The Geology of Pagosa Country

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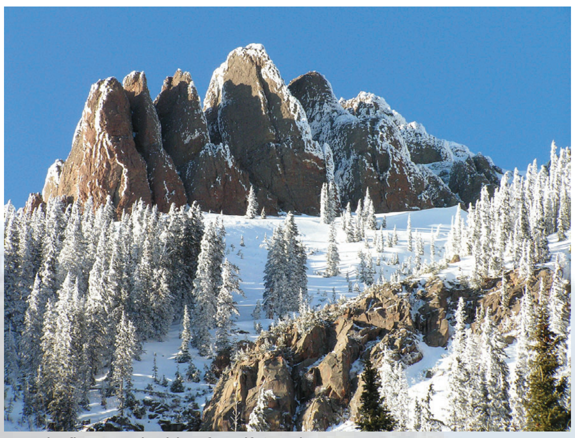

Basalt "fins" north side of Wolf Creek Pass.

Some of the oldest rocks on the district exist along the Piedra River.

Dakota Sandstone along the Piedra River.

Mesa Verde Formation on Oak Brush Hill.

One of the many volcanic Basalt dikes on the district.

Remanents of volcanic times, several hot springs exist in the area.

Windswept shores, leafy swamps, open oceans, and, yes, plenty of fire and ice, are all hallmarks of the geology of the Pagosa Ranger District of the San Juan National Forest.

The rocks that are exposed here are of vastly different ages. The oldest, found only along the Piedra River Trail near Weminuche Creek and further downstream, are the slates and other metamorphic rocks of the Uncompahgre Formation, more than a billion and a half years old. The Uncompahgre is intruded by the slightly younger Eolus Granite, a handsome, often pink, intrusive igneous rock. It, too, outcrops in the very bottom of the Piedra River gorge, but is more easily seen around Granite Lake, just outside the district near the Weminuche Trail. The Eolus is radiometrically dated at 1.46 billion years old.

In the geologic record it is common for vast periods of time to be missing in the rock sequence. These are called uncomformities, and reflect environments of erosion rather than deposition. Between the Eolus Granite and the overlying Hermosa Formation more than a billion years are absent in the stratigraphy. The Hermosa was laid down as shoreline deposits along the east edge of a basin that formed as the Ancestral Rockies were elevated some 300 million years ago (300 ma). A quite similar unit, the Cutler Formation, overlies the Hermosa, and also consists of shales derived from clay, and siltstones of very fine sand grains. These two strata may be observed along the First Fork Road (open seasonally) north of route 160. The Cutler is visible for about a half mile, beginning about two miles from the highway, and the Hermosa from there to the end of the road.

Another long period of erosion occurred before conditions changed to allow deposition. Slivers of the Entrada Sandstone, a windblown dune formation, occur in the Piedra drainage. The Entrada sediments came from the east and north, but during almost all of the rest of our sequence, material came from the west in response to mountain building in Nevada and Utah. The Morrison Formation consists largely of soft clays with a few harder sandstone lenses, and is exposed at the bottom along the Upper Piedra River Trail, and also along the San Juan River beginning about a mile below the confluence with Mill Creek.

Pagosa Springs lies at the easternmost edge of a vast geologic province called the Colorado Plateau. This 140,000 square mile area includes portions of all of the Four Corners states, and is generally comprised of relatively flat-lying, fairly young, sedimentary rocks. The best examples of these, and certainly the easiest to see, were laid down near the shore of a continental sea that stretched from here to east of the Mississippi River. For 30 million years, commencing about 100 ma, this area was near the western shore of the sea, or submerged under its surface as sea level rose and retreated several times.

Initially, the environment was that of a shoreline, so deposits tended to be sand or silt, both of which form hard rock that is well-drained and forms soils that are hospitable to many different types of plants. The Dakota Sandstone underlies most of Pagosa Lakes. A very interesting exposure of the Dakota occurs above the Piedra River, where jointing in combination with glacial-age slippage on the tilted Morrison below has created linear “ice caves”.

After the deposition of the Dakota sands, sea level rose substantially, to depths of perhaps 300 to 400 feet in this region. As a result, tiny clay particles began to pile up, along with organic matter, for about 10 million years. Subsequent heat and pressure have lithified the clay into a soft shale. The Mancos Formation is almost a half mile thick, and is the grey rock at the junction of routes 84 and 160. The towns of Pagosa Springs, Aspen Springs, and Chromo are all constructed on the shale. Unfortunately, the Mancos does not percolate well for septic systems, contains materials that can render groundwater undrinkable, and is very slippery when wet.

Eventually, sea level dropped, and another shoreline formation, the Mesa Verde, was emplaced. Like the Dakota, it is harder than the rocks both above and below, so it tends to form mesas like Eight Mile and Oak Brush Hill south of highway 160. Looking south toward Eight Mile Mesa the Mesa Verde is the cap, while the so-called “clamshell” is eroded into the much softer Mancos Shale beneath. When sea level rose again, another vast and thick column of marine clay collected; this is now the Lewis Shale, the source of all the road-building problems on 160 east of San Juan River Village. As the inland sea retreated for the final time, the materials that would form the Pictured Cliffs Formation were deposited. The spires of Chimney Rock are the erosional remnants of the Pictured Cliffs.

While there are younger rocks just to the southwest of the Pagosa District in the San Juan Basin, the time of widespread sedimentary rocks had ended. Movement of the earth’s crustal plates, such as occurred in the recent Japanese earthquakes, can, over time, result in uplift of large sections of the continents. For Colorado, such a mountain-building event made our state’s average elevation the highest of the 50 states. This was the Laramide Orogeny, which occurred over perhaps 30 million years centered on about 65 ma. During this period some rocks in the San Juan Mountains were raised more than three miles. When the Laramide energy diminished, a period of erosion may have reduced the topography to rolling hills and deep valleys.

Many geologists believe that the end of the Laramide began a period of melting of the Pacific Plate that was being pushed under North America. This infusion of magma is thought to have led to a secondary domal uplift in the region. There is no uncertainty regarding a second result. About 35 ma, volcanism moved down from the north into the eastern and southern San Juans. Large stratovolcanoes, emitting both lava and ash, erupted for a period of about 5 million years, growing over one another until a high plateau was formed.

30 ma the type of eruptions changed as the underlying magma became more viscous and gaseous. Unimaginably large (thousands of times bigger than Mt. St. Helens) explosions emitted thousands of cubic miles of material in single blasts. The ash (ignimbrite) flows were hot, heavy, and incorporated bits of surrounding rocks, spreading out over large distances before settling and cooling into rocks of varying hardness. The Fish Creek Tuff just north of Wolf Creek Pass represents the La Garita eruption, perhaps the largest ever recorded on the planet. By 27 ma things settled back down to quieter eruptions which lasted until about 15 ma.

While the Laramide Orogeny compressed, or shortened, the crust in this region, for the last 26 ma it has been pulling apart. The San Luis Valley is the most obvious result, but this rifting also fractured the lithosphere, allowing late stage magma to be intruded into those zones of weakness. The basalt dikes south of Pagosa Springs reflect this time. So, too, do the precious metal deposits that largely missed the Pagosa District, but caused great flurries of prospecting and mining activity in nearby areas such as Platoro, Creede, Lake City, Silverton, and Summitville. By the time most of the volcanic activity faded, the eastern and southern San Juans were probably a high plateau with much less topographic complexity than there is now.

Over the last 2.5 million years earth has been in a cooling cycle, with significant periods of warming interspersed with increasingly cooler intervals. In terms of creating our mountain profiles, much of the action is very recent. About 20000 years ago, an ice sheet of almost 2000 square miles covered the highest terrain. Glaciers originating in this icefield coursed down existing valleys, deepening them into classic U-shaped profiles such as the East Fork of the San Juan River. Higher up, the mountains were carved into great circular depressions called cirques, which often grow together to form steep-sided ridges. Massive amounts of sediment were deposited into the glacial outwash streams, often filling the lower valleys with sand and gravel. After the ice melted, streams carried much less load and resumed downcutting.

Today, the San Juan Mountains form a barrier to moist airmasses from the southwest, and the resulting precipitation (55 inches annually at the highest altitudes) supports forest communities that range from lush spruce-fir down through aspen-fir, ponderosa, and pinyon-juniper zones. Logging and ranching were the early economic drivers in this area, setting the pattern of private land ownership that continues to the present. The rivers that descend from the high country are the lifeblood of the small cities and towns that fringe the San Juans. The last vestiges of heat from the underlying batholith attract thousands of visitors to the hot springs of Pagosa each year. Today, the San Juan National Forest provides recreational opportunities, fuelwood and other forest products, watershed protection, grazing, hunting, clean air, and many other resources in this beautiful geologic wonderland.

Photos by Mark D. Roper

Basalt "columns" northeast side of the Upper Piedra Valley.

Many waterfalls exist as a result of thick Basalt flows (Silver Falls).

Pictured Cliffs Formation, Chimney Rock Archeaological Area.

Mancos Shale from Haystack Mtn., looking east to Pagosa Springs.

Fish Creek Tuff, south of US Highway 160 headed to Wolf Creek Pass.

Crater Lake and the above cirques show evidence of glaciation.