COLORADO SCHOOL OF MINES

GEOLOGY MUSEUM

Mines Geology Trail

by: Bob Weimer, Professor Emeritus

RECORD OF THE FRONT RANGE UPLIFT

The story of the Front Range Uplift comes from rocks exposed on the CSM Campus, the Table Mountains and Green Mountain, three miles to the south. This walking tour visits outcrops of the Pierre, Fox Hills, Laramie, and Arapahoe formations (Figs. 1, 2 and 3). The younger volcanic-rich Denver Formation, once visible in Campus excavations, is now exposed only on the slopes of the Table Mountains.

Environments of deposition and ancient landscapes are described with emphasis on the mined clay, coal, water aquifers, log imprints and dinosaur tracks.

The mountain terrain to the west is held up by resistant Precambrian crystalline rocks that were uplifted along the Golden Fault (64 to 55 million years ago–ma). The uplift rotated the once horizontal formations in the Campus area to a near vertical tilt (dip). Volcanic lava flows cap the Table Mountains to the east and overlie low-dipping strata of the Denver Basin.

The Golden-Green Mountain area may be regarded as the type locality for the record of events that built the Rocky Mountains, referred to as the Laramide Orogeny, a name derived from the Laramie Formation.

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Computer graphics by Linda G. Martin.

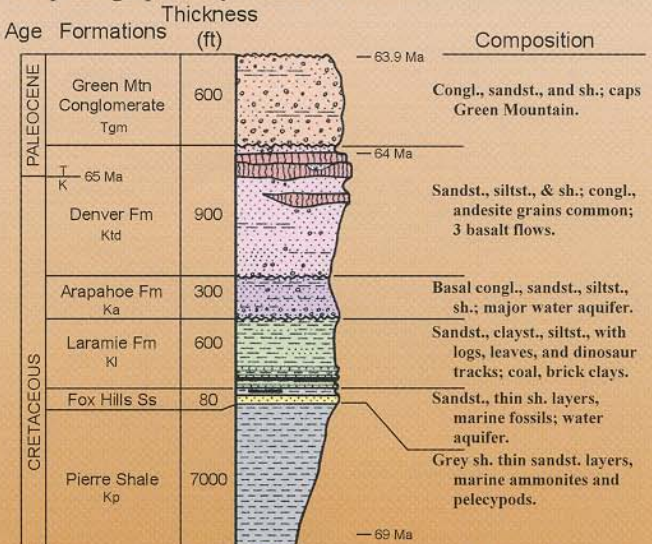


Fig. 1. Generalized stratigraphic section with formations of Golden-Green Mountain area.

STOP 1. THE GEOLOGY MUSEUM

The Geology Museum started as a "mineral cabinet" put together by Arthur Lakes, Geology Professor and first curator of collections in 1874. Today, the Museum occupies a new building that houses about 50,000 minerals, fossils, and artifacts.

The spectacular mountain front geology viewed from the Museum, the exhibits, and educational opportunities are enjoyed by thousands of school children and casual visitors each year. This guide to the geology of the CSM campus describes the history of the Front Range Uplift for all visitors.

Of special note is the geology to the east of the Museum. The Cretaceous—Tertiary (K/T) boundary (65 ma), marking the extinction of the dinosaurs, is a few hundred feet below the lava flows that cap the Table Mountains (Fig. 3).

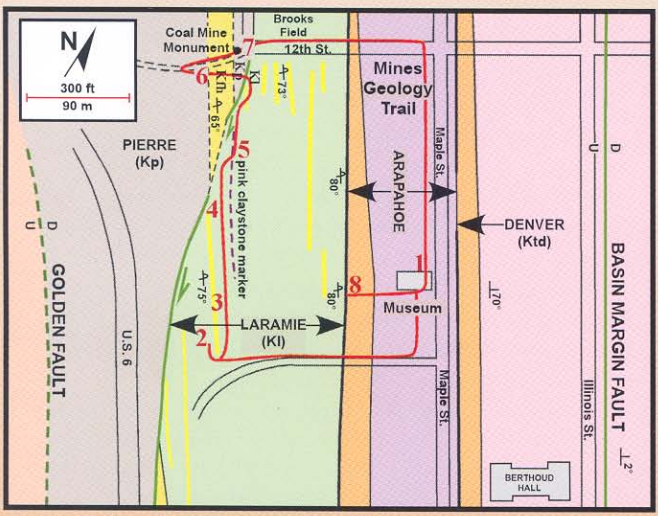


Fig. 2. Bedrock geologic map with the Mines Geology Trail. Sandstone beds within the Laramie Formation are yellow lines; intervening areas are claystone.

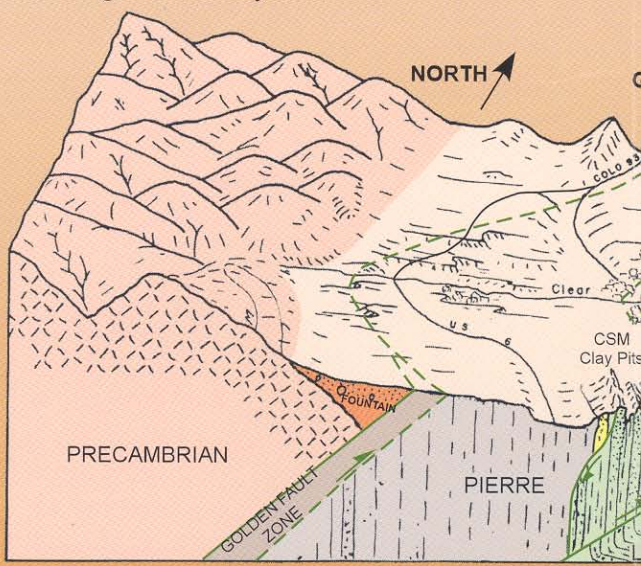


Fig. 3. Sketch of geology of Golden area with Golden.

STOP 2. LARAMIE FORMATION (68 MA). DINOSAUR TRACKS, LOG AND PLANT IMPRINTS

The face of the prominent sandstone ridge has dinosaur trackways made when the layers were flat. Casts of tracks can be located in reference to a conspicuous log imprint as shown on Figs. 4 and 6. The most abundant tracks and trampled areas are probably of a ceratopsid affinity (e.g. Triceratops); a few tracks of theropods (e.g. ostrich-like); and hadrosaurs (e.g. duckbills). (Data and Figures from Lockley and Hunt, 1995). Small fragments of palm fronds and minor faults are also present.

The Triceratops Trail in the Parfet Prehistoric Preserve, about one-half mile to the south, has excellent exposures of dinosaur tracks and palm fronds. This trail and a guide to the fossils have been prepared by Friends of Dinosaur Ridge.

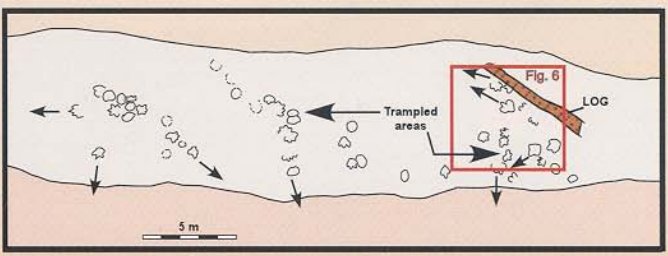
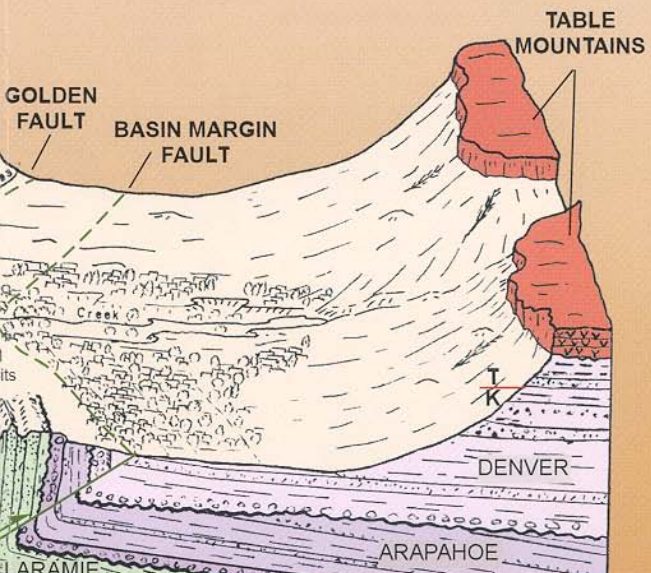


Fig. 4. Sketch of dinosaur trackways on a vertical rock face with prominent log as reference. Arrows indicate direction of dinosaur movement.



Basin Margin and Clay Pits faults (after F. E. Moore)

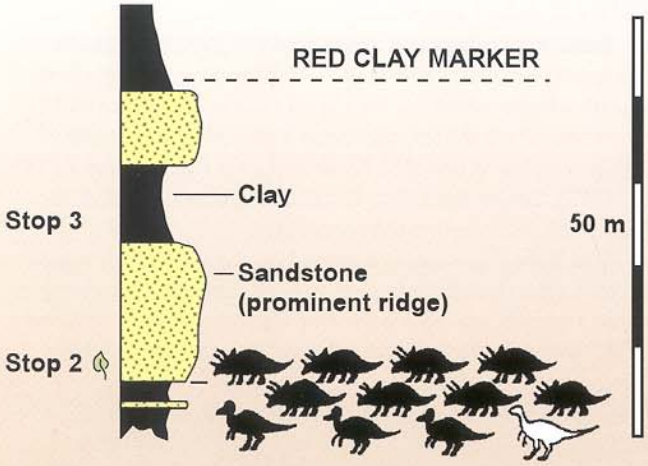


Fig. 5. Stratigraphic column with estimated number of ceratopsian, theropod and hadrosaur trackways at Stop 2 (one silhouette equals one individual).

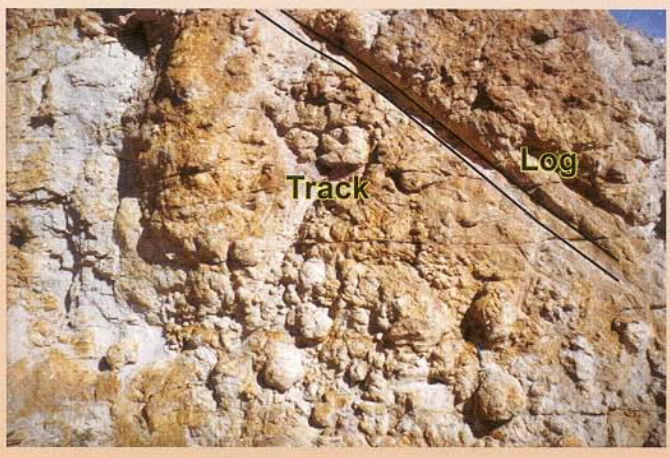


Fig. 6. Photo of tracks and reference log imprint with location shown on Fig. 4.

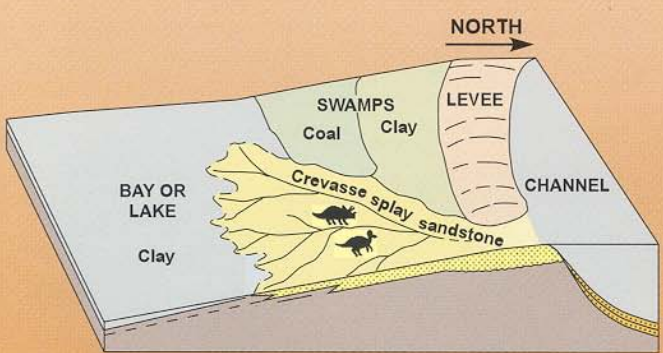
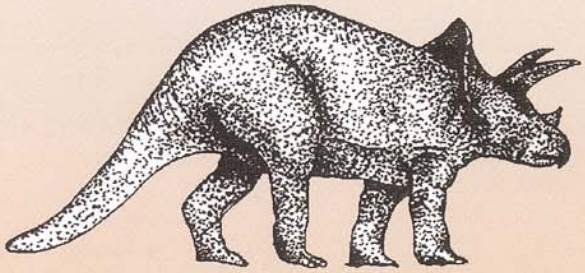


Fig. 7. Environments of deposition of the Laramie Formation in the Golden area.

STOP 3. LARAMIE FORMATION; FIRE CLAY AND SANDSTONE; ENVIRONMENTS OF DEPOSITION.

The gray to tan fine-grained sandstones and gray, red, yellow and black claystones are well exposed at this stop (Fig. 5). They are fresh water deposits on the margins of major river channels that were located two to three miles north of Golden. The sandstones represent crevasse splays that built out into lakes or bays ten feet or less in depth. Clays deposited in back-levee swamps were leached by organic acids to form fire clays rich in kaolinite. Peat (coal) also formed in swamps (Figs. 7 and 8).

Log and leaf imprints, and numerous small faults and fractures, can be observed on the top and base of the sandstones.



Triceratops

STOP 4. CLAY PITS FAULT.

The lower Laramie sandstone, forming a prominent ridge, is cut off and faulted against the Pierre Shale (Figs. 2 and 9). The fault trace follows the west side of the ridge and is exposed in an irrigation ditch 500 feet to the southwest. The fault is interpreted as a normal fault that formed before the strata were rotated to an overturned dip (Fig. 10).

Fig. 9. Photo of Clay Pits Fault looking south.

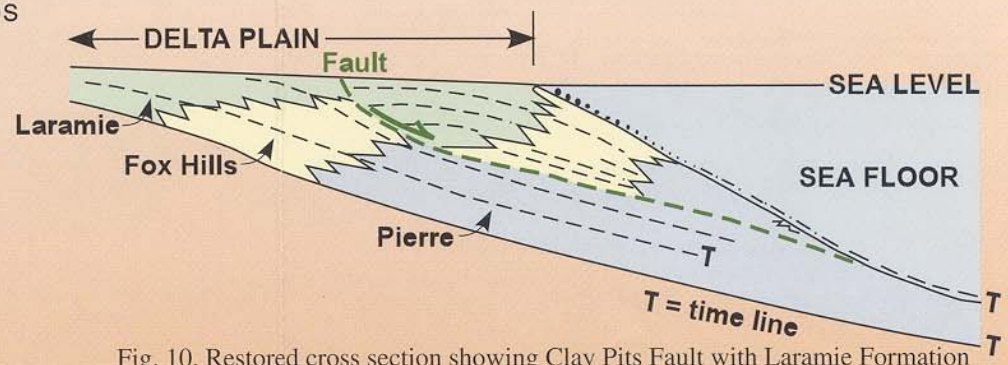


Fig. 10. Restored cross section showing Clay Pits Fault with Laramie Formation faulted against Fox Hills and Pierre.

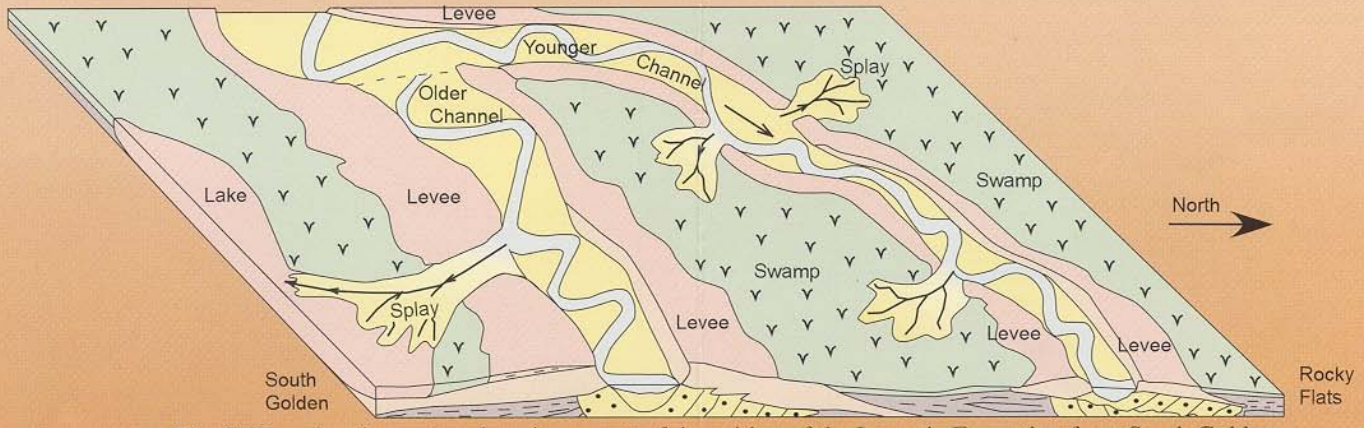


Fig. 8. Map showing restored environments of deposition of the Laramie Formation from South Golden to Rocky Flats, five miles to the north.

STOP 5. OVERVIEW OF CLEAR CREEK VALLEY; ROCK EXHIBIT.

Rocks typical of the older formations exposed in north Golden, that can be seen from this overview, are arranged according to geologic age in a Rock Exhibit (Fig. 11).

A cross section (Fig. 12) is a geologic portrayal of the dipping formations and faults under the north edge of Fig. 3.

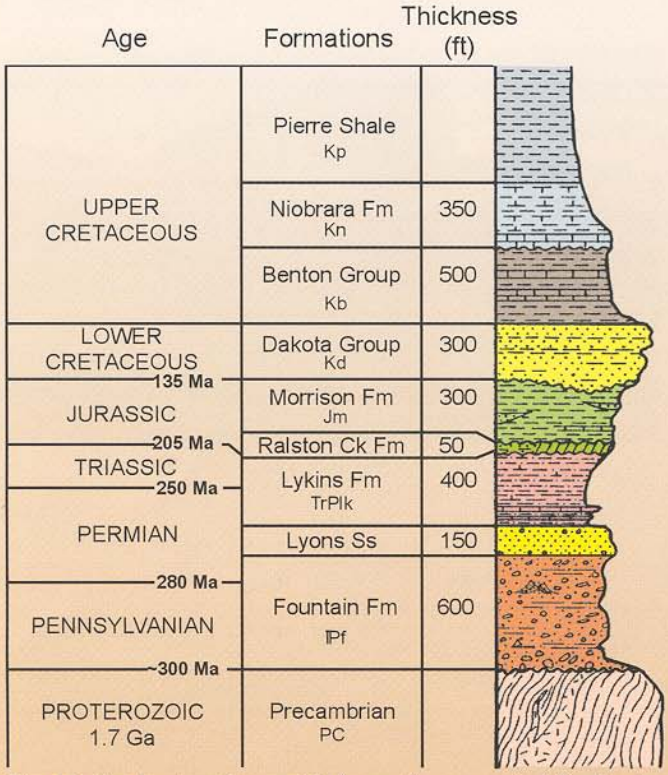


Fig. 11. Geologic column with formations sampled for Rock Exhibit. The three major classes of rocks, metamorphic, sedimentary and igneous are represented.

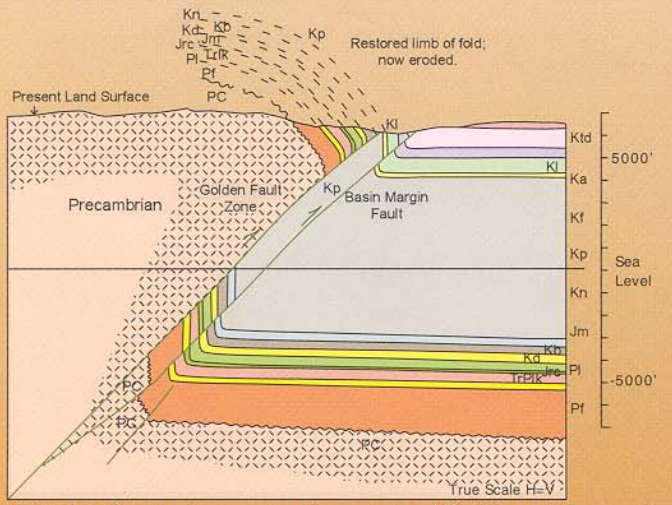


Fig. 12. Geologic cross section north of Golden with use of seismic section in Golden Gate Canyon.

STOP 6. PIERRE AND FOX HILLS FORMATIONS (69 MA).

These formations are exposed along a road that formerly led to an upper level of the clay pits. Gray shale of the Pierre, deposited in a shallow marine seaway, is transitional with yellow, buff fine-grained shoreline sandstones of the Fox Hills.

Fig. 13. Photo of contact between Pierre and Fox Hills formations.

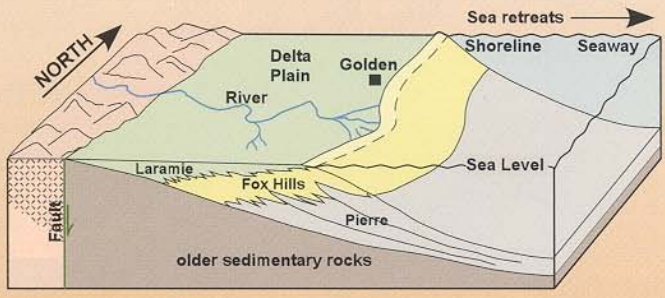


Fig. 14. Core of Front Range Uplift supplied sediment carried by rivers to the seaway and forced an eastward retreat of the shoreline.

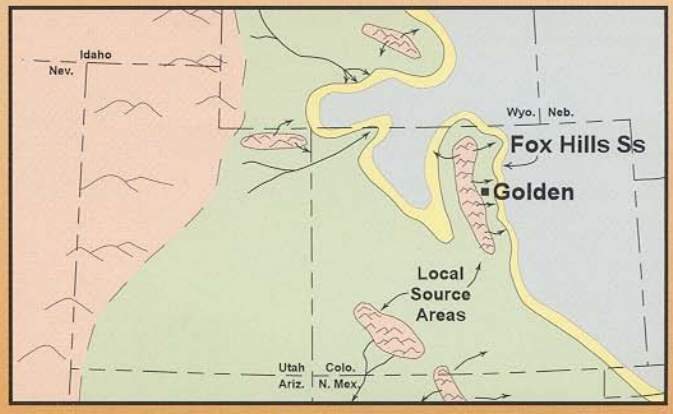


Fig. 15. Map of Colorado showing seaway and local uplifts during time of Pierre and Fox Hills and Laramie deposition.

STOP 7. LARAMIE FORMATION (68 MA); WHITE ASH MINE.

Sandstone ridges still stand south of 12th Street between the mined out clay areas (Fig. 16). The clays used for bricks and tiles were mined by the Parfet family beginning in 1877.

A six- to eight-foot coal seam was mined to a depth of 700 feet in the White Ash Mine before it was flooded in 1889 (Fig. 17). Ten miners were trapped and never rescued; their names are recorded on the monument.

The Clay Pits Fault is exposed on the south wall where lower Laramie sandstones are in fault contact with a tongue of the Pierre Shale above the Fox Hills Sandstone. Drag of strata under the fault plane indicates that the upper block moved to the southwest.

Fig. 16. Photo of Laramie, Pierre, and Fox Hills cut by Clay Pits Fault.

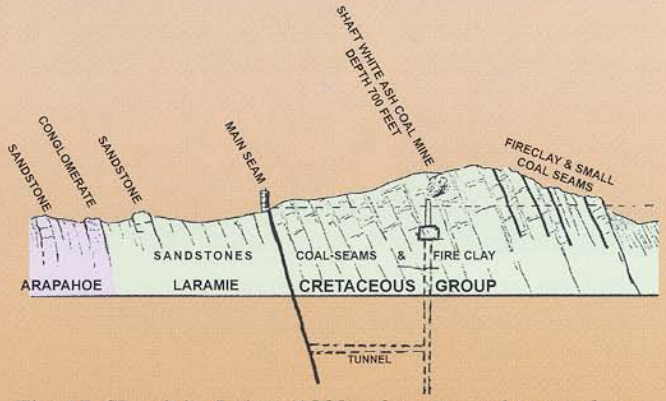


Fig. 17. Sketch by Lakes (1889) of overturned strata along 12th Street with outline of White Ash Mine workings for coal. Photo of mine buildings below.

STOP 8. ARAPAHOE FORMATION (67 MA); STRUCTURAL GEOLOGY.

The unconformable contact between the claystone of the Laramie Formation and the conglomerate of the Arapahoe Formation is in the south wall of the excavation (Fig. 18). The conglomerate with Precambrian pebbles was deposited on the margin of a subsiding basin by braided rivers draining eastward from an uplifted and eroded core of the Front Range (Figs. 15 and 19). The Arapahoe extends under the Denver Basin to the east where it is a major fresh water aquifer for Metro residents

Excavations for CSM buildings southeast of the museum found low-dipping sandstones, conglomerates and shales of the Denver Formation (Fig. 2). Volcanic pebbles in these strata and the lava flows capping the Table Mountains are the record of active volcanism in the area from 66 to 64 ma.

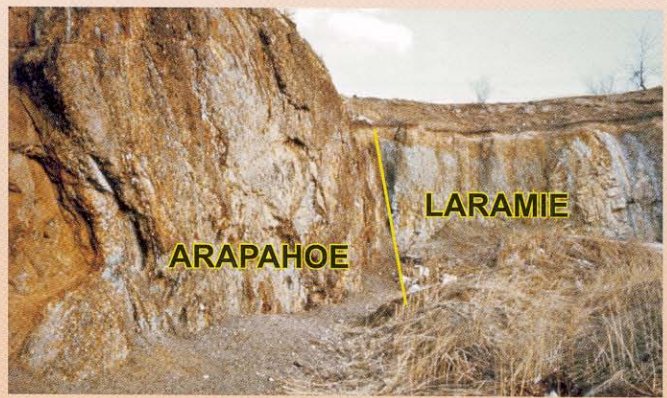


Fig. 18. Photo of contact between Laramie and Arapahoe formations looking to the south.

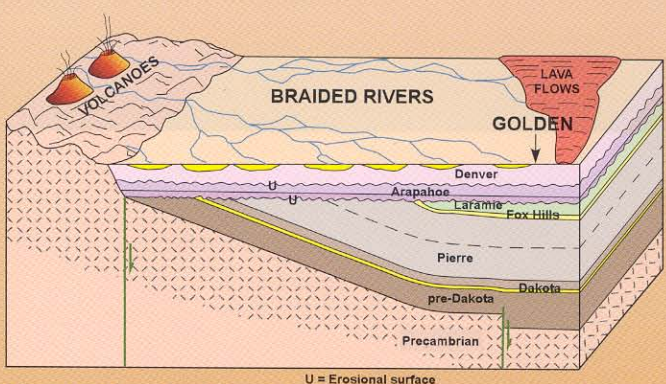


Fig. 19. The Arapahoe and Denver formations were deposited with nearly horizontal dip by rivers and were later deformed to near vertical dip (Fig. 18).

References:

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