MONTANA GEOLOGY

SQUARE BUTTE

"Charles M. Russell and his friends"—C. M. Russell (oil), 1922.

January

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April

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September

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December

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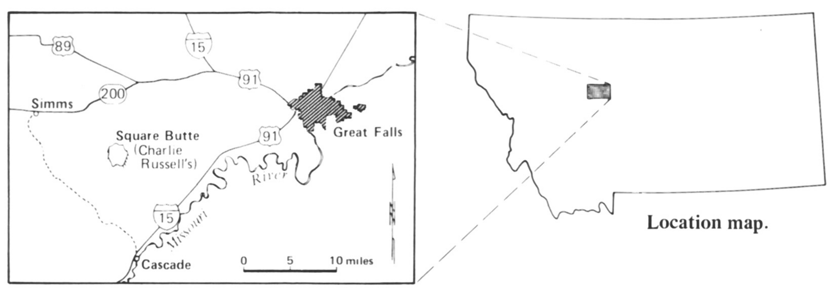
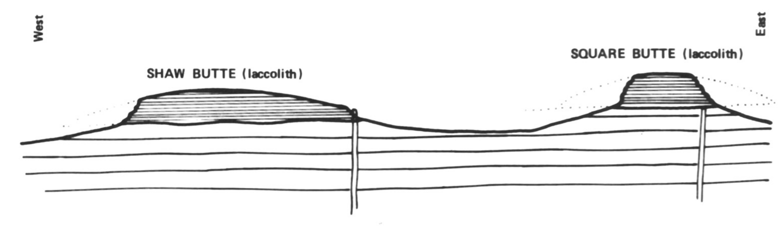


Location map.

Charlie Russell's SQUARE BUTTE



West-east cross section through two large laccoliths between Interstate 15 and Montana 200 west of Great Falls. Eroded parts of the laccoliths, great blister-shaped intrusions of igneous rock, are restored by dotted lines.

Some people say it was his favorite mountain. Charlie Russell must have liked Square Butte because its blocky outline hovers in the backgrounds of a good many of his pictures. And there is no mistaking the mountain. Square Butte is one of Montana's familiar landmarks, well known to everyone who has ever frequented the country a few miles west of Great Falls.

Square Butte's steep sides flare outward at its base to merge smoothly into the surrounding plains, and they steepen upwards into high cliffs that make the flat top of the mountain nearly inaccessible from all sides. The Indians are said to have used it for a fort. Square Butte's broadly undulating tip is a surviving island of the primitive prairie, standing untouched high above the surrounding plains safely beyond the reach of wheels and all they bring with them. Maybe it was his knowing of that secret and unchanging world hidden up there that attracted Charlie Russell to Square Butte, a place so guarded by cliffs that time passes without intruding.

Square Butte is the largest and most distinguished of a small company of geologically similar mountains that dot the surrounding prairie. Nearby Crown Butte is smaller but just as high and perhaps even steeper. Fort Shaw Butte and Cascade Butte are both large, but neither is as high as Square Butte or as cliffbound.

All of these buttes, as well as another group a few miles to the south that include Fishback and Lion Head, are outposts of the Adel Mountains, a rugged volcanic field that covers quite a large expanse of the country between Cascade and Wolf Creek. The Adel Mountains volcanic rocks are easy to recognize because they are almost black and densely salted with rectangular crystals of pyroxene about a half inch long that really are black. The highway through the Missouri River canyon between Wolf Creek and Cascade passes numerous good exposures of these rocks in roadcuts and the big cliffs along the river. About 50 million years ago the area was a spectacular cluster of active volcanoes. A long series of large eruptions built them on top of a stack of sandstones and mudstones that had accumulated in a shallow sea which covered most of the eastern two-thirds of Montana during Cretaceous time a few million years earlier. Erosion has since carved the original volcanic mountains right off the landscape, but plenty of the rocks that made them survive in the modern hills.

Volcanic eruptions happen when molten rock rising from a depth of many miles bursts through the surface. Volcanoes frequently plug themselves so tightly after an eruption that the next batch of molten rock can't easily find a passage through the old plumbing but accumulates in a reservoir beneath the surface and builds up pressure. Sometimes it eventually erupts through the old volcanic vent, sometimes it bursts through the surface somewhere else to start a new volcano, and sometimes it squirts into the surrounding rocks and cools there without ever erupting at the surface. That is what made Square Butte.

The main volcano appears to have been somewhere in the area a few miles south of Cascade. Molten rock accumulated underground there and built up pressure until it finally split the surrounding mudstones and sandstones. Molten rock squirted upward along the crack until it reached a heavy layer of rock that didn't split and then spread out beneath it to make a thin pool sandwiched between two layers of rock.

All this happened deep beneath the surface, perhaps as much as a half mile down and several miles from the closest volcanoes. It probably happened without disturbing the surface much beyond raising it a few hundred feet to the accompaniment of minor earthquakes caused by the molten rock pulsing through the cracks beneath. The small mammals that lived in the area then, during that period shortly after the dinosaurs disappeared, probably didn't notice that anything was happening.

During the 50 million or so years that have passed since that volcanic activity ended, the tediously slow processes of erosion have reduced the landscape to a level below the thin layers of hard igneous rock that formed when the molten magma finally cooled and crystallized. Those layers cap the high buttes now because they resist erosion much more stoutly than the sandstones and mudstones that once surrounded them.

The masses of hard igneous rock that cap Square Butte and the others nearby were originally very broad and thin, shaped about like giant vanilla wafers several hundred feet thick. Erosion has now stripped the softer sandstones off their tops, washed the mudstones away from around them, and nibbled the thin edges of the cookies until only their thicker center parts remain. These form the high cliffs. The gentler slopes that flare outward into the plains below are eroded into soft mudstones.

The molten rock also solidified in the cracks it squirted through, making long, thin intrusions shaped like boards that angle upward through the mudstones and sandstones from the area below the old volcano south of Cascade to the high buttes. Erosion has exposed them too, and now they look like ruined walls running straight across the countryside. A few of them are as much as 15 miles long, and quite a few of them are several miles long. The people who live in the area call them reefs and geologists call them dikes.

The country road between Cascade and Simms provides the best ground views as it follows dikes for miles and occasionally crosses one. In several places it is easy to sight along a dike and see it go right into the base of one of the buttes. I don't know of any other place where the plumbing of an old volcanic system is so well exposed or so easy to understand. In most places either one part or another is not exposed or else completely wiped out by erosion.

A close view of the cliffs at the top of Square Butte or one of its companions shows that they look like towering stockades of vertical columns. These are outlined by shrinkage cracks that formed as the hot igneous rock slowly cooled to the temperature of the cold rocks around it. The dikes also contain shrinkage cracks which run crosswise instead of vertically, making them look like stacked cordwood instead of colonnades.

People who climb one of the buttes will notice that the cliffs are not only broken into vertical columns but also show horizontal layers several feet thick. Each layer is dark at its base and grades upward into lighter-colored rock at the top. Asking how they formed is a good way to start an argument among geologists, so obviously no one can be quite sure. The most popular theory holds that each layer marks a separate pulse of molten rock injected through the feeder dike. The lighter tops of the layers contain more water than their darker bases; it probably soaked in from the sandstone above before the next layer was injected.

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Artwork courtesy Montana Historical Society.

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Charter, Scope and Organization

The Montana Bureau of Mines and Geology (MBMG) was established in 1919 as a public service agency and research entity of the Montana College of Mineral Science and Technology. The Bureau Director serves as the State Geologist and represents Montana in the Association of American State Geologists.

Enacted by Legislative Assembly of the State of Montana (Section 75-607, R.C.M., 1947, Amended), the scope and duties of the agency are summarized as follows:

- To collect, compile, and publish information on Montana's geology, mining, milling, and smelting operations, and ground-water resources.
- To maintain collections of geologic and mineral specimens, photographs, models, and drawings of mining and milling equipment, and literature on geology, mining, and ground water.
- To conduct investigations of Montana geology, emphasizing economic mineral resources and ground-water quality and quantity.

In accordance with the enabling act, the MBMG conducts research and provides information, but has no regulatory functions. To carry out its duties most effectively, the Bureau operates in five divisions: Geology and Mineral Resources, Hydrology, Administration, Analytical and Information Services.