Dinosaur Ridge on a Young Earth
- a guide book

by **Edmond W. Holroyd, III**, Ph.D.

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Cover Illustration. A view of Dinosaur Ridge, west of Denver, at the Interstate-70 road cut, looking south from the crest on the north side. The Rocky Mountains are to the right and Green Mountain is to the left (out of view).

INTRODUCTION

This guide book has been written to acquaint the reader with an interpretation of Dinosaur Ridge that is favored by most of the general public but seldom heard in public schools, the media, and museums. It interprets the rocks and fossils from a young-earth point of view. The discussion will be brief. The appendices contain overviews of selected topics and addresses for resources in which the scientific documentation is sufficiently supportive. Hopefully the reader will seek out the original sources for the ideas presented within this guide. There is great educational value when contrasting interpretations of the same observations are investigated. The reader is then encouraged to carefully examine the evidence presented by both sides and decide which interpretation the evidence supports best.

THE AREA

Dinosaur Ridge is the name commonly given to that part of the Dakota Hogback between Golden and Morrison, Colorado. The hogback was formed by the uplift of the Rocky Mountains to the west. The movement tilted and faulted the rocks between the Front Range and the Prairie. Erosion removed much of the former strata, leaving ridges of resistant rock and valleys in the weaker layers. At Dinosaur Ridge, the cap rock is the hard Dakota Formation sandstone. Some shales, often carbonaceous, lie within the Dakota. To the west and below is the soft and colorful Morrison Formation with its shales and sandstones. The road cut for the Interstate-70 highway (I-70) creates an attractive cross section through the Morrison and Dakota strata (see cover illustration). Interpretive signs are the same along both sides of the road cut.

Dinosaur Ridge is a National Natural Landmark (Figure 1). The crest of the ridge is being preserved from development by Jefferson County Open Space. The Friends of Dinosaur Ridge (FoDR) have been active in creating an educational trail along West Alameda Parkway where it crosses the ridge. Their headquarters are in the stone house at 16831 W. Alameda Parkway, (Morrison, CO 80465) east of the ridge and east of Rooney Road. They can be called at (303 697-DINO for tour information and schedule of meetings. Their web site is at www.dinoridge.org.

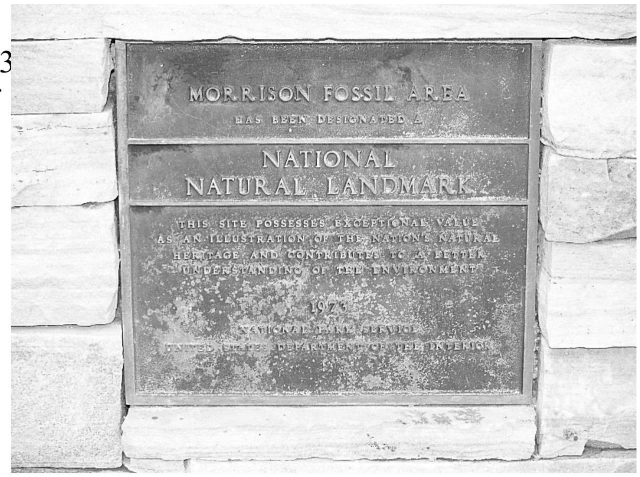

Figure 1. The National Natural Landmark sign, 1973.

The Friends have erected their own signs and shelters along the trail so that the public can take a self-guided tour at any time. Access to the dinosaur footprints is restricted by a tall fence in order to limit vandalism. General "Dinosaur Discovery Days" are held once each month from April to October, usually on a Saturday. The road is now closed to traffic, providing a safer environment for the crowds walking on the highway. About 400 to 2000 people visit the Dinosaur Ridge trail on those days. Knowledgeable people are usually stationed at important features along the trail to give longer explanations of those features. In addition to these "Dinosaur Discovery Days", mid-week tours are often organized for public, private, and home school groups. Most of the board of Friends of Dinosaur Ridge does not endorse the young-earth time scale presented in this booklet nor its implications.

The text of some of the signs was written from the evolutionary point of view, referring to millions of years. Most of the text is neutral, presenting physical observations or history with which we can all agree. The viewpoint of this guide is that the earth is young, having an age of roughly 10,000 years, give or take several thousand. Sign phrases that are contrary to the young earth position are usually an invitation for further comment in this booklet. Many of the great scientists of the past held the young earth position. For the past two centuries modern geologists have promoted long ages and uniformity of geologic processes. Today numerous scientists are finding abundant evidence for catastrophic geologic processes. It appears that the arguments for a young earth were unnecessarily abandoned in the last century. Our modern tools of observation are giving us an opportunity to re-examine the evidence.

GETTING THERE

Dinosaur Ridge is on the southwest side of the Denver metropolitan area between Green Mountain and the Front Range foothills. Compared to its neighbors, the Ridge is not very high, as seen in Figure 2. The white scar on the Ridge is the cut for W. Alameda Pkwy. This road is now closed. Figure 3 shows the regional roads. There is now an exit from C-470 at W. Alameda Pkwy on the east side of the ridge. Foot access is possible from the west side of Dinosaur Ridge. On special days FoDR offers shuttle rides to the west side for a small cost.


Figure 2. An oblique aerial view of Dinosaur Ridge from the southeast.

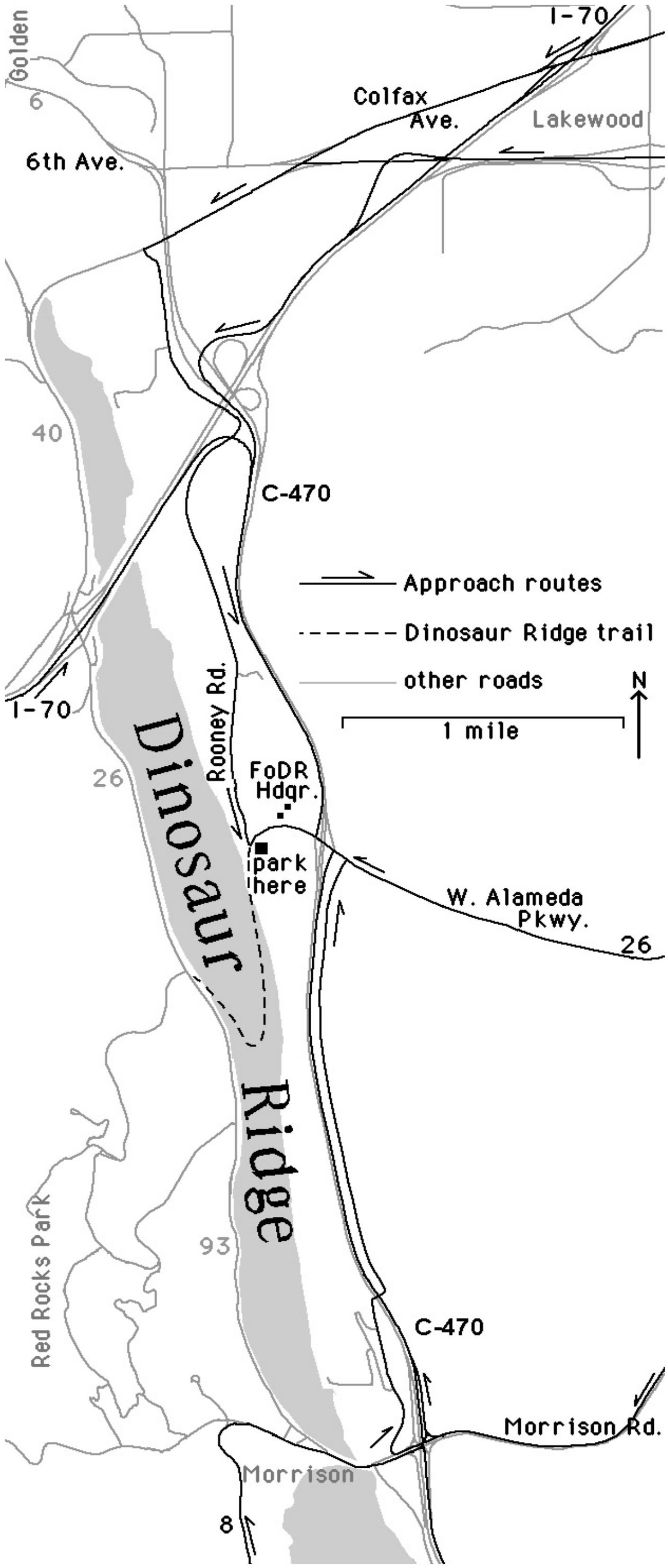

Figure 3. A map of possible routes to Dinosaur Ridge. Parking is best at W. Alameda Pkwy. and Rooney Road on the east side of the Ridge.

TOOLS FOR INTERPRETATIONS

In 1669 Niels Steensen, a Dane working in Italy (Florence, Tuscany), used a Latin name of Nicolaus Steno and published a description of a geologic site from which we derive three principles (laws) which guide the interpretation of the stratigraphic column. These laws are summarized in and quoted from *Interpreting the Stratigraphic Record*, by Donald R. Prothero, 1990, pages 6-7: "Original horizontality Sediments on a solid base must have been deposited horizontally or they would have slid to a lower point. Rocks that lie at an angle must have been tilted after the sediments were petrified.

Original continuity Sedimentary layers normally form continuous sheets that either covered the entire earth or were bounded by solid substances. Discontinuous layers that are similar on either side of a valley must have been separated by erosion from their original continuous state.

Superposition Each layer must have been deposited onto a solid layer, and therefore each layer is necessarily younger than the layer under it. In any succession of rock layers, then, the lower rocks are the oldest and the layers upward (superposed) are progressively younger."

These are still good rules, but we can recognize some exceptions to them. Horizontality: Sediments can be deposited parallel to gently sloping surfaces, such as within a lake basin. Sediments deposited at the leading edges of sand dunes, in water or in air, are nearly always sloping and generate cross-bedded sandstones. Continuity: Sediments can be deposited along a sea coast in the form of several deltas that are not connected to neighboring deltas but have similar composition. A layer can change in grain size and mineral content with horizontal distance. It can be a sandstone close to a sediment source, a shale far from it, and a limestone between or beyond. Such is called a "lithofacies" change. Facies changes (other types being biofacies, ichnofacies, and metamorphic facies) can be gradual or abrupt, but if there has been an abundance of erosion, it can be difficult to recognize any continuity. Superposition: Igneous intrusions in the form of horizontal sills are examples in which a younger rock is inserted between older layers. Salt layers can be squeezed into other locations, usually upwards, long after subsequent layers were deposited. Older rock units can be placed above younger units by thrust faulting and severe folding. These and other exceptions usually make geologic interpretation more challenging and interesting.

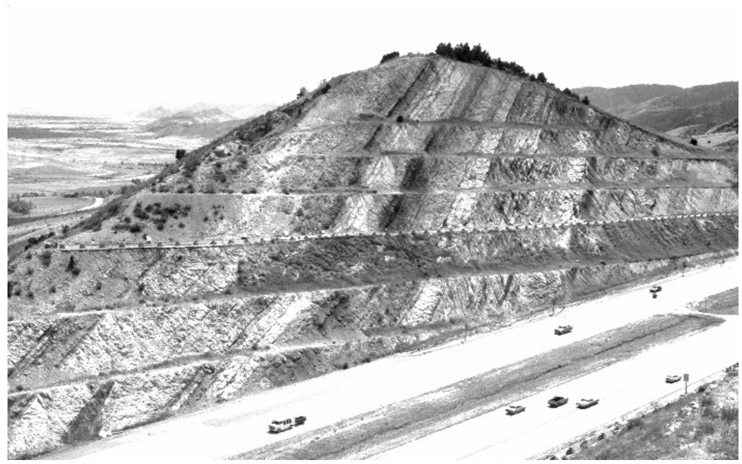
Figure 4. The Interstate-70 road cut through Dinosaur Ridge, looking south.

The I-70 road cut through Dinosaur Ridge. The I-70 area provides illustrations for some of these interpretation tools and others. The older layers (Morrison Formation) are to the right in Figure 4 and on the cover, the younger (Dakota Formation) to the left. The geologic map of the Morrison Quadrangle identifies the Lytle Formation between them. Some geologists combine the Lytle Formation and the Dakota Formation into the Dakota Group. The Morrison Formation can be recognized throughout the state by its bold, alternating colors of reds, purples, grays, and greens. The colors come from the oxidation state of trace iron within the sandstones and shales. The reds and purples are interpreted as being laid down in an environment with abundant oxygen, such as above water. The greens are interpreted as being laid down in a "reducing" environment with little oxygen, such as a swamp. Sediments for both the Morrison and Dakota formations are thought to have come from mountains to the west, such as in Utah. The Morrison Formation in the state of Colorado is thought to represent a sloping terrestrial environment between the mountains and the sea, like the middle parts of the southeastern states of the U.S.A. Flooding along the rivers sometimes created sandbars on which dinosaur carcasses were beached and buried, leading to their preservation as fossils.

The Lytle Formation is a yellowish sandstone with some dark brown iron (concretion) stains. The Dakota Formation is interpreted by uniformitarians as a near-shore environment, like the coastal areas of the Carolinas. The land was subsiding and an inland sea was encroaching from the east upon the land. The more sluggish stream and lagoon environments laid down shales and sandstones, often cross-bedded and with high carbon (black) contents from plant matter. Some deposits may represent beach sands. The shallow water environments recorded animal footprints and ripples from wave action. Afterwards much deeper marine water deposited shales when an interior seaway covered the Plains states.

All of these layers were nearly horizontal when they were laid down. A subsequent rising of the Rocky Mountains, to the west (right), has tilted these layers to their present orientation. The strata were partly eroded. Later, the sediments of Green Mountain and North and South Table Mountain, near Golden, were deposited from materials washed from the Rocky Mountains into the seaway. These were partly eroded and covered with the igneous caprocks, remnants of which can be seen at North and South Table Mountain. Still later the shales were deeply eroded, forming valleys to both sides of Dinosaur Ridge. Streams from the mountains have cut deep notches in many locations. Today we are left with a ridge (hogback) of tilted strata running parallel to the foothills of the Rocky Mountains in much of Colorado. A good overview of the ridge, Figure 5, is provided from Highway 26 looking south from near I-70.

Figure 5. The uplift of the Rocky Mountains has tilted the area strata, including Dinosaur Ridge, left, and Red Rocks Park, right.

A Stratigraphic Section. Geologists sometimes sketch the sequence of layers in a vertical column called a stratigraphic section or profile (see right side of Figure 6). The strata are drawn in their proper sequence and proportional thicknesses. Their left or right edges are extended sideways to indicate a relative resistance to erosion or their grain size. The two styles are sometimes equivalent because durable sandstones have coarse grain sizes and weak shales have very fine grains. Most of the signs along the highway over Dinosaur Ridge have a stratigraphic section, with an arrow pointing to the appropriate position of the site in the diagram.

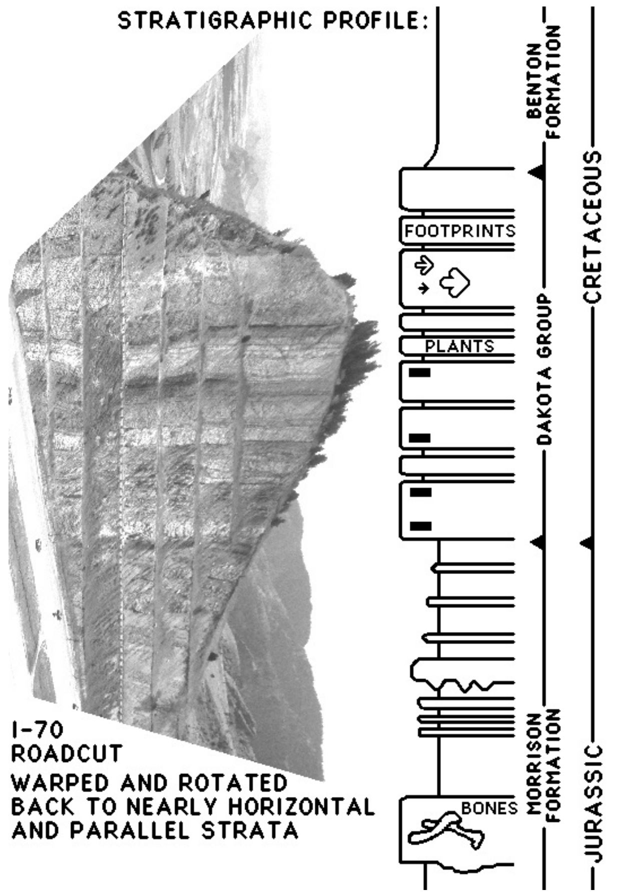

Figure 6. Stratigraphic profile and restored strata oriented for Dinosaur Ridge.

For Figure 6 the view seen on the cover has been rotated by computer to its original horizontal orientation and warped to parallel strata (removing the distortion due to perspective). The stratigraphic section has been drawn at the same scale. Individual layers may not match exactly because these layers have thickness variations. Symbols indicate the presence of dinosaur tracks and bones. The wavy line near the bottom indicates an unconformity. These occur when there has been erosion or a break in deposition. The extents of the Formations are indicated, with the

Figure 7. The Rooney Road cut in the Laramie Formation viewed southeastward from I-70.

Lytle combined into the Dakota Group.

The time periods commonly given to these strata are Jurassic and Cretaceous. Young-earth geologists are usually content to use such names to identify the relative positions of the rocks. In fact, many of the names were nominated by young-earth geologists of the 1700's and 1800's as they worked out the sequences. However, the dates assigned to these names in this century are not acceptable in the young-earth viewpoint.

The Passage of Time. Figure 7 shows a road cut through the Laramie Formation, located northeast of Dinosaur Ridge, and visible from both Rooney Road and I-70. Erosion of the soft sandstones of the Laramie Formation have left only a minor ridge in this location. Beautiful plant fossils from this formation include fans of palmetto shrubs and leaves from hardwood trees, perhaps oaks. A wall in the Morrison Museum of Natural History shows a replica of these fossils. Such plants presently grow in the states bordering the Gulf of Mexico. Uniformitarians interpret such plant fossils as indicating a warmer, moister environment here in the past. However, the plant matter may have been washed here by major storm water currents, invalidating climate interpretations.

The layers in the bottom of the view have a nearly vertical orientation, having been tilted at the same time as Dinosaur Ridge to the west (right). Erosion truncated these strata to an irregular surface that is generally horizontal. The next layer is a zone of stream cobbles, presumably washed out of the Rocky Mountains by a major flow of water. Together these layers form an "angular unconformity", in which the layers on either side of the contact have a measurable difference in the angle between their bedding planes (the nearly parallel bands that you can see). Angular unconformities usually indicate a passage of time during which the lower strata were tilted and eroded after being laid down. Angular differences occur also in cross-bedding (discussed later) in which the layers are not being laid down horizontally but rather along sloping surfaces of sand dunes, either above or below water.

Above the stream cobbles is a shale layer with bedding that is not quite horizontal, indicating that deposition was in an environment with surface undulations like we see in this area today. A dark band caps the shale layer and is essentially horizontal. This is a soil layer, rich in organic matter.

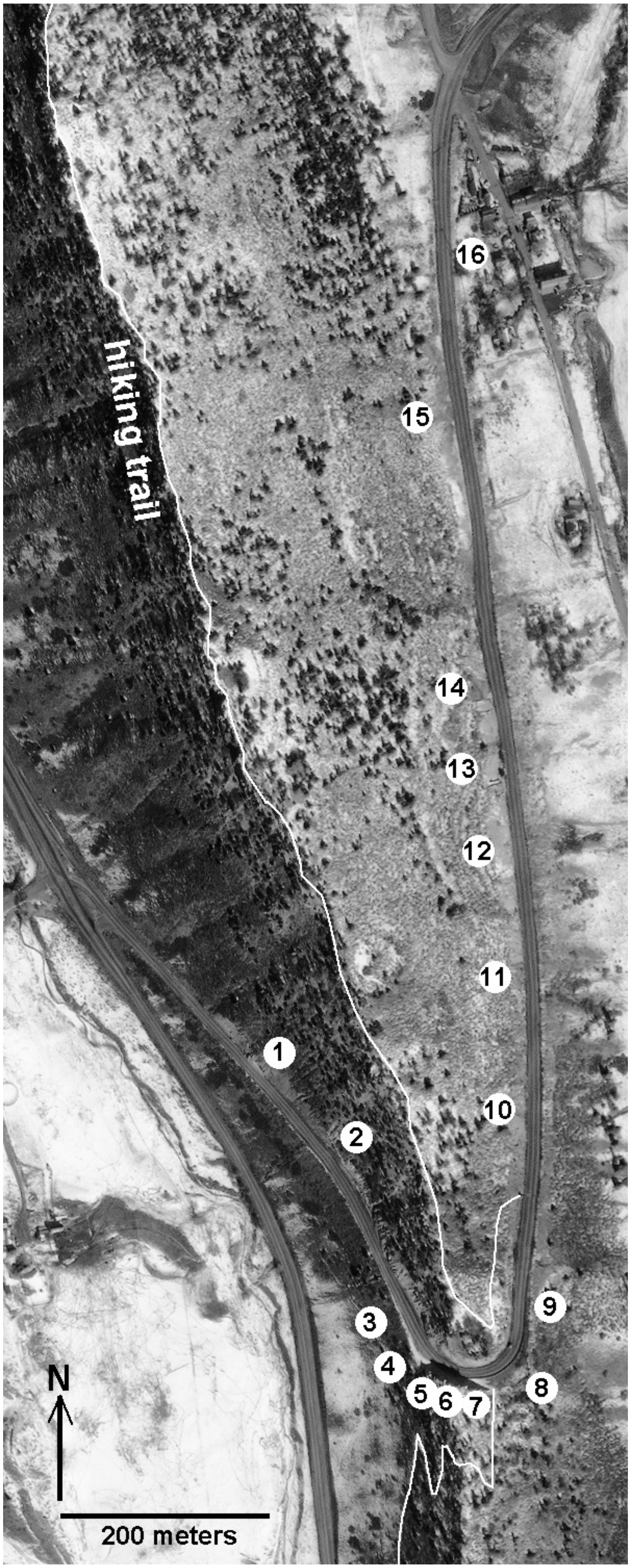

Figure 8. The location of some signs and sign clusters along the Dinosaur Ridge educational trail. The numbers are arbitrary and do not appear on the signs. There is a hiking and biking trail along the crest of the ridge.

1. Dinosaur bones and steel canopy.

Morrison Formation sign

2. Dinosaur footprint bulges.

3. Rock deformations (small faults).

4. The Rocky Mountains, Red Rocks, shelter.

5. Volcanic ash bed.

6. A puzzle (concretion balls).

7. Cretaceous time, plant fossils.

8. Denver Basin, fluid traps, shelter.

9. Coal and clay mining.

10. Ripple marks.

11. Ecology.

12. Trace fossils.

13. Dinosaur tracks.

14. Mangrove swamp.

Dakota Sandstone sign

15. Western Interior Seaway.

16. Rooney Ranch.

Benton Shale sign

Additional features may be between the major signs.

Soil formation takes time, depending of the climate and plant community. As you look at Dinosaur Ridge, try to find similar soil layers preserved in the rock. You will probably conclude that they are not there. That indicates that the interludes between the deposition of contrasting sediments were not sufficient to make soils of this type. Above the soil layer is artificial fill, caused by dumping of rock by human mining and excavation activities. That sealed in the soil layer and is comparable to the catastrophic deposition of subsequent sediments by natural processes. A new soil layer is forming at the present top surface, showing that even in this dry environment a soil can form in decades or a century. Any exposed surface on this planet that has adequate water will be rapidly colonized by plant life. Similarly, any exposed surface that is not receiving sediments will be experiencing erosion to some degree. Animal activity and repeated frost will both blur the boundaries between adjacent layers. All surfaces are affected by the passage of hundreds and thousands of years. Remember this as you interpret what happened between sedimentary events and how much time might have passed. Are the contacts sharp or indistinct?

A FIELD GUIDE FOR DINOSAUR RIDGE

This guide for Dinosaur Ridge starts on the west side, near the end of West Alameda Parkway, in the Morrison Formation. Figure 8 shows an aerial view of the ridge. The locations of interpretive signs, placed by Friends of Dinosaur Ridge, are indicated by sequential numbers. The numbering system is arbitrary and does not correspond to any numbers on the sign posts themselves. Figure 9 is a former view of the west side from the road intersection. The sign indicating the site as a National Natural Landmark and the bone access ramp had not yet been erected. It is from this side that many people start their tour of the ridge, viewing the oldest layers first.

Figure 9. An old view along the west side of Dinosaur Ridge, from the intersection to the road cut.

The educational signs gives some background and guidelines. They may proclaim that the fossils have been here for millions of years. Throughout this guide the time scale will be questioned. We can properly ask, "Who was here millions of years ago to leave us recorded observations?" Obviously no human being by either scenario. The theory of evolution requires vast ages of time, actually in excess of the billions of years supposedly available. Creation theories do not. The documentation for long time periods comes from extrapolations of rates and processes observed over recent decades and centuries, such as sedimentation rates and decay rates of radioactive atoms (see Appendix 1). More often, rocks are dated by their fossils, and then other fossils are dated by the rocks containing them (circular reasoning), all under the assumed time scale of evolutionary processes: "It must be that old." Young-earth scientists typically use the general names for "ages", like Cambrian, Jurassic, and Cretaceous, as a matter of convenience for recognizing a sequence of events, but not the millions of years generally assigned to them. In fact, some of the names were supplied by creationists of the past centuries as they developed those sequences.

Dinosaur Bones, Site 1. The steps, shade structure, and ramp to the south (Figure 10) were constructed in 1995. This structure received an award for excellent architectural design that year. The ramp makes possible wheelchair access to the dinosaur bones. Bench seats are on the east side of the structure. Signs are on the west side of the seats.

Figure 10. This ramp makes it easy for you to see and touch the dinosaur bones.

Figure 11. You can see different shapes of dinosaur bone in the large boulders on both sides of the steps.

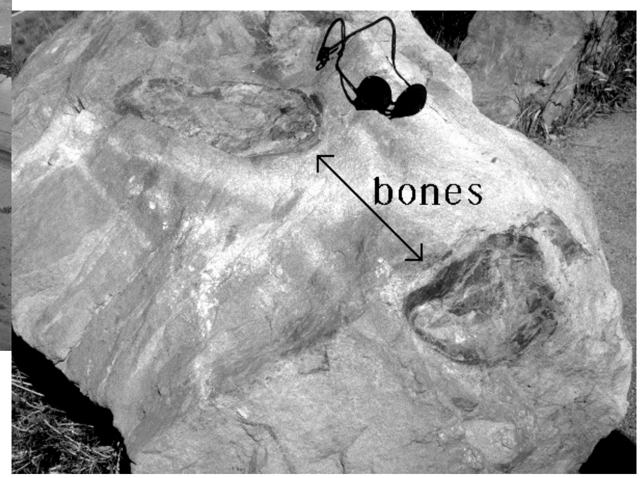

Figure 12. Large leg bones are seen in cross section in this boulder.

As you climb the steps (Figure 11), notice the dark patches in the large boulders next to you. They are fossil dinosaur bones. To the left of you (Figure 12) are large leg bones. How would you like to meet in a swamp with a live animal having leg bones of that size? To the right of you, look at the bones very carefully (Figure 13). Can you spot a backbone vertebra? A rib bone? Bone marrow? These boulders were originally where the ramp is now located but were moved decades ago for the road construction. Now they are back near their former positions.

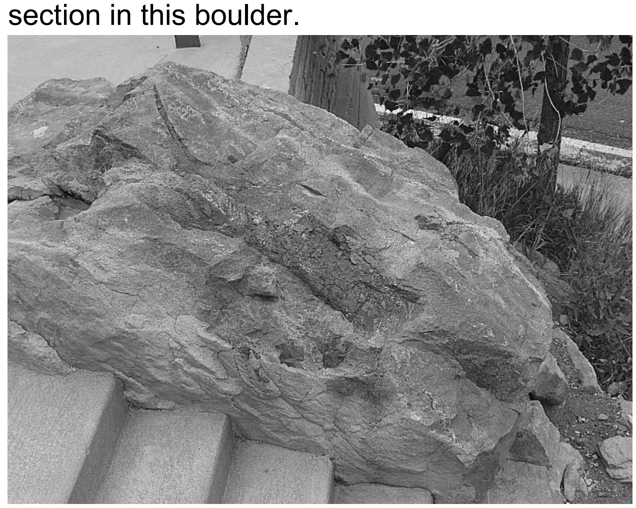

Figure 13. This boulder contains dark bones of many dinosaur body parts.

To read the three signs stand on the west side between the wall and the structure. The sign to the left points out the features of the bones along the steps. The middle sign mentions the original discovery of similar bones by Arthur Lakes in the Spring of 1877 as he was looking for plant fossils. The discovery of large dinosaur bones started a "bone rush" by Eastern museums.

Marsh obtained the bones from this ridge while his main competitor, Cope, worked deposits elsewhere. The rivalry between these two men makes some interesting historical reading. The Dinosaur Ridge site was quickly abandoned because it was too difficult to extract the bones from the hard sandstone. The fossil bones, indicated by arrows in Figure 14, are found only in this particular layer of sandstone at Dinosaur Ridge and not in the other layers. It appears to be a sandbar deposit, as illustrated on the sign to the right, onto which dismembered carcasses settled during a flood. All three signs present descriptive and historical information which is generally independent of the time scale interpretation.

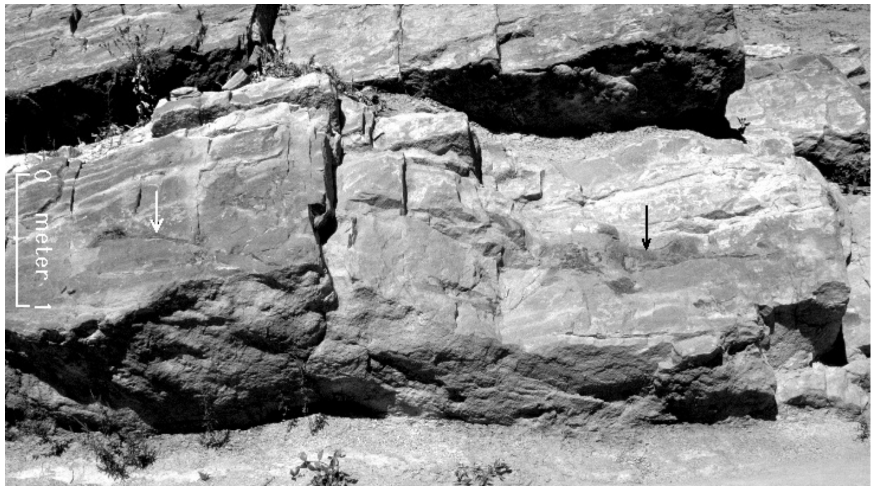

Figure 14. The dark bones are in layers of hard sandstone.

Fossil bones. Most of these bone fragments should make you feel small. Near the south end of the ramp is a view of bones of an animal about the size of a chicken (Figure 15). Most dinosaurs were small, with a range similar to modern dogs. Even more amazing is how fast the animal had to be buried for there to be a fossil for you to see. The discussion in Appendix 2 suggests a deposition rate of more than the animal's thickness in a fraction of a year. See why that must be so.

Figure 15. These bones suggest an animal size similar to that of a chicken.

DNA. A sign previously located with the large leg bones mentioned findings of original bone material. Elsewhere scientists are discovering real fragments of the DNA molecules in fossil material that has been well preserved, especially in amber. That contributed to the story line of the movie *Jurassic Park*. What most people do not know is that this real DNA discovery has something very important to say about the time scale that is used to date the fossils. That story is in Appendix 3.

Radioactivity. On "Dinosaur Discovery Days" and during some guided tours, the Friends of Dinosaur Ridge may have a scintillation

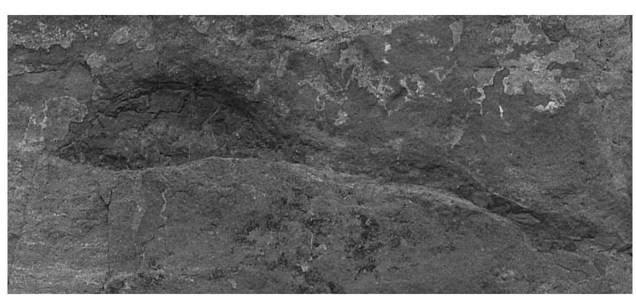
Figure 16. This rib bone in the wall has the greatest level of radioactivity.

counter at this site to show that these bone fossils are radioactive. In fact, that is one of the best ways to distinguish between fossil bones and concretion material of similar color. Look in Appendix 4 to see why the bones are radioactive and what that means about one of the dating techniques.


Figure 17. These colorful shales of the Morrison Formation come from clays and silts with varying states of iron oxidation.

Between Sites 1 and 2 is a sign identifying the Morrison Formation with its colorful shales (Figure 17). At Site 2 a sign titled "Late Jurassic Time" gives it a multi-million year span on the evolutionary time scale. The Morrison Formation is from the upper part of the Jurassic time period. The roughly 300 feet of sediments converts to about 100 meters. Perhaps the Morrison represents only about 25 million years of the supposed 60 million year span of the Jurassic period. Dividing those numbers results in an average deposition rate of 4 micrometers (0.004 mm) per year. Keep that rate in mind as you examine the other sites along the trail. Of course the deposition rate varied. Burial of the dinosaur bones and footprints required a higher rate of deposition. Look in Appendix 2 for a picture of some modern bones and read the discussion about burial rates. Periods of erosion are essentially negative deposition and create an unconformity. There is a time gap between the deposits of strata in contact at the unconformity.

It is appropriate to ask at each distinct layer of rock how long did it take to deposit those sediments. There are clues to be discovered. Similarly it is appropriate to ask how much time passed in the gap between the deposition of adjacent layers. There are several discussions of these rates in Appendices 2, 5, and 9. As another time reference, consider that some geology texts point out that at today's rates of erosion, ignoring the uplift processes, the earth's highest mountain ranges can be reduced to sea level in roughly ten million years. Therefore any surface exposed to weathering for millions of years (a time gap) should show evidence of severe erosion.


Figure 18. Tan sandstones cap the colorful shales.

Look ahead (Figure 18) towards the next site. The soft, colorful clays are capped with a series of hard sandstone layers. Watch carefully for places where the layers are not parallel, as in Figure 21.

Site 2. The next educational signs are located close to a layer of hard sandstone. (Figures 19, 20) They highlight the downward bulges (there are several of them) that appear to have been caused by the footsteps of a large dinosaur. They are therefore called "trace fossils", created by biological activity.

Figure 19. A ramp aids access to the bulge site. The steel pillars help prevent rock falls.

Figure 20. There are several bulges below the nine-inch layer of sandstone that fills those footprints.

Some geologists had thought that these bulges (Figure 21) were load casts caused by sediments of differing density flowing to more equilibrium positions while the rock dewatered and hardened. Others noticed the regularity of the bulges as evidence for footprints. In Figure 20 the scene has been tilted to horizontal and some of the bulges are indicated by the arrows. Can you find any more? They all appear to come from the same layer of rock. Assuming that these are footprints, how fast did they fill with sediment? In Appendix 5 are two copies of Figure 21, one showing what a slow deposition might look like and the other a fast filling. One is simulated and the other is real. Guess before you look. A different view of trace fossils made by dinosaurs is at Site 13 on the other side of the ridge.

Figure 21. A close-up view of a bulge. Notice a lack of banding within it.

Figure 22. A view towards the road cut. The next sign and shelter are on the right.

As you walk farther south towards the road cut (Figure 22), notice that the red, purple, and greenish shales are replaced by light tan sandstones with dark brown concretion deposits. Some of the designs caused by the weathering of these cross-bedded rocks are attractive. The transition marks the top of the Morrison Formation and the bottom of the Lytle Formation.

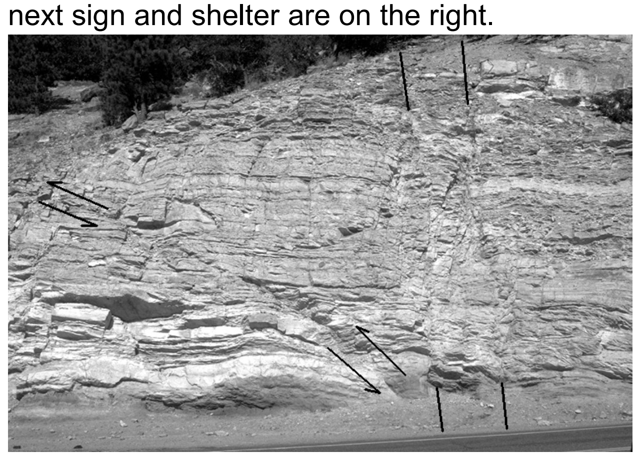

Figure 23. The rocks are fractured in two directions.

Site 3 on the west side of the road directs your view to the east side of the road (Figure 23). Notice the slippage along the major cracks, forming a triangle. The strata were deposited first. The cracks, highlighted in Figure 23, happened later. Such evidences help us understand the sequence of events.

Figure 24. A shelter and a view of the Rocky Mountain foothills and Red Rocks Park.

Site 4 (Figure 24) has a shelter and a sign explaining the uplift of the modern Rocky Mountains. They are composed of granite and gneiss. Eroded granites are the source rocks for the hard sandstones and conglomerates in the tilted outcrops seen across the valley at Red Rocks Park. The conglomerates of pebbles and cobbles usually indicate the rapid erosion and transport of rock materials from an adjacent mountain range. As the sign says, there was a former Rocky Mountains that was eroded away before the present Rockies were lifted. The multi-million year ages, however, are the assigned dates on the evolutionary time scale.

Erosion can wear down rocks to a "base level" and no further. The base level is the lowest elevation in a region to which water can flow. For an entire continent the base level is usually sea level. For interior parts, such as central Utah, the base level may be a lake surface. We can see evidence of three base levels in this region. The highest is at the tops of the highest mountains, all near the 14,000 foot level. Longs Peak and Pikes Peak, for example, have flat tops, indicating that ancient erosion brought a previous mountain range down to that level. The next base level is indicated by the nearly uniform elevation of hill tops of the Front Range east of the Continental Divide, at roughly 10,000 feet. Seen from an airplane (as in Figure 25) just slightly above that level, the high ground forms a shelf (erosion remnant) that is being eroded again. The Figure 25 view towards Pikes Peak and Mt. Evans shows the second base level at the arrows. The third local base level is the prairie on which the Denver metropolitan area is built, at roughly 5000 feet.

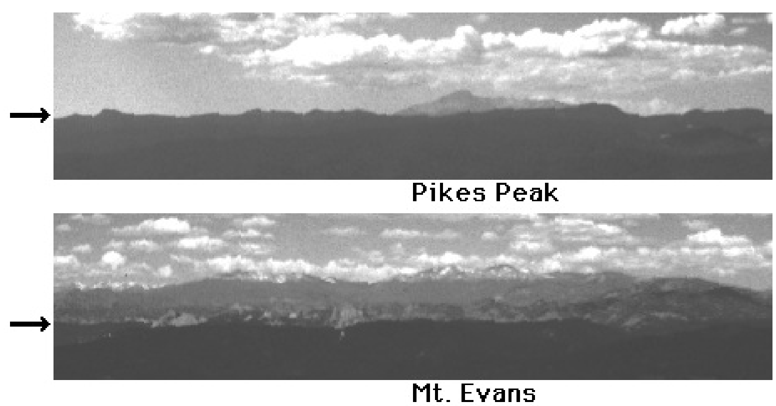

Figure 25. The foothills summits are at a common level, an ancient erosion surface.

After the first uplift of the ancestral Rocky Mountains the erosion cycle that leveled the tops of Longs Peak and Mount Evans deposited the Fountain and other lower Formations. Eventually the land was gently sloping across Colorado, with higher ground in western Utah. Then the

Morrison and Dakota strata were deposited. There were no high mountains here in Colorado at that time. Later there was another uplift with partial erosion to the level of the tops of the eastern hilltops of the Front Range. The final uplift raised the Rocky Mountains again, separating the plains and the foothills by faulting. The rocks of this hogback could have been tilted during the second or third known uplifts, or a combination of them. Young-earth scientists can agree on the sequence of events shown by the physical evidence, but will disagree with old-earth scientists about the "dates".

The rocks that are now exposed in the Front Range are crystalline and are labeled Precambrian in age. These are the basement rocks of the continent upon which all sedimentary layers were deposited. There are a few areas in which the Precambrian rocks appear to be ancient sediments that have been tilted, melted, or otherwise stressed by metamorphic processes. Sometimes they can be turned into rock types known as schist which still retain some sedimentary banding features. Some of the Precambrian rocks have crystals of a dark mica (biotite), which have layers that can be peeled off by hand. (Muscovite mica has transparent layers.) See Appendix 6 for an interesting story about tiny spherical discolorations (haloes) in biotite caused by radioactive decay.

The Road Cut. There are numerous features of interest within this road cut through Dinosaur Ridge. However, only three signs have been placed here to date. Perhaps more will be created in the future.

Bioturbation. This is the technical term for the disturbance of strata by animal activity. Look carefully at the rocks on the lower right side (Figure 26) of the road cut as you face south (direction of travel assumed in this guide). From a distance you can see what looks like normal, parallel strata. If you get very close, you should see that the rocks are full of holes (trace fossils) and some distortions. It is likely that small invertebrate animals were burrowing in the sediment, ingesting it for organic matter. Perhaps their food was an abundance of plant debris laid down with the sand. If so, nothing remains of such plant debris, unlike the charcoal and impressions at the other end of this road cut. In the bioturbation process the sediments are disturbed and sharp contacts made less distinct. This type of burrowing takes time if the number of trace makers is small. It could occur relatively quickly if there are many burrowers. The bioturbation could have continued under conditions of rapid burial as long as the overburden did not smother the trace makers. Appendix 7 shows a picture of another product of bioturbation (fecal pellets) from half way through the road cut. The rocks near Site 12 show bioturbation in unconsolidated sediments just offshore of a marine beach.

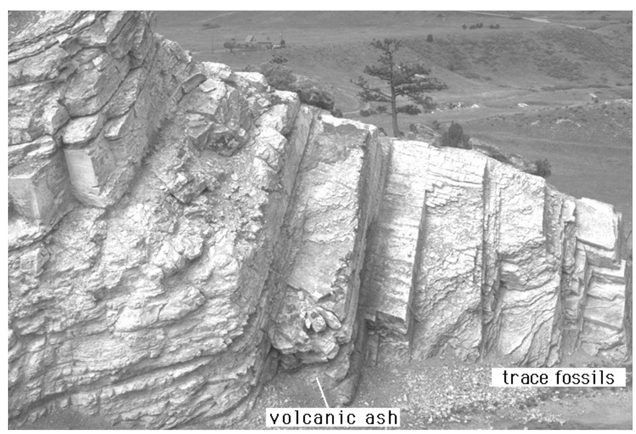

Figure 26. At the west end of the road cut the rocks show probable bioturbation holes and a thin layer of volcanic ash.

Site 5. Volcanic Ash. Some geologists have noticed that some of the next higher layers (center of Figure 26) are of volcanic ash that has been changed over time. This ash layer, only a few inches thick, has been altered to a yellowish rock (Figure 27). Such layers are useful for establishing a common instant (an event horizon) in geologic time over a region. Later events create deposits on top of the ash layer, erode it, fault it, or fold it. Volcanic ash is not a major contributor to the strata in Dinosaur Ridge. Ash contributed abundantly to younger layers that are now to the east of the Ridge. The alteration of the later ash layers has resulted in the formation of bentonite clays. These clays swell when exposed to water. Land movements caused by clay swelling are a major problem in area housing developments, cracking foundations and walls.

Figure 27. The yellowish layer is volcanic ash. Some of these rocks have since fallen away.

Volcanic ash is also used for radiometric dating of event horizons. The potassium-argon method is used by some geologists to determine ages where many tens of millions of years is the desired result. Special techniques are necessary to identify possible contamination by atmospheric argon. Many such datings from the Colorado Plateau region have qualifiers like "excessive argon", meaning that the derived date was much older than expected. Young-earth geologists tend to be highly suspicious of potassium-argon dates. See Appendix 1 for the results of "dating" a 10-year old rock from the new dome in Mount St. Helens.

The sign at this site indicates that a radiometric “date” of 106 million years was obtained from a precision uranium-lead analysis in a few zircon crystals extracted from this ash layer. Zircon crystals are found throughout the sediments of this ridge, being eroded from granites to the west and deriving their “ages” from those igneous rocks. The volcanic eruption must be younger than the granites. The analysis failed to compare the ages within the ash to those within the adjacent sediments to show that the zircons from the ash were indeed younger than those from the granites. Without such confirmation, the 106 million year value may not be from the eruption. See Appendix 13 for more discussion.

Site 6 directs your attention to a large ball high up the cliff on the southern side of the road cut. There is also a cavity of similar size to the lower left of the ball (Figure 28) where another ball was apparently located. The hard, dark material is a concretion. No one knows why it is nearly spherical in shape. Most of the concretion material in this ridge is in flat or slightly curved layers. The concretions form when mineral-laden water flows through the rocks, especially through the cracks. In this case the concretion material is largely the dark,

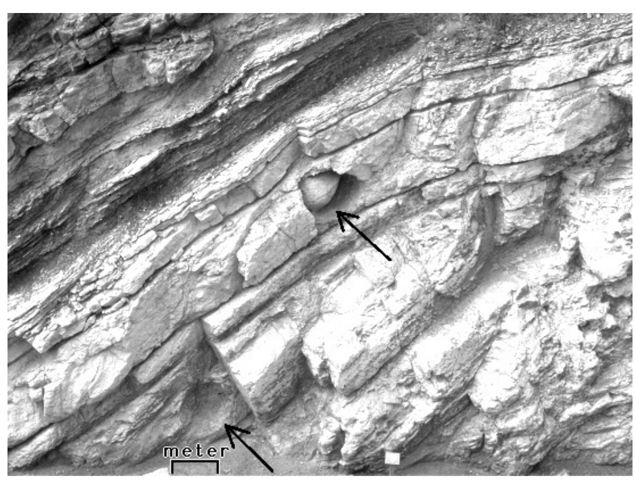

Figure 28. A view of the large spherical concretion exposed by the road cut.

reddish-brown iron mineral hematite. The color is similar to the fossil bone material in the Morrison Formation. However, the concretions at this site contain no structures indicative of animal bone. Nor are they radioactive. Many people pick up brown concretion pieces here, thinking that they are bone fossils.

Figure 29. The light band in the middle of the road cut is another layer of altered volcanic ash.

In the middle of the road cut, just below the channel sandstone, is another volcanic ash layer (Figure 29) which has been altered to white kaolinite clay with rust stains. There are some additional thin ash layers within the road cut but they are hard to find.

Channel Sandstone In the middle of the road cut, on both sides, is a large block of uniformly colored light sandstone about 12 feet (4 meters) thick. Figure 30 shows the northern exposure. The block, outlined here in dashed black lines, is called a channel sandstone. Many geologists believe that the strata in which it lies was eroded by a creek. Then sand filled the channel as the creek dried. For the channel to fill with uniform sand rather than with several layers of banded sand indicates that the filling was essentially from one flood event, perhaps measurable in days.

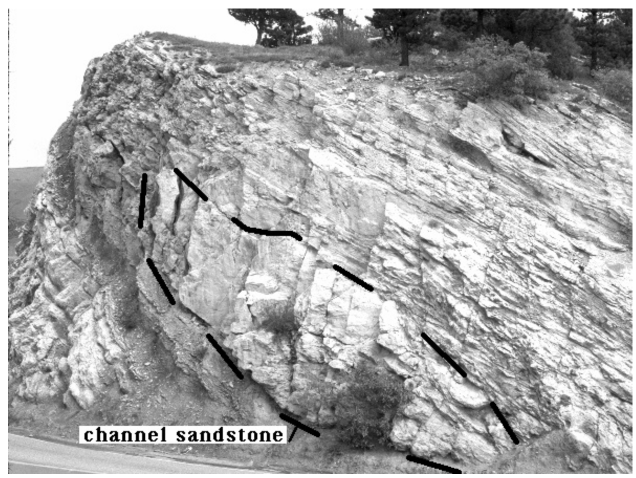

Figure 30. Both sides of the road cut expose a channel sandstone about 4 meters thick.

Site 7. Plant Fossils. The Friends of Dinosaur Ridge, in their first field guide, pointed out the plant fossil material at this site. The plant matter impressions extend from below the channel sandstone to the east end of the road cut. No permanent sign has yet been made to discuss them. The plant fossils, none of which are attractive, are still important because of their relationship to the discovery of the other fossils. Arthur Lakes was looking for plant fossils in 1877 when he accidentally found the dinosaur bones. Now the plant material is ignored by most people. Plant matter, if it is identifiable, can give an indication of the climate zone and ecological community in which the plants grew. These plant fossils are also important in what they can tell us about

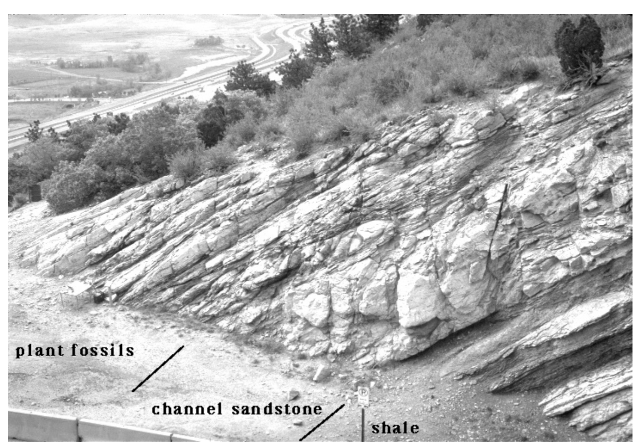

Figure 31. Plant fossil material is found in the cross-bedded sandstone at the east side of the road cut from the channel sandstone upwards.

the rapid processes necessary for their deposition and preservation. Figure 31 shows the general extent of the plant fossil material at the east end of the road cut through Dinosaur Ridge.

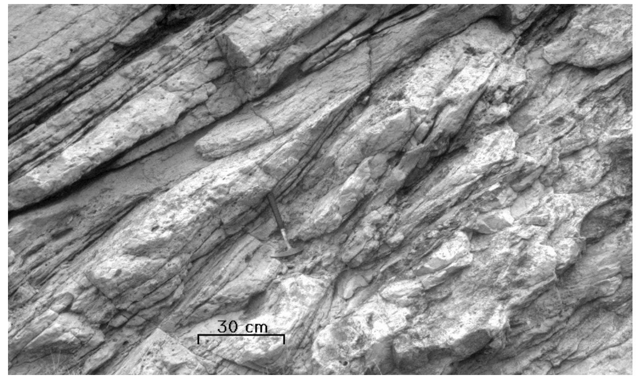

Figure 32. Cross-bedded layers are not parallel.

Cross Bedding. The plant fossil impressions are found in the bottom of the channel sandstone and more abundantly in the cross-bedded sandstone above it. The flows making the cross-bedded pattern eroded some sediments and filled some depressions across the landscape. Try to trace an individual bed, such as in Figure 32. It may terminate at a minor erosion surface. The depressions caused by erosion may have bedding planes (the parallel lines that you can see in the strata) that are tilted compared to their neighbors. During deposition, new sand and silt are deposited on the leading edge of a sloping surface. This is the same mechanism used to build deltas where a stream enters a large body of water. Deposits are mainly at the far edge of the delta where it changes from mostly horizontal to mostly sloped. Much less material is deposited on top of the horizontal surfaces. The streams building deltas tend to meander, changing channel locations, cutting and filling as they move. Similarly these cross-bedded deposits indicate meandering stream beds. There is some passage of time inherent in this process, but the time scale cannot be fully determined. Coarse sands are associated with faster stream flows while fine silts and shales (usually thin and horizontal when deposited) indicate a period of relative quiet. The flow patterns here suggest a mostly energetic environment.

Plant Fossil Details. Page 12 of A Field Guide to Dinosaur Ridge by Martin Lockley (1990) said that more than 25 species of plants had been identified from the fossil remains in this area. It also mentioned the technique of determining plant types from pollen grains found within the rock. However, no mention was made of whether the plants were identified by leaf shapes or by pollen. His revised guide (1995), available from Friends of Dinosaur Ridge, omited the fossil plant topic entirely when discussing this location, in spite of its historic importance in the bone discoveries.

The only recognizable impression that I have found near the road cut and for hundreds of feet along the ridge to the north has been a fragment of a stem that has the longitudinal ribbing and joint collar of Equisetum, a plant (also known as horsetail and scouring rush) commonly found along river banks today. Figure 33 shows the impression with a thumb for scale. Equisetum is frequently found in rocks of this time period, so the artists often include it in their illustrations, as on a sign at the bone site.

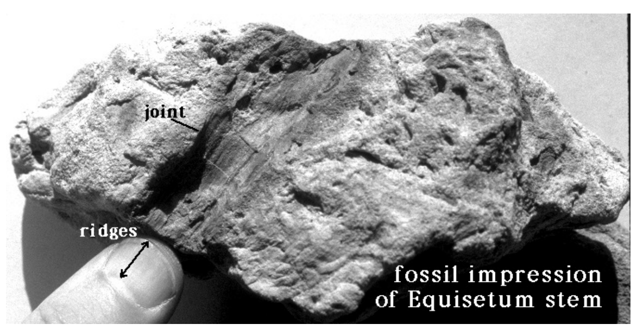

Figure 33. This fossil impression has a diameter four times larger than similar plants now growing along Clear Creek.

There are some other impressions that resemble leaves (Figure 34), but they may be simply cracks filled with thin concretion deposits.

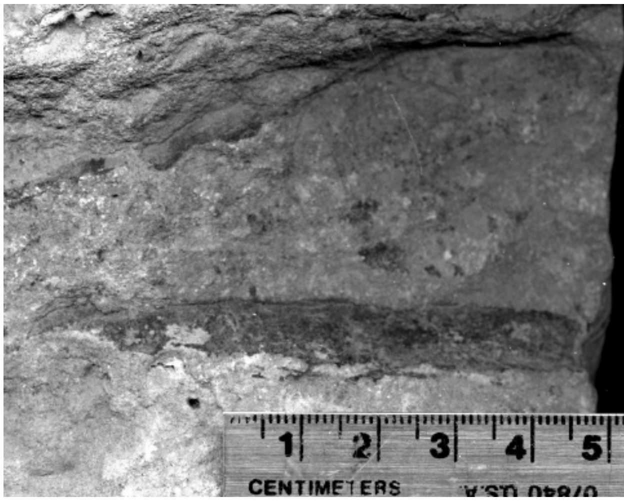

Figure 34. A flat leaf-like impression (dark).

Figure 35. Deep impressions of a twig (lower) and a nut (upper right) in a black surface.

Figure 36. One of numerous bark impressions.

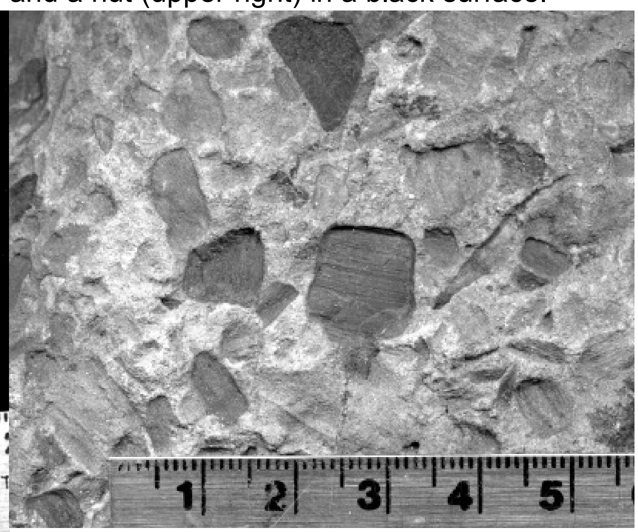

Figure 37. These wood chip impressions show wood grain striations.

Some twigs are present. Something resembling a nut has been found (Figure 35). Numerous bark impressions (Figure 36) have good detail but do not seem to be identifiable by experts in terms of plant types.

Wood Chips. Nearly all of the black you see in the rocks here is carbonized plant material from long ago. It is not thick and pure enough to be minable coal as there is too much sand and silt mixed with the carbon. The bulk of the fossil material that remains here appears to be of broken fragments of wood chip size. Some consist only of impressions, with the carbon having been washed or oxidized out of the rock. Those preserved by orange concretion deposits show wood grain striations, confirming the wood chip interpretation (Figure 37).

It is difficult to determine what the whole tree looked like when it has been reduced to wood chips. The largest specimens I have been able to find here are impressions of a twig, a piece of bark, some branches, and of a stem. Except for the Equisetum stem, none of these shapes are identifiable as to the plant type. The pieces have been broken beyond recognition. That requires pollen analysis to determine the types of plants present in the area when the rocks were laid down.

Charcoal. It appears that most of the plant material deposited here was already in the form of charcoal pieces. It may have come from a forest fire or from wood baked by a volcanic flow and later excavated by erosion. Most was broken during transport. Appendix 9 shows how that was determined on the basis of the fracture pattern, wood grain direction, presence of powdered carbon, and the indigestibility of charcoal. Some plant matter, however, was apparently green or dead because something ate it after deposition. Some of those small animals excreted the fecal pellets shown in Appendix 7.

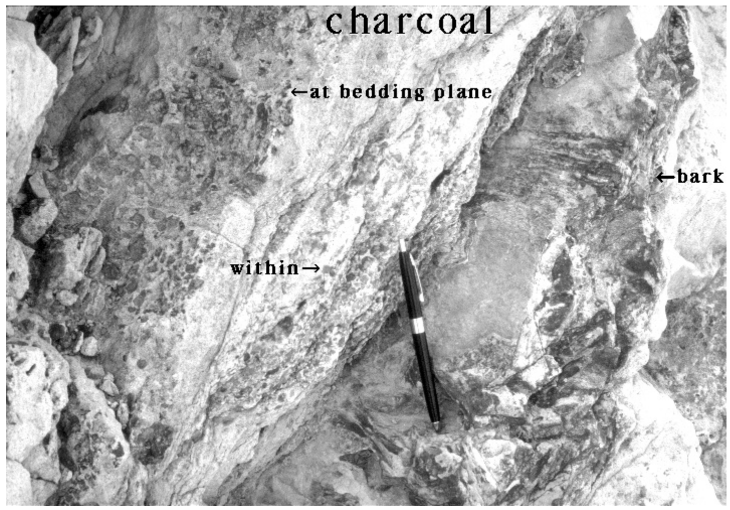

Figure 38. Two styles of plant deposition are visible at Dinosaur Ridge. Much plant matter is at bedding planes but the rest is mixed within the strata.

Catastrophic Deposition. Under normal depositional conditions of abundant water and agitation, buoyancy will cause sand to be deposited first with the plant matter (green, rotten, water-logged, or charcoal) on top. If it is shallowly buried, the plant matter may float upwards through the sand if it can move. We will therefore expect to find plant fossils concentrated at bedding plane contacts, as in Figure 38.

At Dinosaur Ridge we also find examples of the charcoal chips mixed throughout the rock interior. That means that there was enough water to move the materials into place here but not enough water within to let them separate by buoyancy. The deposition mechanism would therefore be a debris or mud flow. The material would have a consistency like pancake batter or wet concrete mix. With that in mind, look again at the rocks. They were apparently deposited at a rate of inches to feet at a time. That is fast compared to rates that we normally see today except in catastrophic flows. We can sometimes see such flows, like those that slide off the sides of volcanoes in Columbia and bury villages and those slides that destroy homes in coastal California. A catastrophic flow in Colorado from the Storm King Mountain fire site (where 14 fire fighters were killed in July 1994) blocked Interstate-70 for three days in September, 1994. Appendix 9 shows that the materials from that flow have the plant matter mixed within the deposits. Deposits in the aftermath of a debris flow or from ordinary water deposition have the sand and plant matter highly stratified by buoyancy, with the plant matter present at bedding plane contacts. Both types are found here at Dinosaur Ridge. Look for them in Figure 38 and in the rocks themselves. Appendix 10 shows a simple experiment that can demonstrate the power of buoyancy in separating charcoal and sand in a water environment.

Deposition Rates. Debris flow deposits of the thicknesses observed here at Dinosaur Ridge were laid down in a matter of minutes. What happened during the interval between successive flows? Look carefully at the contacts. Are there any evidences of plant roots growing down through the strata, soil formation, or animal burrows? There are none. Was the charcoal at bedding planes washed out of its uniform distribution by a subsequent rain shower? Again there is no such indication. This was supposed to be a moist environment, like the Carolina or Georgia coastal region, during deposition times. Barren surfaces there have biological colonization within a decade. That means that no more than decades passed between these flows. In fact, it is entirely possible that all of the cross-bedded sandstone from the channel sandstone upward was deposited here in a fraction of a year. The plant matter and other observations rule out the "millions of years" interpretation held by other geologists. So we have an estimate of a meters per year average deposition rate for this site with much higher rates during the individual debris flow deposits.

Figure 39. Pine pollen is available in bulk in May and June.

Pollen Analysis. When the fossil plant material is not identifiable (fragments, wood chips), we can dissolve the rocks in powerful acids (hydrochloric and hydrofluoric) and extract the pollen grains (the actual organic exine shells) that are mixed in with the sand grains. As an example, during the "Dinosaur Discovery" days, I have under the microscope (40X stereo) modern ponderosa pine pollen. It comes from trees, like those on the ridge, in great abundance in June. I show the bulk sample in the small jar in Figure 39. Under the microscope, as illustrated in Figure 40, one can see little yellow balls with a crease, or line, down one side. The crease is distinctive for pine, according to the field guide (How to Know Pollen and Spores by Ronald O. Kapp, 1969). So when we find pine pollen in the fossil record (as in the scanning electron microscope micrograph of fossil pollen, shown in Figure 41) we can understand that pines were present when the rock was laid down. In

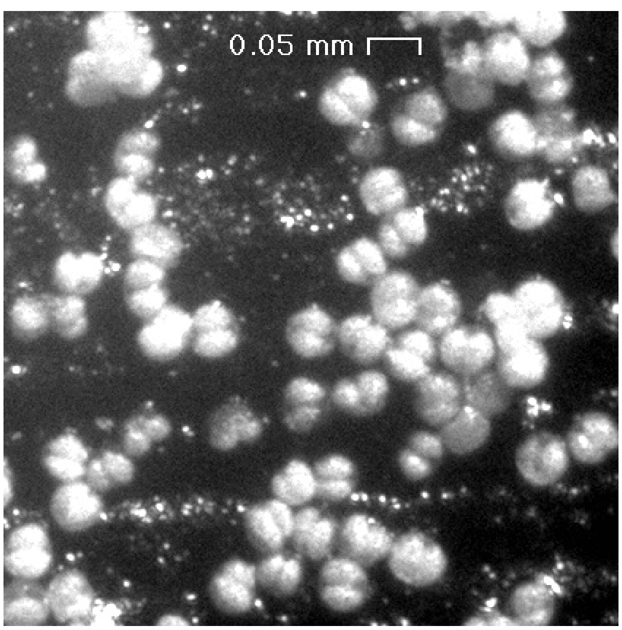

Figure 40. Modern ponderosa pine pollen under 40X microscopic magnification. Notice the line through their centers.

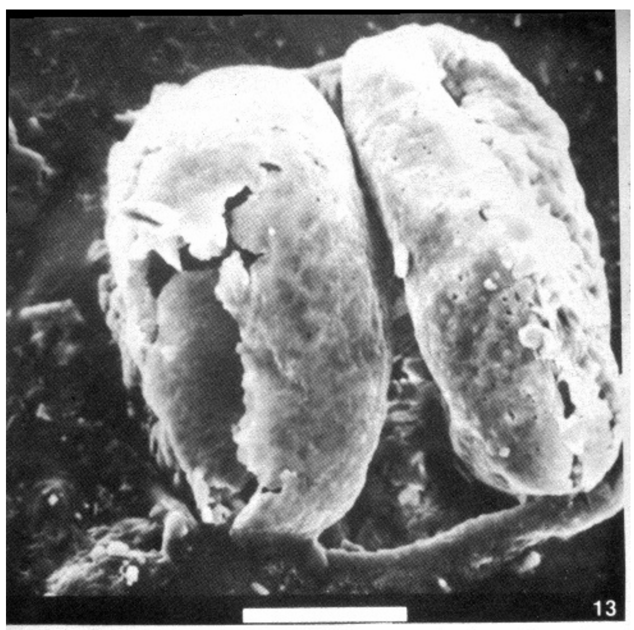

Figure 13. Scanning electron photomicrograph of an object from Hakatai shale. [30 x 35 μm] Note white bar on this figure is 10 μm. Palynologist's comments: "This is a badly corroded saccate pollen grain, probably referable to the genus *Pinus* (pine). I base this on the relatively small size of the specimen, the body of the grain being only about 30 μm. Unfortunately, identification to species or even subgenus is not possible here."

Figure 41. Fossil pine pollen found in the Hakatai Shale of the Grand Canyon. (Reprinted by permission of the Creation Research Society, 6801 N. Highway 89; Chino Valley, AZ 86323)

the same way, if we find the pollen of other plants in the rocks, then we know that those plants were somewhere in the territory at the time of deposition. From an assortment of plant types we can get some indication of a former climate.

Nearly everyone, from elementary school age upward, can see the same basic pine pollen shape under the microscope, in the field guide, and in the fossil image (Figure 41). The modern pollen size is about 55 to 60 micrometers in diameter. (Compare that with the calculated 4 micrometers per year average deposition rate for the entire Dinosaur Ridge by evolutionary dating.) Occasionally some visitors ask if pines were present when the Dakota Sandstone was being deposited. Lockley's former Field Guide does not say if pines were among the plants discovered here. However, the illustrated fossil pine pollen comes from much older layers, so there is no problem answering in the affirmative. However, that fossil pollen tells an extremely important story that few realize. Look for it in Appendix 8.

The sign at Site 7 discusses the Cretaceous time period and has a coastal scene as an illustration. The extent (Yukon to Yukatan) of the Western Interior Seaway is shown on the sign at Site 15. The environment was much like the Carolina coast, generally flat with low hills, beaches, and swamps. The shoreline moved westward across Colorado to central Utah before the present Rocky Mountains were uplifted.

Figure 42. This shelter overlooks the lower landscape east of Dinosaur Ridge.

Site 8. The next signs, at the shelter (Figure 42) to the east of the road cut, illustrate the strata and faulting of the rocks east of Dinosaur Ridge. It is difficult to comprehend the distances involved in those cross sections. Figure 43 shows the view from the road cut south towards the auto racing track and on to Soda Lakes. Some deep holes were drilled south of Soda Lakes, indicated by two vertical lines in the illustration. The shape and location of the Dakota Formation that were revealed by the drilling are drawn as the segmented band, properly scaled for the distance of those drill holes. Along the east side of Dinosaur Ridge is the Golden Fault. The squeezing forces that raised the Rocky Mountains buckled the rocks

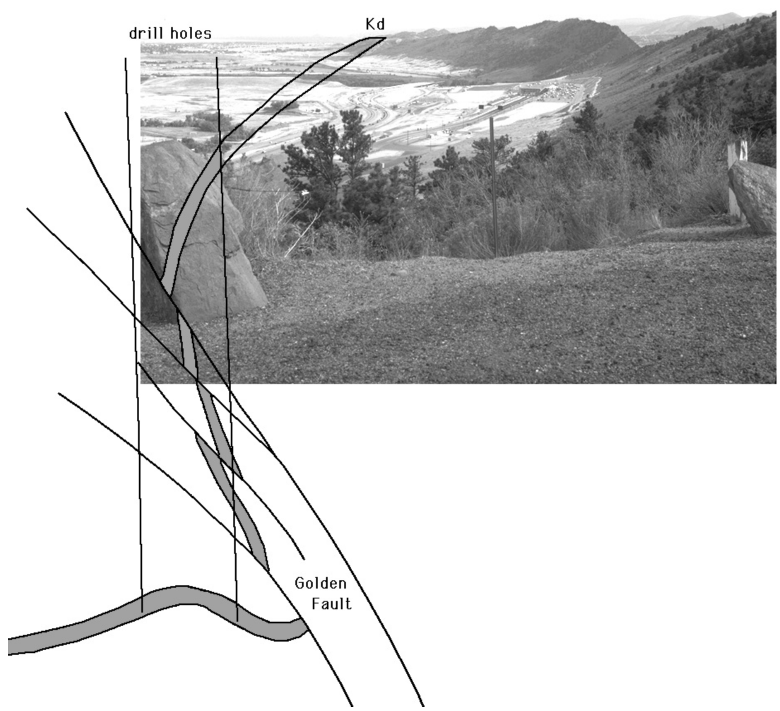

Figure 43. Drilling has revealed a complicated structure to the Golden Fault and the presence of the Dakota Formation (shaded) at a depth of two miles (three kilometers) below the lakes.

into the indicated shape. The Dakota sandstones (Kd) on which you are standing dive to a depth of two miles (three kilometers) underground before leveling eastward. That puts them a mile below sea level there.

Figure 44. Three different types of rock have been placed here by the road construction crew.

The Dakota formation is made up of highly porous rock, illustrated by the drawing on a sign. The voids in the sandstone can be filled with fluids, such as water and petroleum and natural gas. The shales above and below the sandstone are impervious, trapping those fluids in a sandwich-like layer. The upward doming of some of the rocks forms reservoirs from which we can extract gas and oil. The downward bending layers can be a source of water, possibly artesian, freely flowing upwards through drill holes. The Dakota Formation is therefore a layer of great economic importance in the Denver area. Notice that the displacement along the fault surface indicates an overthrust from the compression forces that raised the Rocky Mountains. The two mile vertical displacement shows the power of those forces. Human activity is insignificant by comparison.

3 Boulder Types. North of the shelter, notice the composition of the boulders placed beside the highway (Figure 44). The pinkish boulders are a granite from the Rocky Mountains, not from Dinosaur Ridge. The tan sandstones appear to be from the Dakota Formation or from a sandstone layer from the Morrison Formation on this ridge. The dark gray rocks are made of lava of the type that caps North and South Table Mountain to the east of Golden. The lava flowed from a vent farther north along the foothills. That lava never reached this far south along Dinosaur Ridge. The granite and lava rocks are classified as igneous, derived from melted rock. The sandstone is sedimentary. Shales are illustrated elsewhere.

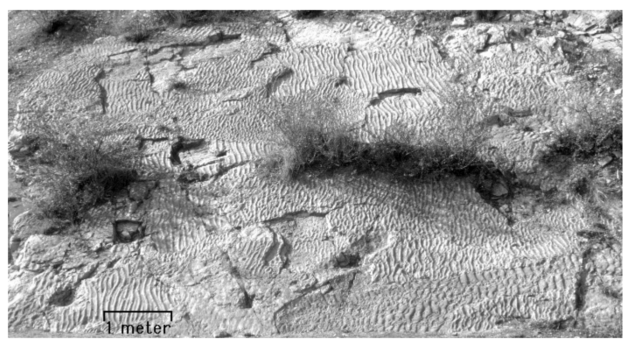

Figure 45. Ripples between near the road cut show successive layers with different orientations.

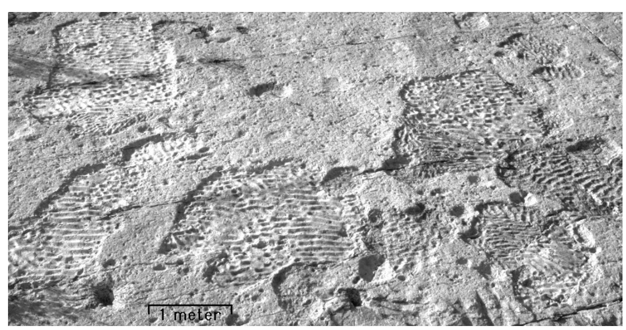

Figure 46. These ripple patches are just north of the dinosaur footprints and may indicate holes in algae maps where the water could oscillate.

Site 9. The sign, Coal and Clay Mines, gives historical information about mining in the valley. The vertical strata allow simple trenches for the excavation of useful materials. The clay is still being used for making of bricks.

Site 10. The signs now switch to the west side of the road. The sign highlights ripples in the sandstone layers. Ripples form on sand surfaces by the actions of moving water or air or by waves on the surface of pools of water. These appear to be caused by water rather than wind. Figure 45 shows several layers of ripples far south of the sign, most with east-west crests. Contrary to what the sign says, algal mats tend to suppress the waves that cause the ripples. However, the mats can trap sediment. The ripple patches of Figure 46 (from farther north, between the track site and the mangrove swamp site) may have been in the open water formed by holes in the algal mats. The author of the sign text was probably concerned that the ripple marks have to be preserved in some way before they are destroyed. Rapid but gentle burial just after ripple formation is a better hypothesis.

The ripple patterns can tell us several things. Symmetric ripples form in still, shallow water. The wavelength indicates water depth. Asymmetric ripples indicate water currents. The cross-bedding seen elsewhere indicates strong water movement and sediment accumulation. The direction of movement of the currents can be indicated by the perpendicular to the wave crest lines or cross-bed slopes. One geologist studying these ripple patterns found currents coming from the north in some of these rock exposures. It would be a worthwhile project to map current directions throughout the Dakota Formation, from Texas to Canada and westward into Utah to see how the water was moving along the western shores of the Western Interior Seaway.

Site 11. The sign departs from rock descriptions and discusses the ecology of the area. Typical plants and animals are listed as occupants of this habitat (Figure 47) in the transition zone between the mountains and the plains. Dinosaur Ridge is a favored flyway for eagles and hawks, especially when the ridge interacts with winds to produce a zone of updrafts.

Figure 47. From west to east across Dinosaur Ridge the ecological zones change from prairie to ponderosa pine to pinyon-juniper and back to prairie.

The last sentence on the sign, suggesting a relationship between birds and dinosaurs, is another example of modern speculation. It is based on a similarity of design in some of the bones of the two groups. However, the laws of genetics prevent the creation of the necessary DNA coding information required convert dinosaurs into birds. Feathers come from hair-like pores, not from scales. Bird lungs have a flow-through design, contrary to the in-and-out bellows design of reptiles and mammals. The bird-hipped dinosaurs have bodies built like tanks and would never get off the ground. The dinosaurs which are supposed ancestors of the birds have arms much too small to develop into wings and the wrong hip design. Any similarity of design is better explained by a Designer who created both of them to function well in their particular habitats.

Design is everywhere we look, at all scales. We can see that plants and animals are designed to live in the environments in which they are found. There are interrelationships in which they are dependent upon each other. Many of these interrelationships are too complicated for them to have been achieved by chance, as claimed by the evolutionists. Examples can be found in the resources listed in Appendix 15.

Design is present in the structures of the earth, the solar system, the galaxy, and beyond. We live in a world that has conditions that are precisely what we need. Even the nearest planets and moon are not appropriate for us to live in without us designing structures to recreate our necessary environments.

Design is present as we examine smaller structures within living things. Even the "simplest" single cell is a complex system of parts that work perfectly together. This design is coded into the strands of DNA within each cell. The information content of a microscopic strand of DNA is comparable to a large library of books. Some scientists have been using radio telescopes to listen to other star systems in a "Search for Extra-Terrestrial Intelligence". They ignore the incredible intelligence signal coded into the DNA molecules that regulate life processes all around us. This message content and design all point to an intelligence who has the power to carry out his design in the world we live in, and who exists apart from his designed and created universe.

The materials in this sign, in the road, in the automobiles and airplanes you can see, did not come together by random, chance processes. They were designed and built by human beings. Even greater is the requirement that the complexity and design in all of life resulted from a higher intelligence and the ability to create.

The DNA design in living things allows them to vary within a fixed range of possibilities. We have been able to breed many varieties of dogs, cats, horses, cattle, and corn. A dog, however, can never change into a cat. Mutations of the genetic code result from a rearrangement or a loss of information and almost always lead to an inferior creature. Most result in no apparent change. Never does a mutation improve the information content in the DNA. If an animal or plant has a significant small departure outside the established limits of variability, then it will be eliminated by natural selection processes, including an inability to breed with others of its kind. Natural selection keeps living things within their limits of variability. It never creates new kinds. Microevolution, the small changes in variety within the limits, however, can be observed. Macroevolution is impossible because of design. We call this fixed limits to variability "stasis", and it is seen throughout the fossil record.

Site 12. The sign is labeled **Trace Fossils**. Before you are some excellent preservations (Figure 48) that record the former presence of some small animals. The text and drawings on the sign provide a good description. At the time the animals made their traces, the sediments were unconsolidated sands and silts just offshore of the beach environment.

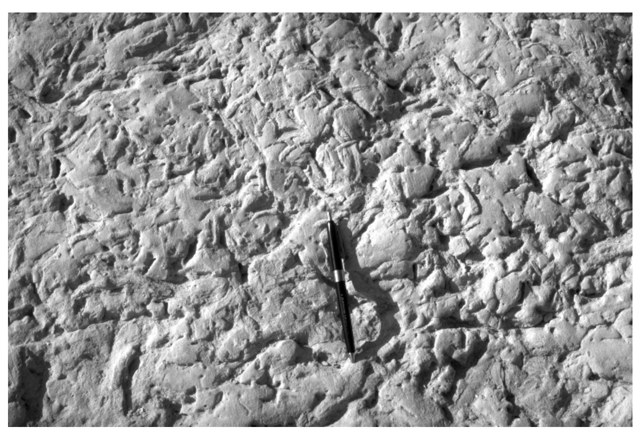

Figure 48. Excellent traces of burrowing animals show that they inhabited the area when it was unconsolidated, submerged sand. A pen gives the scale.

This burrowing by animals disrupts the sediment layers. The trace fossils are physical evidence for the passage of some amount of time. How much time in needed? Obviously, it is less than the lifetime of those animals. Animal colonization density usually depends upon many environmental factors. While other geologists might want to attribute long periods of time to a bioturbated layer, the individual animals themselves do not live very long. Long periods of time would disturb a layer so greatly that it would become homogenized. This layer before you still retains top and bottom features of the strata and retains the traces of a limited number of animals. They do not overlap completely. These traces, now preserved as fossils, could easily have been created within very short time frames (days or weeks), depending upon the conditions in which they were made and the number of animals doing the work.

Site 13. Dinosaur Footprints. The chain-link fence around the dinosaur track site (Figure 49) helps protect the trace fossils of large terrestrial animals from further vandalism. The gate is open on "Dinosaur Discovery Days" and for some tours at other times. The several signs illustrate and describe the dinosaurs that make these tracks. Similar tracks are common in the rocks formed from the near-shore environments of the Western Interior Seaway.

Figure 49. The dinosaur track site.

The dinosaur footprint area is very popular. The area inside the fence was recently expanded, exposing new layers of tracks. The weathering of the smaller new tracks makes them more visible with time. Dusting them with charcoal helps even more. The 1994 annual report of Friends of Dinosaur Ridge indicated at least 335 footprints of 37 sets of trackways. Figure 50 shows some of the footprints. Books about and maps of the track patterns, here and in other states, are available from Friends of Dinosaur Ridge. There are now several engineering structures here to limit the deterioration of the rocks that result from weathering. Any future excavations are expected to reveal more tracks.

Figure 50. There are many trails made by at least two types of dinosaurs.

Diet. How does the sign writer conclude that one animal is a vegetarian and the other carnivorous from only the footprints? Did he watch them eat? He probably makes the assumption that the carnivores have sharp claws on agile feet showing in the tracks and that the vegetarians have large cumbersome feet with no more than blunt claws. But is that always reasonable? Though these dinosaurs are thought to be reptiles, some scientists think that they may have been warm-blooded. The feet of today's cold-blooded reptiles may not be a good guide to their behavior. Few fossils exist of the animals that made these tracks, so checking their teeth is difficult.

Beneath my bird feeder are several types of footprints when there is light snow. They are sketched in Figure 51, but not to scale. Tracks 1 and 2 have sharp claws on small graceful feet, suggesting high mobility. Track 3 has longer sharp claws. No claws show on track 4. The claws on track 5 are large and blunt. By the criteria apparently used on the dinosaur tracks, which are the vegetarians, the carnivores, and the omnivores (eat anything)? One might conclude that the owner of track 4 is in danger of being eaten by the owners of tracks 1 and 2 and possibly 3.

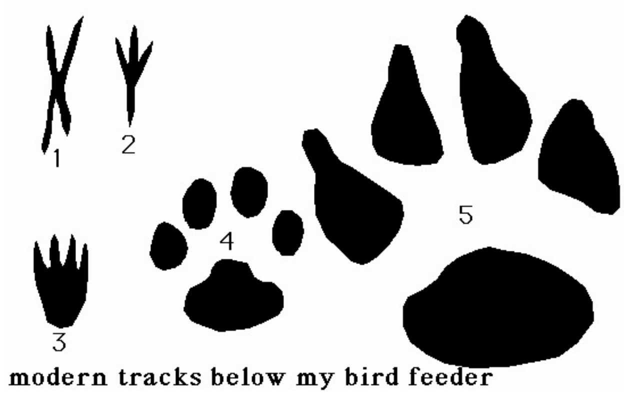

Figure 51. Can you guess the diet of the animals that made these tracks at my bird feeder? Which is in danger of being eaten? By whom?

The animals of tracks 1, 2, 3, and 4 actually use their sharp claws mostly for climbing in trees. All five (with the exception of some types of 2) can sometimes be seen eating both vegetable and animal matter. Track 1 is from a woodpecker known as a flicker, who normally eats insects but sometimes berries and dog food. Track 2 comes in various sizes for perching birds: sparrows, finches, robins, blue jays, chickadees, and grackles, most of whom prefer seeds but some of whom will eat animal matter and other things. Track 3 is the front foot of a squirrel who cannot get to the bird feeder but likes to eat spilled bird seed and dog food. Track 4 is from our cat, who likes to sit for hours watching the birds above in the feeder. She also likes several types of vegetables, especially corn. Track 5 is from our dog, a definite omnivore, who likes to chase the squirrels, flickers and grackles away from the dog food. So it seems unlikely that one can reliably tell the diet of an animal from only its footprints.

Figure 52. When they were young my children enjoyed chasing waves on a New Jersey beach. How long did their footprints last?

Burial Rate. These Dakota strata are supposed to represent a beach environment, like that shown in Figure 52. How fast must the footprints be buried for them to be preserved? Before the next wave, the next tide, the next rain, or the next animal passage. They must be buried by more than their own depth before the operation of the next destructive forces, or we will never see them as fossils. That means brief instantaneous rates equivalent to meters of sediment per year. See the end of Appendix 9 for more footprint comments.

Site 14. The sign is labeled **Mangrove Swamp**. However, do not be mislead into believing that the mangroves actually grew here for many years in a quiet environment. They probably were in the area. When the dinosaur footprint area was enlarged by recent excavations some of the clay was examined for pollen. Mangrove pollen was reportedly found. There are supposed impressions here that are diagnostic of mangrove roots and branches, as in Figure 53.

Look at the orientation of the large impressions. They are lying flat on what was a semi-horizontal surface. That surface, shown in Figure 54, is undulating with a large amplitude. This indicates that the sediments may have been heaped up into piles by the passage of a hurricane. The mangrove remains are broken pieces that have been floated here from somewhere else. They did not grow where they now lie. No roots penetrate into lower strata like normal growing roots. So this site is essentially a natural garbage dump. Though mangroves need time to grow and hurricanes take time to pass a particular site, there is no indication of a long passage of time in these rocks. What is seen here is better explained by a severe storm.

There is a drainage channel to the north of this sign. Can you see its sloping sides (Figure 55)? There are actually several such slopes here and oppositely-facing slopes farther north. These slopes are probably the sides of a channel delivering backwaters or terrestrial waters to the inland sea.

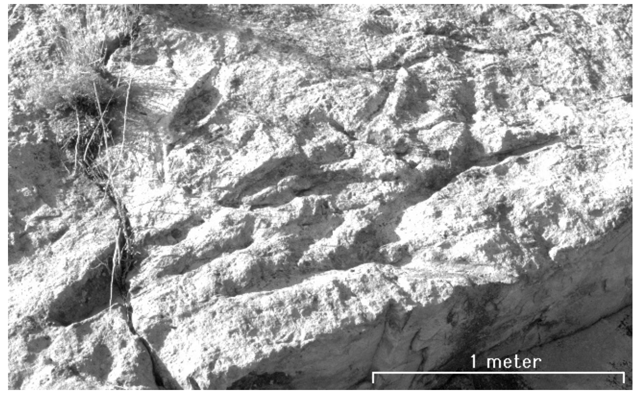

Figure 53. Broken branches made these impressions on a wavy, sandy surface, perhaps after a severe storm like a hurricane.


Figure 54. Though difficult to see under this illumination, the rock surface is made of sand waves rather than being flat.


Figure 55. The sloping surface suggests the sides of a stream flowing towards the ocean. The opposite bank is farther north.

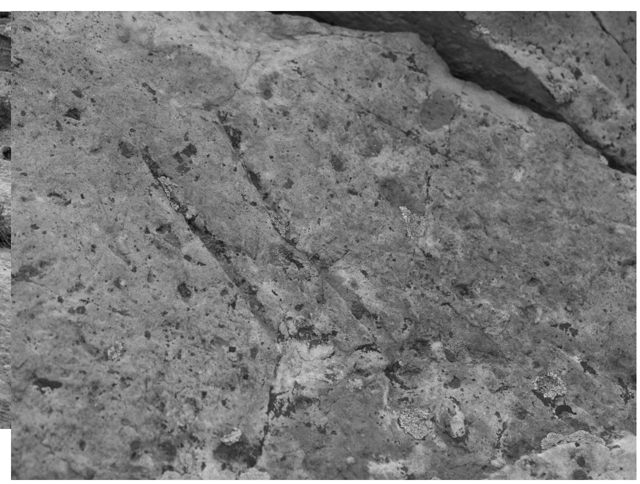
Figure 56. The linear scratches on some boulders may be from crocodile claw marks.

Between the two facing slopes there is a pile of large boulders near the road. On some of them there are what look like claw marks (Figure 56), dark linear scratches. They are interpreted as from a crocodile trying to climb out of the stream.

As you look south (Figure 57), notice the change in rock type. Pick some of them up. You will see gray shales in thin flat pieces. Many have yellows and oranges caused by iron oxides (rust). Drop the pieces and listen to their sound. The shales are hard and compact. Occasionally some ammonite fossils have been found. Therefore these Benton Formation rocks are interpreted as marine shales, deposited from the salt-water environment of the Western Interior Seaway. Softer shales in subsequent marine deposits, such as the Pierre shale (or Mancos shale in western Colorado) are up to a mile deep. In contrast, the soft, highly colored shales on the other side of the ridge, in the Morrison Formation, are interpreted as terrestrial deposits made from the overflow of streams onto flood plains.

Figure 57. These hard shale fragments make sounds when dropped. They were once muds deposited by a large, salt-water inland sea.

Site 15. The sign here provides an approximate map of the extent of the **Western Interior Seaway**. Except for the estimated date, the text provides good information about the sea and its deposits. A similar map is shown in Figure 58. The animal and plant remains buried with these sediments are thought to be the source for the petroleum trapped in the lower Dakota Formation.

The late Cretaceous deposits from this body of water are among the last continental-sized rock formations. Later deposits up to recent times generally cover smaller areas as the earth became less active. In a young earth scenario, this body of inland water is representative of the last major inundation and then the draining of waters from the continental interiors at the end of the global flooding that is summarized in Appendix 11.

Figure 58. The Western Interior Seaway once extended from the Yukon to the Yucatan Peninsula and westward to central Utah. That was the last time the sea was over the interior of North America.

Site 16. The sign describing the **Rooney Ranch** is on the east side of the road and easy to miss. It gives some historical details about this original 1860 homestead. The Rooney family still operates this ranch. At least parts of the Rooney family are home schoolers and support the young-earth interpretation presented in this booklet.

You may continue farther east along West Alameda Parkway. Before you reach the C-470 expressway, there are stone buildings on the north side of the road. These are the headquarters of Friends of Dinosaur Ridge. Within you will find exhibits and literature, some of which promotes the evolutionist interpretation and dating seen on the signs.

CONCLUSIONS

Dinosaur Ridge is a valuable educational resource that is accessible at any time. It gives a window through which to observe the products of geologic and biologic phenomena of the past. We observe the rocks and fossils in the present. We can also observe geologic and biologic processes today and the products that they create. Those processes may not be the same as in the past. Present observations can guide us in the interpretations of the features that we can see today. However, that is where our differences generally start. Our interpretations are always biased by our prior assumptions and general views of the world. That is why some people look at these rocks and fossils and seem to see the passage of millions of years. Others look at the same rocks and fossils and see evidence for only thousands of years. We then use our observations and interpretations to reinforce our own starting positions.

Neither case (young or old earth) can ultimately be proven because the origin and past history of the earth are not subject to experimental repetition. Nor did any human observers record that they personally saw events that laid down the specific layers of rock that we find in Dinosaur Ridge. Therefore our discussion, from either viewpoint, about past events at Dinosaur Ridge is not scientific, being based neither on direct observations nor on experimental repetitions. This guide has stressed those observations and processes that are consistent with a young earth whose age is measured in thousands, not millions, of years. Sedimentation rates in particular are not consistent with time spans of millions of years. All fossils at Dinosaur Ridge require rapid burial by sediment in a fraction of a year for preservation.

You have now seen the claims (in the signs) from those who support the passage of millions of years. You have seen the claims of the young-earth arguments presented in this guide. You may now have a sufficient basis for choosing which scenario seems most reasonable. Perhaps you need further study of the evidences. While only one side can be right, both may be wrong. Choosing either side is an expression of faith, hopefully based on observations. A choice is important be cause, as shown in Appendix 14, there is also an issue of personal accountability at stake that affects our entire lives. That issue is more important than rocks and fossils.

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