Geologic History of Gunnison's Climbing Areas

The climbing areas surrounding Gunnison are composed of three main rock types, although one, Precambrian age (~1700 million years old or Ma) granite, dominates. The other two are Mississippian age (~330 Ma) limestone in lower Cement Creek and Tertiary (~28 Ma) volcanic breccia along Henson Creek near Lake City. These various rock types and their origins are explained below in the order of their formation, that is from oldest to youngest.

Precambrian granite

The Precambrian complex of intermingled granitic and metamorphic rocks forms the "basement" of the Gunnison region. They are the solid foundation on which all subsequent sedimentary and volcanic rocks were laid.

Precambrian metamorphic rocks originally were sedimentary and volcanic rocks that were compressed and fused together by the intense heat and pressure of mountain-building. Intrusions of granitic magma in the form of great blobs of molten rock also contributed heat to their metamorphosis. It is this granite, formed from the slow cooling of magma deep below the surface that provides most of the excellent climbing throughout the Gunnison region. Climbing areas composed of this ancient granite include upper Cement Creek, Spring Creek and Taylor Canyon, Hartman's Rocks and Aberdeen (~1721 Ma), the Gunnison River Canyon at the head of Blue Mesa Reservoir, and the Pioneer Point/Curecanti Needle area just below the reservoir (~1420 Ma). Although the granitic rock in each of these areas varies slightly in mineral composition, crystal size, and age, they share a similar origin and mode of formation.

Prior to ~1800 million years ago southwest North America, including most of Colorado and Arizona, part of Utah, and all of New Mexico, did not exist. Much older rocks (>2500 Ma) of Wyoming formed the south coast of the continent. The sea to the south was dotted with numerous volcanic islands, in geologic terms called **island arcs**. These were the seeds of southwest North America. Tectonic activity in this sea was in overdrive, with the thin crust of ocean floors being shoved beneath the thicker island arcs at a rapid pace, a process known as **subduction**. As the oceanic crust was subducted beneath the island arcs it sank to a depth at which it began to melt. Because molten rock is less dense than the surrounding solid rock, the magma rose to the surface to erupt and build volcanoes, contributing further to the growth of island arcs and, eventually, to the evolution of the Southwest.

As the oceanic crust separating two or more of these island arcs was consumed completely by subduction, the volcanic islands collided to unite into a single, larger landmass. Such collisions produce great heat and pressure, metamorphosing the volcanic and sedimentary rocks that made up the islands. Following this violent union, heat built up deep within the thickened continent and melted some of the rocks at these levels. *This* molten material also rose, but instead of making it to the surface to erupt as volcanoes, it halted in the middle crust to cool slowly and solidify into the crystalline granite that abrades our hands today.

The final event in constructing the Southwest was the amalgamation of innumerable island arcs and related landmasses into several much larger landmasses. Although the exact scenario remains debatable, sometime between 1700 and 1650 Ma, these monstrous landmasses, termed the Yavapai and Mazatzal terranes for rocks in Arizona, “docked” onto the south margin of North America. This large scale accretion onto the south margin expanded the North American continent southward by approximately 1000 kilometers.

The extreme compression of two landmasses colliding generates the rise of mountains (e.g. the Himalayan Mountains), yet no Precambrian age mountains are present today. Instead we climb on the roots of these mountains. Following the Precambrian accretion of southwest North America, the region spent the next 1000 million years warding off the ravages of erosion. As always erosion won and several kilometers of the upper crust were reduced to clay and sand, whisked away by wind and water. Much later, at ~320 Ma (the Pennsylvanian Period), these ancient rocks were shoved skyward in another mountain-building event to produce the Ancestral Rocky Mountains, centered in Colorado and New Mexico. Again these rocks were exposed to the indignities of erosion, this time for ~100 million years. Eventually the Ancestral Rockies were worn flat and were slowly blanketed by a thick succession of sedimentary rock.

More recently (?!) (65-50 Ma), compression again rippled through the region and the modern Rocky Mountains were born, initiating yet another cycle of uplift and erosion. It is the more recent signature of erosion that has produced the granite walls and crags that we crawl over today. The process continues. Every time a hold breaks, a rock whirs over your head, or is heard bouncing down a gully, erosion is proceeding at its own deliberate pace. Thus the landscape is, and always will be, a work in progress, with no end in sight.

Mississippian Leadville Limestone

The Mississippian age Leadville Limestone makes up the sport climbing area on the north side of lower Cement Creek, near the mouth of the canyon. Because limestone is more easily dissolved in natural waters than most rock types, it weathers readily to a very rough texture pocked with dissolution holes and an abundance of sharp nubbins. While these textures provide great holds and good friction, falling on this rock tends to shred clothes, shoes, ropes and skin.

During the early and middle Mississippian Period (~360 to 330 Ma), Colorado and surrounding areas were a vast, low relief landscape that was inundated by a shallow sea. The climate was warm and the water was clear and teeming with organisms. As with most ancient limestone-forming environments, the setting was similar to such modern low latitude, tropical settings as the Bahamas. It is in these tropical islands that limestone formation is taking place today. The accumulation of a significant thickness of limestone in the rock record requires multitudes of carbonate-secreting organisms – invertebrates with hard parts such as shells. Because most of these carbonate-producing organisms were filter feeders or required abundant sunlight, clear clean water was vital. The traces and outlines of these organisms are evident on close inspection of the Leadville Limestone in Cement Creek.

The final chapter in the Mississippian history of the Gunnison area was a dramatic drop in sea level across the region. As the shallow, limey sea receded from the region, the previously deposited limestone was exposed to the slightly acidic rain and runoff. Several million years of this slow dissolution created a deeply weathered surface and a maze of shallow caves in the subsurface. Mississippian limestone throughout western North America is characterized by these features. In fact, several such caves are obvious in the limited exposures of the Leadville on the northern hillside near the entrance to Cement Creek canyon and are easily seen from the road.

Picayune Megabreccia Member of the Sapinero Mesa Tuff

The Picayune Member of the Sapinero Mesa Tuff makes up the climbing area along the walls of Henson Creek canyon, a few miles west of Lake City. The Sapinero Mesa Tuff, and thus by association, the Picayune Member, has been dated at 27.9 Ma, and was erupted from the San Juan caldera, one of many large volcanoes that was active in the area around this time.

The Picayune Megabreccia is one of scores of rock units related to intense volcanic activity that wracked southwest Colorado from ~30 to 22 Ma, and formed the modern San Juan mountains. The term megabreccia describes a rock composed of large angular blocks that have been cemented together. In the case of the Picayune, blocks up to 500 meters across are mixed in a jumble of smaller blocks, all composed of andesite lava. Typically megabreccia is formed when a steep cliff or mountainside collapses into a immense pile of rubble. These monstrous blocks must have collapsed from a wall of colossal scale – but one that is no longer present. The origin of the Picayune begins with the initial eruption of the andesitic lavas from which the blocks derive and parallels the history of the San Juan volcanic field.

Over the 8 million years that the San Juan volcanic field was active, extremely violent eruptions sporadically emitted huge volumes hot ash that spread across the region. Quieter eruptions were marked by the slower paced extrusion of lava which flowed viscously down the flanks of the volcanoes, ultimately constructing them. None of the numerous San Juan volcanoes are preserved in their original form. All at some point, late in their history, experienced huge explosive eruptions and subsequent wholesale collapse. The huge volcanic collapse crater that formed is called a **caldera**. Following a long period of volcano construction, producing a large mountain similar to Mt. Rainier or any similar volcano, its collapse was initiated by an exceptionally explosive and voluminous eruption. This had the dual effect of shaking the volcano violently, and emptying its underlying magma chamber. Soon after, the unstable volcano collapsed into the void of the evacuated magma chamber. This left a large caldera encircled by an escarpment where previously a volcano towered.

Following the downward collapse of the volcano to form the caldera, the surrounding walls were steep and unstable. It was the post-caldera collapse of parts of this wall into the caldera that generated the Picayune Megabreccia. The andesite lava that comprises the megabreccia previously was the building block of the original volcano. The intense cementation of the rock is attributed to silica-rich fluids associated with the caldera. After caldera collapse and the subsequent fall of shattered parts of the encircling wall into the caldera, the silica-rich fluids that emitted from the fractured caldera floor easily permeated the porous rubble, recycling the loose angular blocks into a fiercely resistant rock suitable for climbing.

Writing about the geology of the climbing areas in the Gunnison/Crested Butte region is like coming full circle for me. In 1979 I moved from Oklahoma City to Crested Butte to climb and attend college at Western State College (in that order). The climbing lasted longer than college, which dragged on for half a semester. But after a good four years of climbing throughout the west and being poor (you know the story), I became intensely interested in Geology and reacquainted myself with Western State College. The next 5 years were spent in a blissful learning experience, still climbing and still poor. With much still to learn, I entered graduate school, 3 years in Flagstaff, Arizona, still climbing, and 4 years in Lawrence, Kansas (definitely NOT climbing). After they told me I couldn't go to college anymore (I received my PhD), I began to look seriously for a teaching position. After several part-time teaching positions and numerous interviews in horrible places, I was rewarded with my dream job as a professor, back at Western State College and in the mountains that originally inspired me on this journey. Not to get all warm and fuzzy or anything, but it was the discipline that I learned through climbing (in many situation you either do it or you die) that got me through all that schooling. If you can survive spinning on jumars two thousand feet up on El Cap, Calculus becomes *easy*. I thank Leo for putting this book together and letting me be a small part of it.