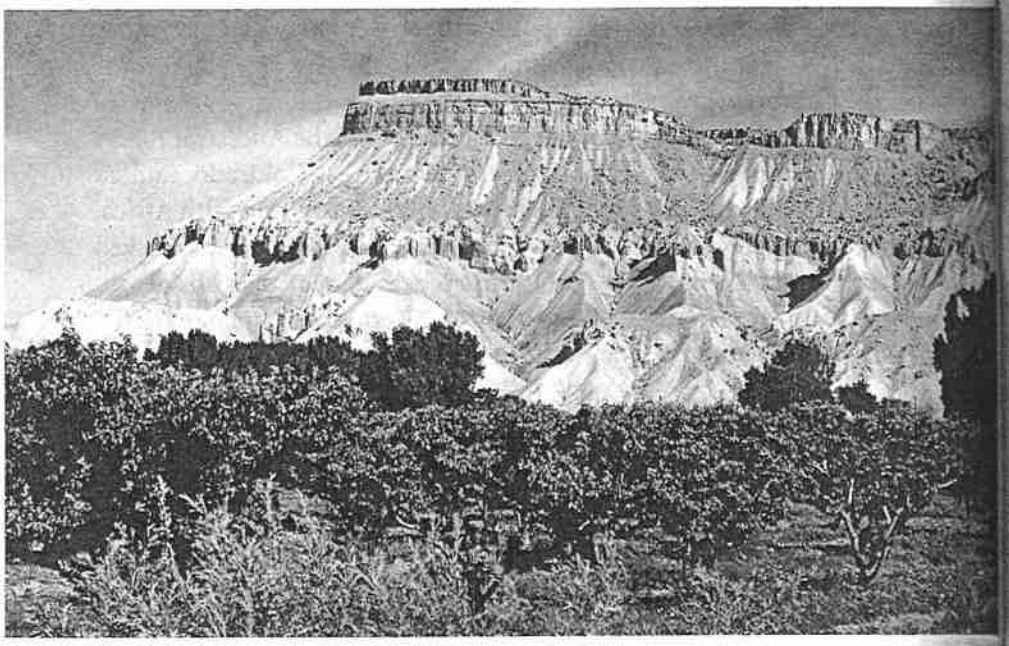
North America's collision with a Pacific subcontinent in Jurassic time created the Sierra Nevada in California and Nevada. This immense range blocked sea-moistened winds from reaching the interior, creating a broad dune-swept region as large as today's Arabian and Saharan Deserts. The region that eventually became the Colorado Plateau lay at about the same latitude as today's major desert areas, 20 to 30 degrees from the equator. Gradually, the scattered dune fields of early Triassic time were replaced by sweeping sand seas that became the Wingate, Navajo, and Entrada sandstones.

As time went on, the climate changed: the deserts were replaced by lush, swampy lowlands watered by meandering rivers. Mud, sand, and volcanic ash deposited in these lowlands late in Jurassic time is now the Morrison formation, famous for its abundant and varied fossil dinosaur fauna.

As the Cretaceous period began, streams and rivers deposited discontinuous patches of the Burro Canyon formation, more mud and sand. Then, a short-term advance and retreat of an eastern sea left behind the thin but widespread shore deposits that are now the Dakota sandstone.

As the central part of the continent slowly sank, it was finally inundated by a shallow sea that blanketed the Dakota sandstone with a thick, uniform layer of mud known today as the Mancos shale in the Plateau Country, the Pierre shale in eastern Colorado and adjacent states. This thick gray shale preserved the shells and skeletons of innumerable marine animals, among them coiled ammonites, giant oysters, clams, and swimming reptiles.

Late in Cretaceous time the wave of mountain building that started in California in Jurassic time arrived in Colorado, and the land began to rise, forcing the sea to retreat eastward. The receding sea left sandy beach deposits, river deltas, and the muds of bays and swamps—now layers of sandstone, shale, and coal collectively called the Mesaverde group—in western



Mt. Garfield near Palisade, with slopes of Mancos shale and a cap of Mesaverde group sandstones, displays the cliff-slope-cliff topography characteristic of the Plateau Country. —Jack Rathbone photo

Colorado. Because the shoreline shifted eastward as the sea retreated, the western part of this unit is somewhat older than the eastern part. Such time-crossing is quite common in shoreline sediments.

We know that the Cretaceous period came to an abrupt end with the violent impact of an asteroid or comet around 65 million years ago. Although the continent suffered little physical harm—the rise of the Rockies was not related to it—biologically Earth changed forever. The dinosaurs, along with a large proportion of other life forms, were gone. Freed of fearsome predators, mammals gradually took over the world.

Cenozoic Time

Strangely, the entire Colorado Plateau escaped the Laramide Orogeny almost unscathed, like a well-built raft floating in a stormy sea. Mesozoic sediments between the Wasatch Range in Utah and the Rockies in Colorado remained nearly flat-lying. Gently warped or faulted structures of this land—including the many lesser plateaus—were hardly more than ripples on the foreland of the Rockies.

During and since Tertiary time, great rivers flowing from the Rocky Mountain and Uncompahgre highlands have played major roles in shaping the land. When drainage was blocked by surrounding uplifts, an immense basin formed in the area where Colorado, Utah, and Wyoming join. Many thousands of feet of silty and sandy mud were swept from the rising mountains and deposited on river floodplains and deltas in the basin, forming the Wasatch formation. Eventually, a lake known to geologists as Lake Uinta filled part of the basin south of the Uinta uplift. During its 6.5-million-year existence, the lake filled with fine muds that became the Eocene Green River shale—some of it oil shale, one of the greatest undeveloped fossil fuel sources in the world.

Then for many millions of years, possibly fueled in some way by the subduction of the Pacific plate, volcanoes reigned supreme. Lava flows and welded ash sheets spread from large volcanic centers around the margins of the Colorado Plateau, while volcanic ash drifted across much of the western part of the state. As volcanic activity decreased, uplift began again, the regional lifting and stretching of mid-Tertiary time that brought Colorado and parts of adjacent states to their present elevations. Breaking its ties with the Rockies, the Colorado Plateau pulled away, its southern edge swinging westward, opening a long, narrow rift valley that extended from central Colorado south through New Mexico. Basalt spread from deep faults along the rift and along faulted edges of the Colorado Plateau.

Boosted by the renewed uplift as well as by increased rainfall and snowfall during Pleistocene time, the Colorado River and its tributaries assailed the Plateau Country, carving intricate canyons, mesas, cuestas, and badlands, blending the scenery of western Colorado with that of adjacent parts of Utah, Arizona, and New Mexico.

The Plateau Country possesses not only superb scenery but a wealth of important energy resources—oil and gas in Paleozoic, Mesozoic, and Cenozoic rocks, uranium in Triassic and Jurassic sandstones, coal in Cretaceous strata, oil shale in the Tertiary Green River formation, and sunshine, gift of its desert climate.