The Geology of Hall Ranch: Stepping Back into Deep Time

Introduction

We who call this part of Colorado home live in one of the most interesting and diverse geologic settings to be found anywhere in North America. The eastern flank of the Rocky Mountains delineates one of the most important and dramatic geographic and geologic boundaries in western North America. To the east, one must travel 1,100 miles across the great plains and central lowlands before sighting the western foothills of the Appalachians. Going west, one crosses 900 miles of mountain range after mountain range before finally arriving at the Coast Range of California and the Pacific Ocean.

The Rocky Mountains seem permanent and ageless, but their formation is actually a comparatively recent development in the overall history of the region. 80 million years ago, there were no Rocky Mountains. Where you are now standing lay nearly 2 1/2 miles ***below*** sea level under a thick blanket of younger sedimentary rocks and a mile and a half of oceanic muds. Pterosaurs soared above the open ocean that was Colorado in search of a meal!

Setting the Scene

During today's walk, we will examine a fascinating intersection between the old and the very, very old. Here we are surrounded by a majestic landscape of towering ramparts of layered red rock dipping gently to the east. The many layers of this thick sequence testify to the passage of vast periods of time. These imposing formations lead our eyes to the west where we are greeted by the crest of the Rocky Mountains in the near distance. The beauty and serenity of what lies before us belies the tumultuous battle between the forces of uplift and erosion that has taken place here over more than a third of our planet's history.

We are standing alongside a mammoth stack of layer upon layer of red sedimentary rock known as the Fountain Formation. Toward the top of the stack the rocks change character and blend into the overlying Lyons Formation. You're looking at about 60 million years of deposition! The bottom of the stack started to be deposited about 310 million years ago. Close examination of these rocks will help reveal their surprising origin as flash flood deposits washed off the arid slopes of the now vanished but then nascent Ancestral Rockies. But more surprising, these rocks lie directly upon rocks more than a billion years older. What happened during the intervening eons of time?

The Bottom of the Pile

At Hall Ranch we stand upon the oldest layers of sedimentary rock found in Boulder County. They were brought up from great depth when tectonic forces began to push up the Rocky Mountains about 70 million years ago. Along the margin of the rising mountain front, a stack of more than two miles of younger, nearly horizontal, rocks and sediments were tilted upward along the flanks of the mountains. The tilting only occurred in close proximity to the mountains. Proceeding east they soon dive down to their original depths. Erosion since that time has removed most of the overburden, leaving about 240 million years of accumulated rock layers exposed at the surface. Going east, the rocks get younger and younger until they disappear under recent alluvium. Like a toppled stack of books, each layer is exposed at the surface. Those layers that are hard resist erosion, creating hogbacks parallel to the mountain front. The softer layers erode more rapidly, creating valleys between the hogbacks. Here at Hall Ranch we are at the very bottom of the stack… and a mighty resistant one at that. What a special place we live in… especially for a geologist!

Take a Walk into Deep Time

As we walk the trail westward toward the mountains we will shortly reach the bottom of the Fountain Formation. In one step, we will be able to cross over more than a billion years of geologic history onto the ancient tortured bedrock that makes up the Rocky Mountains. While the mountains themselves have only been around about 70 million years, they are made out of rocks that are 1.7 to 1.4 ***billion*** years old! Chances are these rocks are the oldest thing you will ever touch or walk upon in your lifetime. Very few places on the earth's surface possess rocks as old or older than these.

Over the eons these rocks have been raised up into mountain ranges numerous times, only to be eroded and buried under thick sedimentary layers of their own debris. Seas would advance and retreat over the face of the land, piling up huge deposits of oceanic sediments only to have them raised up as new mountains and eroded again. At Hall Ranch, all the early chapters of that story have been lost to erosion, but studying rocks in other parts of Colorado has helped fill in the chapters of the story that are missing here.

Closing Thoughts

From the perspective of knowing how the rocks of Hall Ranch were assembled over time, the tranquil beauty of this special place takes on new meaning as we enjoy the present and marvel at the past.

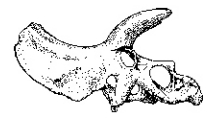
"In the presence of eternity, the mountains are as transient as the clouds."

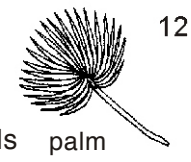
(verse from the Qur'an written in the 7th century A.D.)

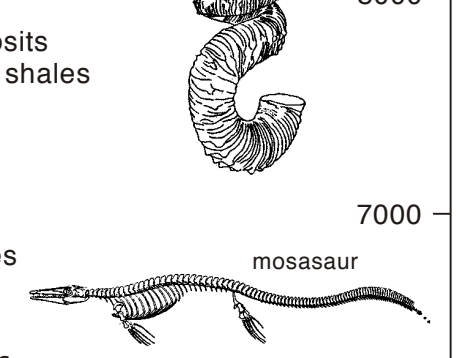
Prepared by BCPOS volunteer naturalist Roger Myers, September 2017.

Sedimentary Rocks of the Boulder Area

Age			Stratigraphic Units	Thickness feet (meters)	Lithologies	Features and Fossils
Mesozoic	Cretaceous		Laramie Formation (Kl)	750 (229)		River sands; Overbank mudstones with plant fossils; Coal (swamp deposits); Estuary sands with oyster beds
			Fox Hills Sandstone (Kfh)	500 (152)		Beach sands
			Laramier and Rocky Ridge Ss Members	8020 (2445)		Alternating shales and sandstones; 3750 ft gap; Offshore sands; Locally abundant ammonoid fossils, rare marine lizard (mosasaur) and fish fossils
			Terry Ss Mbr			0ffshore sand
			Pierre Shale (Kp)			offshore mud deposits that became black shales
			Hygiene Sandstone Member (Kph)			Offshore sands that became brown sandstones; Western Interior Seaway
		Niobrara Fm. (Kn)	Smoky Hill Member	360 (110)		1375 ft gap; Black shales; Giant, "dinner plate" inoceramid clams; Chalks and black shales
			Fort Hays Mbr	20 (6)		Limestone ledges with bowl-shaped inoceramid clams
		Benton Fm (Kb)	Carlile Mbr	450 (137)		Limestone beds with wing-shaped inoceramid clams; Offshore muds
			Greenhorn Member			
			Graneros Member			
		Dakota Group (Kd)	South Platte Formation	250 (76)		River to beach deposits
			Lytle Ss	70 (21)		Major hogback
	Jurassic		Morrison Formation (Jm)	300 (91)		Dinosaur bones; Multicolored mudstones
			Sundance Ss	30 (9)		dune sand
	Triassic		Lykins Formation (ŦRPl)	675 (206)		Deep red mudstones and sandstones
	Permian		Forelle Ls Mbr			Dolostone with stromatolites; Red mudstones
			Lyons Sandstone (Ply)	220 (67)		Dune sands with amphibian tracks; Major hogback
Paleozoic	Pennsylvanian		Fountain Formation (ĦPf)	1000 (305)		Fine-grained sandstone sheets; Reddish arkosic sandstone and conglomerate derived from the Ancestral Rockies; Ancestral Rocky Mountains
Proterozoic			Boulder Creek Granodiorite, gneiss, quartzite (pЄ)			Great Unconformity, with a weathered zone; Sandstone crack fills (Cambrian?); Roots of mountains, 1.7 billion years old







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Relative Thicknesses		Boulder Area Landmarks
12,640 ft (3853 m)	Kl	Marshall
12,000 ft	Kfh	Sandstone Ranch
11,000		Longmont
10,000		
9000		
8000	Kp	
7000		Boulder Valley Open Space
		Boulder
6000		
	Kph	Nelson Road
5000		
4000		
	Kn	Six-Mile Fold
3000	Kb	
	Kd	Rabbit Mountain
	Jm	
2000	Js	Eldorado Springs
	ŦRPl	Heil Valley Ranch
	Ply	Lyons
1000	ĦPf	Flatirons
0 ft	pЄ	Hall Ranch; Boulder Creek Canyon; Left Hand Canyon

Compiled by E. Evanoff, 2001, with minor additions by Roger Myers, 2012