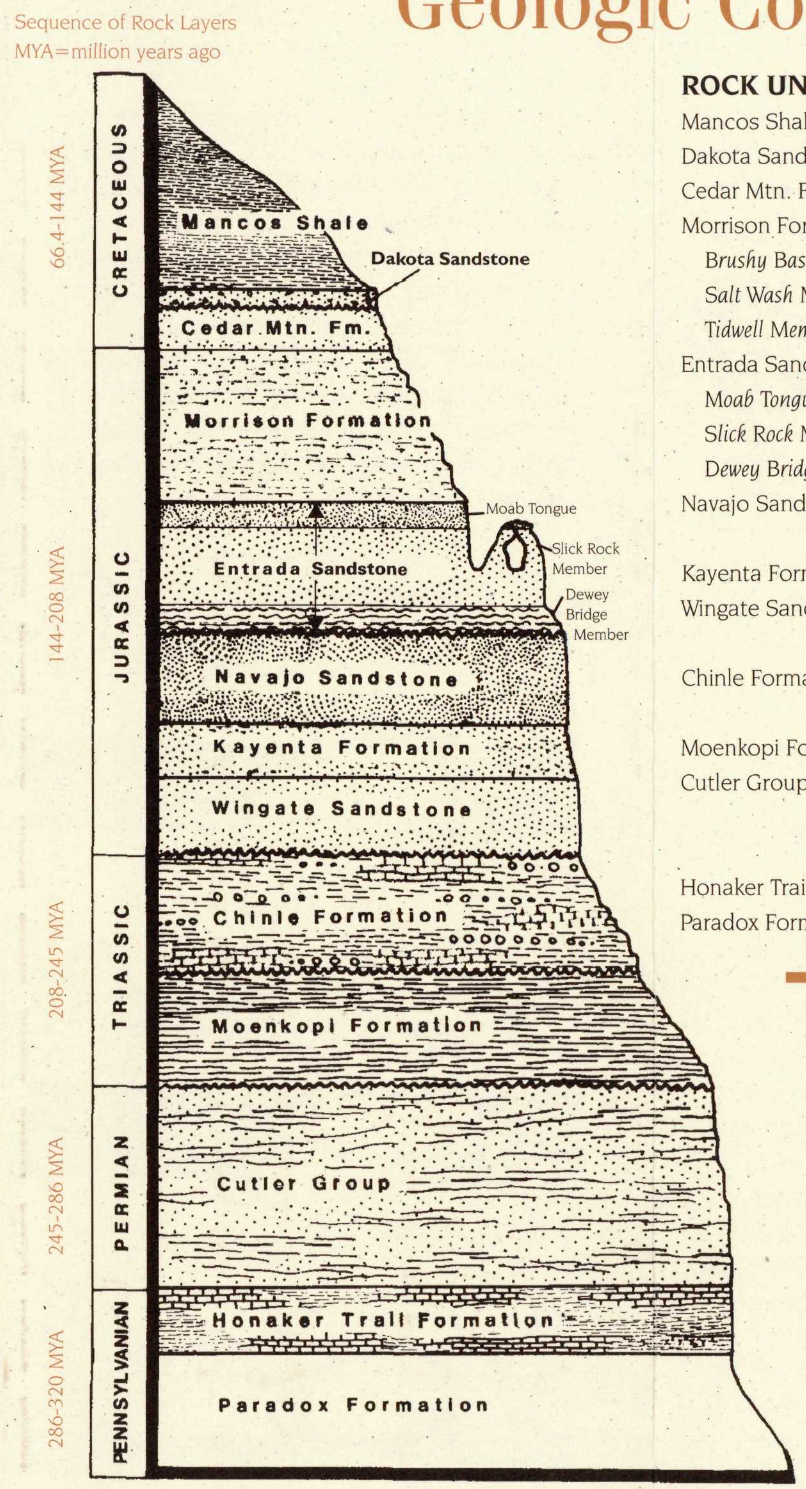
Geologic Column of Arches National Park



ROCK UNIT	ORIGIN	APPEARANCE
Mancos Shale	Stagnant sea	Gray shale in rounded slopes
Dakota Sandstone	Rivers on a broad coastal plain	Light-colored sandstone
Cedar Mtn. Formation	Streams	Varicolored shales
Morrison Formation		
Brushy Basin Member	Lakes and streams	Green and maroon shales
Salt Wash Member	Streams and floodplains	Light yellow-gray crossbedded sandstone
Tidwell Member	Coastal marine mudflats	Thin-bedded red silty shale with large chert boulders
Entrada Sandstone		
Moab Tongue	Marginal marine sand dunes	Light-gray massive jointed sandstone
Slick Rock Member	Marginal marine sand dunes	Reddish-orange cliff-forming sandstone
Dewey Bridge Member	Marginal marine tidal flats	Red muddy sandstone with contorted bedding
Navajo Sandstone	Wind-deposited dunes	White to light red or tan sandstone, large cross beds. Forms rounded domes and cliffs
Kayenta Formation	Streams	Ledge-forming reddish-brown sandstone
Wingate Sandstone	Wind-deposited dunes	Reddish-brown vertical cliffs with streaks of desert varnish
Chinle Formation	Streams on a vast floodplain	Reddish-brown slope-forming sandstone with interbedded ledges
Moenkopi Formation	Coastal floodplain and tidal flats	Chocolate-brown thin-bedded siltstone; forms slopes
Cutler Group	Stream-deposited alluvial fans	Red and maroon sandstone with conglomeratic shales. Due to faulting, this unit does not appear in Arches National Park.
Honaker Trail Formation	Offshore marine	Interbedded limestone and sandstone
Paradox Formation	Restricted inland sea	Interbedded salt, gypsum, and shale

Color

Red comes from oxidized iron. Sandstone consists of approximately 3 percent iron, mostly as surface coating on individual grains of sand.

Green layers are comprised of volcanic ash that fell into a large seasonal lake about 150 million years ago. Lake sediments covered the ash creating a low-oxygen environment in which iron turns green.

Dark brown to black streaks, known as desert varnish, cover many rock surfaces in the area. This micro-thin coating receives its color from manganese oxides (black) and iron oxides (reddish-brown). Geologists argue how the manganese and iron, which are derived from sources outside the rock, are bonded to the surface. Some believe the process involves bacteria that oxidize the minerals and cement them to the rock, while others believe a purely chemical reaction occurs between iron, manganese, and water.

Canyonlands Natural History Association
3031 S. Highway 191
Moab, Utah 84532

Arches National Park
P.O. Box 907
Moab, Utah 84532

Text by David Williams
Illustrations by Nancy Stonington
and Michael Taylor

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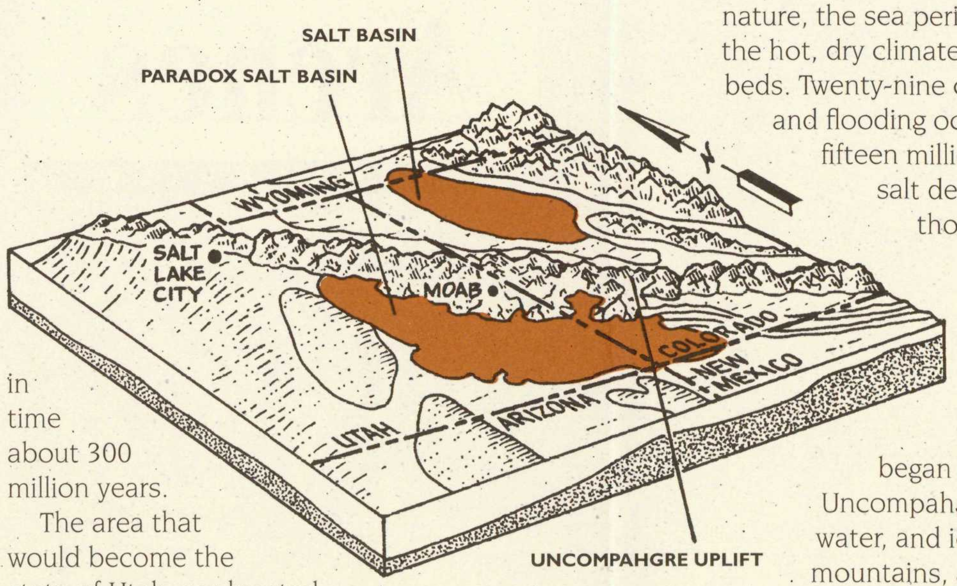
Geology of Arches

AN OVERVIEW

ARCHES NATIONAL PARK

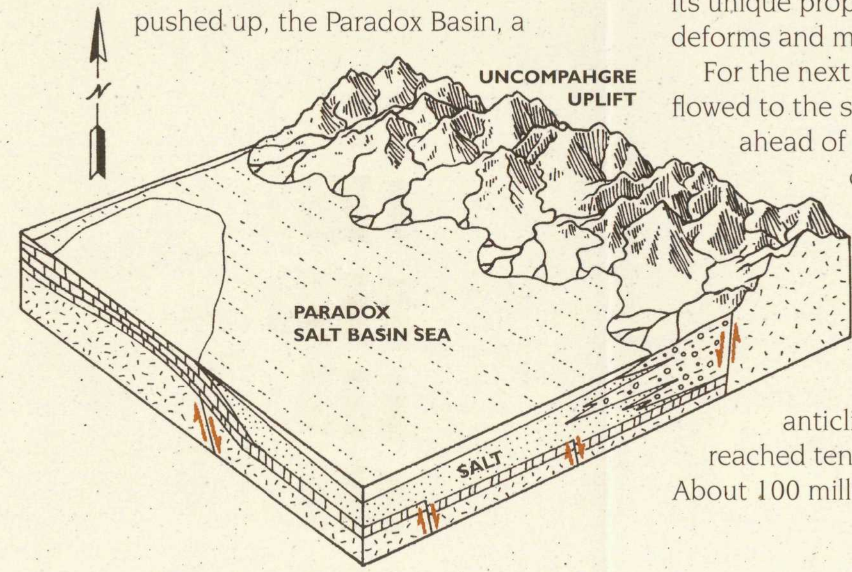
Arches: A Story of Salt . . .

Two ingredients—salt and water—tell the story of the arches of Arches National Park. To understand how each influences the landscape requires going back



in time about 300 million years.

The area that would become the state of Utah was located near the equator. An ocean lay to the west and a mountain range now known as the Uncompahgre Uplift had begun to rise to the northeast. While the mountains pushed up, the Paradox Basin, a

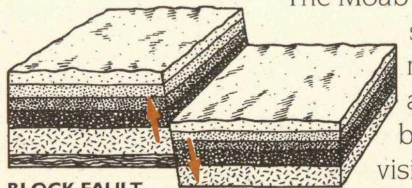


deep trough composed of fault-created valleys and ridges, began to form adjacent to their northwest slope. The basin extended from northwest New Mexico to near Price, Utah.

Over time, the ocean flooded the basin, creating an inland sea. Due to its restricted nature, the sea periodically evaporated in the hot, dry climate, producing vast salt beds. Twenty-nine cycles of evaporation and flooding occurred over ten to fifteen million years, leaving salt deposits five to six thousand feet thick.

Eventually the basin faults stopped moving and sea levels stabilized. The processes of weathering and erosion began to assault the Uncompahgre Uplift. Wind, water, and ice weakened the mountains, and rivers and streams washed millions of tons of sediments from them down onto the salt beds. Beneath the tremendous weight of the sediments, the salt began to display one of its unique properties: under pressure it deforms and moves like a glacier.

For the next 200 million years, the salt flowed to the southwest as it was pushed ahead of the heavy overburden coming down from the Uncompahgre Uplift. The uneven, block-faulted surface over which it flowed pushed it up in some places, and surface bulges formed long, low hills known as anticlines. Some salt accumulations reached ten thousand feet in thickness. About 100 million years ago the salt finally became confined and unable to move under thousands of feet of sediments.

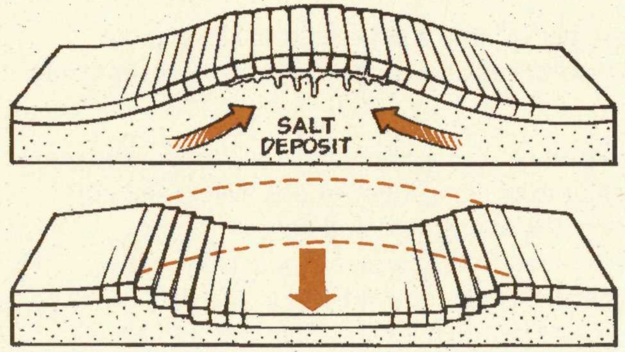


BLOCK FAULT

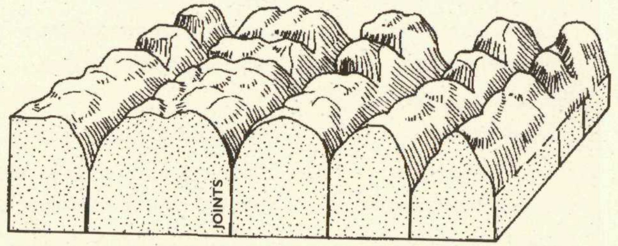
The Moab Fault, best seen from the main park road about a mile beyond the visitor center, was formed 40 million years ago when regional tectonic forces generated 2,600 feet of vertical movement.

. . .and Water

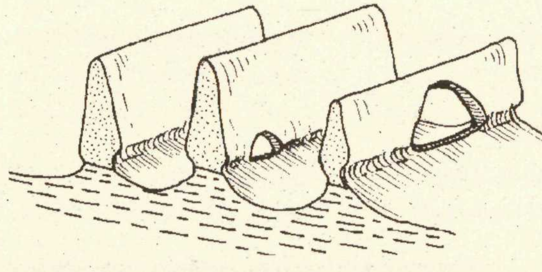
About ten million years ago water began to exert its influence on the landscape of Arches National Park. While the entire region was uplifted several thousand feet, the Colorado and Green Rivers started to cut down into the rocks, removing vast amounts of sediments. So much rock was eroded that the salt anticlines were exposed at the surface. Small streams started to flow across these structures and ground water began to percolate down into the salt, dissolving it. With a weakened support system, the anticlines began to collapse, and the stage was set for the formation of arches. Erosion and dissolution created the Moab and Salt Valleys, both of which are less than two million years old.



As overlying rock units collapsed into widening valleys, parallel cracks or joints formed. Erosion attacked these joints, widened them and created fins such as those of Klondike Bluffs, Devils Garden, and the Fiery Furnace. The Entrada Sandstone is the critical rock unit for formation of the area's fins and arches.



Usually arches are formed in fins through the process of acid dissolution. Rainwater mixes with atmospheric carbon dioxide to



form a weak acid. This carbonic acid then attacks and weakens the calcium carbonate cement in the sandstone. Acid seeps down into the eroded sands collected between the fins and is protected from evaporation. It then has time to attack the sides, further thinning the fins until an opening appears.

Another method is frost wedging, whereby water gets into the zones of weakness between layers of rock and freezes. During freezing the water expands and begins to pry the rock apart. The contact between the soft, crumbly Dewey Bridge Member and the harder Slick Rock Member is especially susceptible to this process. As the Dewey Bridge erodes away from the overlying Slick Rock, a gap forms.

After an opening develops by either process, rock begins to fall from inside the developing arch. Sloughing continues until a stable curved shape evolves.

Arch formation continues to this day, and there is no way to tell the age of an arch by its size. Erosion is neither predictable nor consistent—an arch may take a few hundred or thousand years to form by small increments, or large amounts may fall, doubling the size of an arch overnight as happened with Skyline Arch in 1940.