Editor's Comments

Every Spring students (and parents) face the challenge of a science fair project. It is not always enjoyable; a major obstacle is the choice of a suitable topic. Perhaps the Quarterly can be of help.

There are many worthwhile projects which involve creation science. Some are table-top experiments; others require data collection through the convenient interlibrary network. Such projects are suitable for the public, private, or home school setting. They may also lead to eventual publication.

Can you think of student research projects from your own discipline? Please send me a list with two or three sentence descriptions. They will be presented as letters or in a summary collection. Your suggestions may encourage and prime the next generation of creationists.

The lead article by Dr. Edmond Holroyd on Dinosaur Ridge in Colorado is quite interesting. Part III of the Grand Canyon erosion series is included in this issue as well as a fascinating discussion of deep sea hydrothermal vents by Jacqueline Lee. Dr. Robert H. Brown has done an excellent job on correlating C-14 ages with real time. The history and evaluation of the concept of atavism is presented by Dr. Jerry Bergman. Several shorter items make enjoyable reading. Please consider contributing either an article, technical note or letter to the editor to participate in developing the creation model of science.

Don B. DeYoung

COMMENTS ON THE FOSSILS OF DINOSAUR RIDGE

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Abstract

The details of the strata associated with dinosaur bones and footprints and fossil plant matter in a hogback west of Denver are indicative of rapid burial. Physical evidence for millions of years of deposition of the Morrison and Dakota formations at this location is lacking. This paper summarizes interpretations that are shared with some of the public during monthly open house tours of the site.

Introduction

Southwest of Denver, Colorado, is a hogback formed by the tilting of the sedimentary strata by the uplift of the Rocky Mountains. It is sometimes named Dakota Ridge after the durable sandstone of the Dakota Formation that limits the erosion of the Morrison Formation shales and sandstones below. The ridge is cut in several places by creeks draining the mountainous Precambrian blocks to the west and also is cut by a few roads.

Of particular interest in this report is the section between the towns of Golden and Morrison. That portion between Interstate 70 and West Alameda Parkway, shown in Figure 1, has been set aside as Hogback Park by Jefferson County Open Space, which has placed a trail along its summit. At the north end the colorful Morrison and Dakota strata are well exposed in the deep road cut of Interstate 70. On both the north and south sides of the cut are parking lots and trails so that the public can walk beside the near-vertical strata and read the many large interpretive signs along the walkway.

The ridge has been unofficially designated "Dinosaur Ridge" by the Friends of Dinosaur Ridge, in association with the Morrison Natural History Museum. Their goal is to preserve and make accessible this ridge for its historical and educational value. The Friends of Dinosaur Ridge have placed numbered stops along West Alameda Parkway, in about the center of the ridge, to draw attention to the special geologic formations exposed by the road cut. That portion of the road is closed to vehicular traffic about once each month, especially the major holidays, during the warm parts of the year. Crowds numbering hundreds or thousands can then safely tour the stops. An interpretive Field Guide (Lockley, 1990) describes the highlights. Efforts are also made to have knowledgeable volunteers at most stops to amplify on the interpretive signs.

The Morrison Formation, named for the town to the south, nearly spans the north-south extent of the contiguous United States over the eastern Rocky Mountains and western Great Plains. It is famous for its preservation of dinosaur bones. It was from this ridge in 1877 that the first specimens were discovered of *Apatosaurus, Stegosaurus,* and *Diplodocus.* The quarries are no longer visible in the Morrison strata along the western side of Dinosaur Ridge, having been closed in 1879. The few bones that remain are typically radioactive because of the deposition of water-borne uranium into the organic matter during fossilization (Gentry, 1986, pp. 51-62).

On the eastern side of the ridge, dinosaur tracks were discovered in the top layers of the Dakota strata in the 1930's. They are generally identified as Iguanodon-like vegetarian dinosaurs and ostrich-sized carnivorous dinosaurs. The strata also contain symmetric ripples probably indicative of shallow water. In between, exposed by the rock cut of the hairpin turn at the crest of Alameda Parkway, are plant fossils. The sandstones and shales at this location are blackened by a presumably large carbon content. The fossils are

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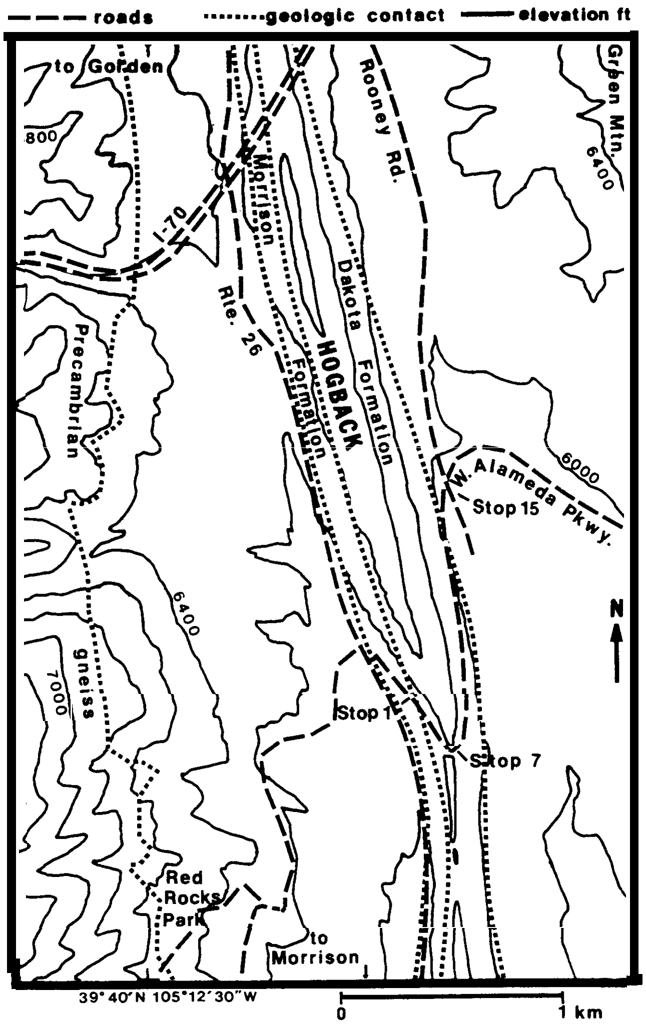


Figure 1. A map of the region near Dinosaur Ridge, labeled HOGBACK, showing elevation contours, roads, and some geologic formations.

highly disappointing because there are no impressions of anything complete, like perhaps a leaf. Though an exposed surface can be more than half covered with fossil plant matter, it is broken beyond recognition. The plant remains, when large, resemble pieces of low density charcoal. Weathering removes this black material, leaving hollow sandstone casts.

For the past two years I have been the volunteer speaker at Stop 7, labeled “plant fossils” in the Field Guide. It is at the left side of the south-facing panorama in Figure 2. The dinosaur bones, footprints and geologic formation exposures always attract speakers. However, no other volunteers fill in at Stop 7 when I have to be absent. Yet these otherwise disappointing plant fossils have an interesting story to tell. They call into question the scenario of millions of years for the deposition of the Morrison and Dakota strata.

The Stop 7 Message

Most people touring Dinosaur Ridge spend only several minutes at each of the 15 stops. The basic message at each stop therefore must be brief. I set up a card table (light patch on the left side of Stop 7 in Figure 2) on which are placed rock samples from the adjacent ground, a zoom stereo microscope, and relevant literature.

A single sheet interpretive guide supplied by the Friends says,

> 7. *Plant Fossils* The sandstone layers in front of you contain impressions of plant stems and leaves. Identifying these plants helps paleontologists reconstruct the climate of this area 100 million years ago. These fossils are most important because it was while looking for plant fossils that Arthur Lakes accidentally found the dinosaur bones in the Morrison Formation!

Under the same heading Lockley (1990, p. *12)* states:

> The sandstone layers at this stop contain many impressions of plant stems and foliage. Such fossil evidence is useful in reconstructing the vegetation and climate of the area 100 million years ago. As early as the 1890’s more than 25 species of plants had been identified from fossil remains in this area. In fact, it was a fossil-leaf-hunting expedition that led to the discovery of dinosaur bones at Stop 1.
>
> Recent work by palynologists, paleontologists who study fossil pollen, has revealed a large number of different plant species that grew in this area in Cretaceous time.

The first figure on that page has a caption, "Plant fossils: remains of ancient Cretaceous vegetation from the sandstones of the Dakota Group." The figure shows complete leaves of Ficus, Magnolia, Lomatia, Salix, Sequoia, and Torreya. The second figure has a caption, "One-hundred-million-year-old fossil pollen attributable to a species of flowering plant." The image is of the side and top views of a pollen grain, magnified 1000 times, but the species is not identified.

The page does not specifically state that those six plant types were found at Stop 7. Nor does it state whether the identification is from leaf impressions or pollen analysis. I have yet to find any intact leaves there. The closest is a surface that resembles a willow (Salix) leaf, but it could also be interpreted as a fortuitous smooth crack (no veins or edges). Some broad linear impressions can be interpreted as bark fragments, the largest of which is 6 X 70 cm. Otherwise, everything at this stop is just junk fragments. The page therefore gives the impression of a scholarly study, but there are breaks in the logic.

My own verbal presentation is variable but goes something like this, as I point to rock samples, the microscope, and literature:

> All of the black that you see in the rocks behind me is from carbonized plant material from long ago. In some places the carbon is powdered so fine that it simply stains the rock (referring to a dark gray shale sample). It can also be chunky, like charcoal fragments (pointing to another sample). Elsewhere the carbon can be thick and pure enough to be mined as coal. Weathering removes this black material, leaving behind these abundant hollow impressions.

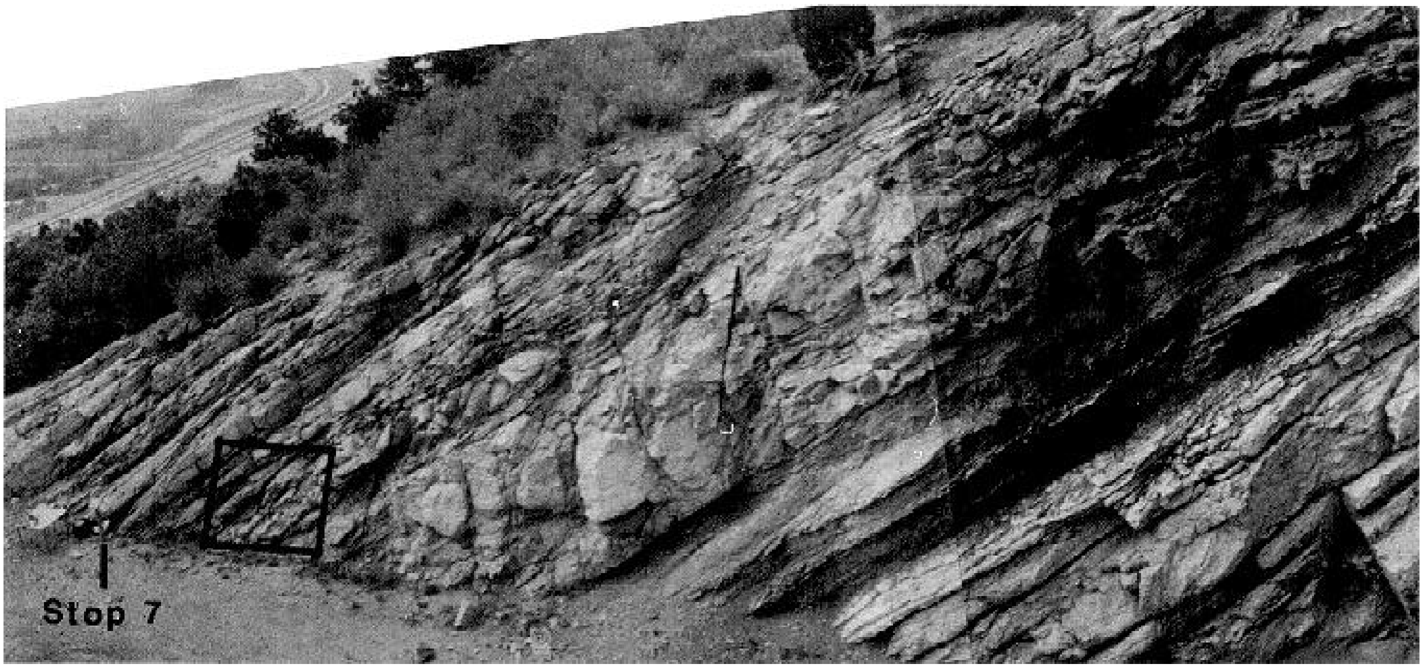


Figure 2. A south-facing panorama of the West Alameda Parkway road cut. Stop 7, highlighting plant fossils, is at the left and

However, these plant fossils are fragments only. They are broken beyond recognition. Rarely do you see something that resembles a leaf, a stem, or a piece of bark. There is no way to identify the former plants at this stop from these pieces.

To identify the plant types we have to dissolve the rocks in strong acids and extract the pollen grains that are mixed with the sand. Every plant type has a distinctive size and shape for its pollen.

Under the microscope (at 40X magnification) is *modern* ponderosa pine pollen, gathered from the tip of this branch last June along with the entire milliliter of pollen in this sample bottle. Its large size and crease down one side are indicators for pine, as you can see in this book (Kapp, 1969, p. 38). When we find fossilized pine pollen in rocks, as shown in this picture (Figure 13, Howe et al., 1988), then we know that pines were present when the rock was laid down. In the same way, finding other species of pollen in the rocks proves the presence of those species of plants near the time and location of the rock deposition.

Everyone sees that the basic shape of the pine pollen under the microscope is the same as the fossil pine pollen illustrated in the research article published in the *Creation Research Society Quarterly*. The fossil pollen just has ends that are somewhat shorter, which may be a species difference or a result of preservation or extraction. For most people, this brief presentation and the look through the microscope seem to be about all the new information they are interested in absorbing at that time.

For those who linger longer, there are other sheets of paper to read. One points out that the fossil pine pollen comes from the Hakatai shale at the bottom of the Grand Canyon, below the Great Unconformity, in Precambrian strata. A few realize the implication of functioning pine trees in Precambrian times. Another sheet compares average depositional rates for the evolutionary scenario with the thickness of the pollen grains. A third sheet questions how the sand and charcoal-like plant fragments got mixed and preserved.

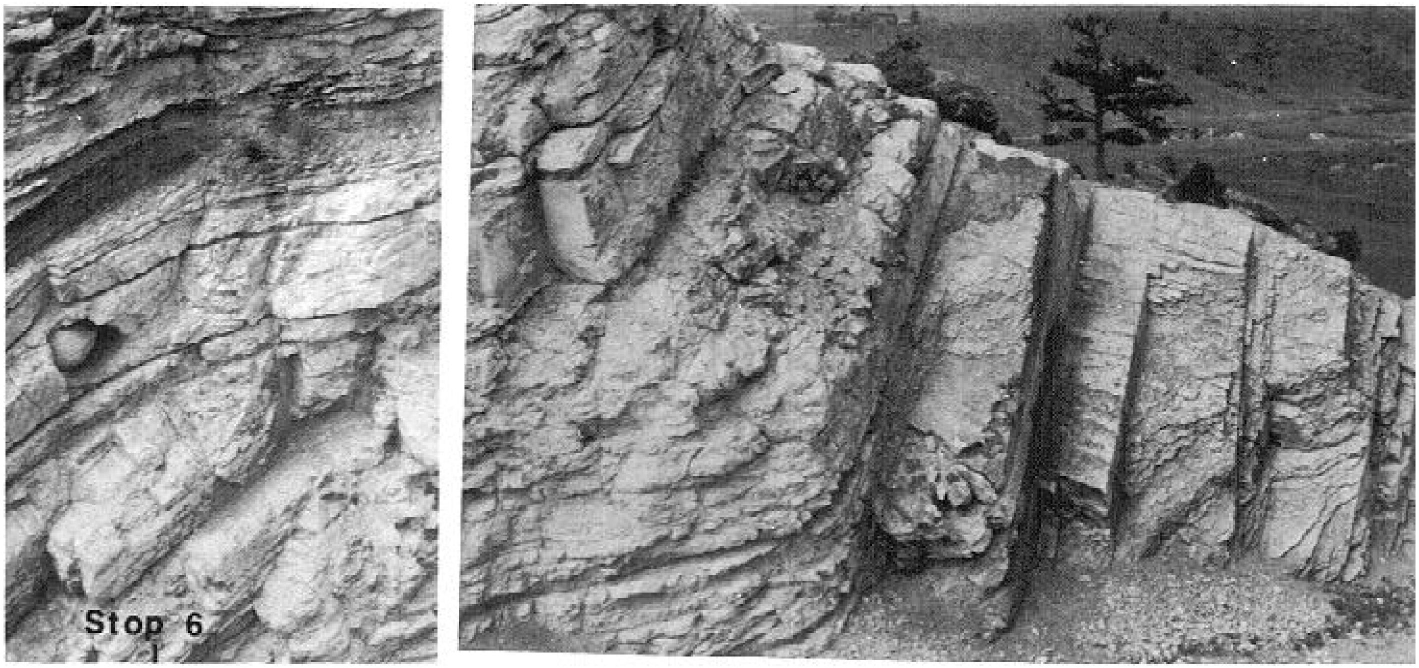
Fossil Pine Pollen

There are several questions that typically come from those who have the time to linger at Stop 7. Some ask, for clarification, if pines were so old that they contributed to the plant material at Dinosaur Ridge. I cannot confirm or deny that anyone has found pine pollen or fossils here; the Field Guide does not mention pines. However, the Hakatai strata is much older than the Dakota Formation. Since pine pollen was found in the Hakatai shale, then pines span the period from the Hakatai deposition to the present, including that of the Dakota Formation.

Others ask for more details about the fossil pollen, leading to an explanation of the original and confirmatory discoveries (Howe et al., 1988) of pine pollen in the Precambrian Hakatai shale. That gives the opportunity to point out that the evolutionary scenario indicates that only single-cell and simple multi-cell organisms should have been present in Precambrian times, not functional pine trees. Therefore the fossil pine pollen in the picture challenges the entire evolutionary time line.

Deposition Rates

Another question that is asked frequently is how long ago were these rocks of the Morrison and Dakota Formations laid down? The Field Guide gives 150 million years ago for the Morrison, in the upper part of the 208-144 million year ago Jurassic Period. A value of 100 million years ago is listed for the Dakota Formation, in the lower part of the 144-66 million year



Stop 6, highlighting a possible large concretion, is near the center. The location of Figure 3 is shown by the black outline.

ago Cretaceous Period. Scott (1972) lists each formation as about 300 feet (100 meters) thick.

A crude estimate of average depositional rates can be made by dividing 200 meters of strata by 50 million years, yielding an average of 4 micrometers per year. Being off by a factor of about 2 in either or both of these numbers does not really affect the illustration. For comparison, the pine pollen grains that are being observed under the microscope are about 60±5 micrometers in length, though a few are as small as 40 micrometers.

Nearly everyone can see that nothing can be buried and preserved at that slow rate. Dinosaurs, especially, need to be covered with at least their own thickness of sediment before they rot or are scavenged. That means that a minimum depositional rate of one to a few meters per year is necessary for there to be fossil dinosaur bones.

Though not mentioned in his Field Guide, Lockley has verbally claimed to have found some dinosaur footprints in the area that are so perfect that he can even see the texture of the skin of the feet. Preservation of such features necessitates burial by about a cm of sediment in a fraction of a day in gentle, non-erosive conditions. Otherwise wind, water currents, rain, or other animals would obliterate the footprints. Waisgerber (1990) reminds us that fresh deposits are particularly vulnerable to erosion prior to consolidation and cementation. Though it varies with habitat and moisture conditions, the rate of destruction of footprints can be easily observed today. It can range from the time to the next wave on a beach, to a few weeks in a sheltered environment. Footprint preservation appears to require at least brief burial rates that are on the order of a meter or more per year.

Some apologists for the evolutionary / uniformitarian scenario acknowledge the great difference (six orders of magnitude in this case) between average and necessary sedimentation rates. They claim that the sedimentation was not continuous. The abrupt changes between types of strata and colors in Dinosaur Ridge, some of which are visible in Figure 2, certainly point to discontinuous sedimentation processes. Today we can readily observe different surfaces respond to a variety of geological activity. Some receive sediments at a measurable rate. Others are eroding. Some seem stagnant when viewed from the human lifespan. Most of the rates of geologic activity that we can measure today are slow, but they are also inadequate for fossil preservation.

When deposition ceases and erosion is not strong, then biological activity usually leaves its mark on the surface. Roots penetrate the strata and worms homogenize the layers, making them indistinct. Soil layers develop and organic residues accumulate. There are no such soil layers observable on Dinosaur Ridge, even at the road cut of Interstate 70 which exposes nearly the entire multicolored sequence of the Morrison and Dakota Formations. Interludes between depositional periods cannot have lasted more than a century because, as we can easily observe today, a soil or a highly weathered surface layer would develop within such a period.

One person objected to this soil layer argument by referring to Stop 13, which is labeled "an ancient mangrove swamp" by Lockley (1990). Those strata are at the top of the Dakota group just under shales that are considered marine. There are impressions of what appear to be large branches in cross-bedded sandstone. The Friend's single sheet also mentions the presence of root impressions. The strata are undulating there like a chaotic wave pattern with an amplitude of many centimeters. I have yet to see any evidence that the impressions are from plants that were grown in that place, like roots that penetrate several layers of sand. The patterns of the branches and the cross-bedding of the sand suggest instead that this is better interpreted as another dump of flood debris that was transported here from elsewhere. There is no thick or thin layer of black swamp muck mixed with roots here that would indicate decades or centuries of swamp growth in this place.

Surfaces which are dormant for many millions of years should also acquire some meteorites. Estimates vary, but if the arrival rate is something like one meteorite per square kilometer per million years, then in 50 million years there should be many meteorites within Dinosaur Ridge, some of which should have been found in the rock cuts and quarries. Furthermore, theories about the evolution of the solar system suggest that the rate of meteorite bombardment should have been greater in the past than it is today.

If a surface is not experiencing deposition or zero growth, the alternative is erosion. Ancient creek beds can be found in these formations, and their sand bars are good locations for possible fossils. However, there are no canyons or stream cuts comparable to those carved by today's creeks to the north and south.

Figure 2 shows to the right of Stop 7 a large light-colored sandstone lens with a thickness of over 3 meters. The lens is pinched out before it reaches the ridge top. The layers at Stop 7 are cross-bedded, as shown in Figure 3. That picture was taken within the black box marked in Figure 2; the rock hammer shows the scale. The relatively shallow angles of the cross-bedding may be more characteristic of water rather than air transport. These features may be indicators of minor erosion while the Dakota strata were being deposited. That erosion is limited and cannot reasonably represent the passage of millions of years. Referring to all mountains, Foster (1975) says "The present rate of erosion is such that, theoretically, all topography will be removed in about 12 million years. . . ." It is therefore hard to imagine million-year interludes that would leave the surface layers relatively untouched by sedimentation, erosion, or biologic colonization.

In order for dinosaur bones and footprints to be preserved, meter-per-year or faster sedimentation rates are required for at least a fraction of a year. Interludes appear to separate individual layers within these formations, but the lack of soil layers, meteorites, or major erosion features speaks against these interludes lasting more than centuries. There is no physical evidence at Dinosaur Ridge for interludes lasting even a million years, as required to achieve average depositional rates as low as several micrometers per year.

The Fragmentary Plant Fossils

Stop 7 was selected because of the plant fossils in the rocks. They are, however, highly fragmented and disappointing. It is appropriate to question what might have caused the breakup of the plant matter and texture of the sand and fossil mixture.

Two textures of carbonized plant matter from Stop 7 are shown in Figure 4. On the left are the typical irregular black chunks at several levels. In the upper right and bottom center the linear pattern suggests bark fragments. The pen gives the scale and the box in Figure 3 gives the location.

Over 300 km to the southwest, near Montrose, Colorado, the Morrison and Dakota Formations can be seen in the Uncompahgre Plateau. In the same relative position within the Dakota Formation there is the similar texture of plant fossils and carbonization. Some particularly photogenic samples are shown in Figure 5 along with a metric scale. They were collected along Route 90 at about 38° 21' 43"N 108° 2' 49"W, 2415 meters above mean sea level. Notice the sharp edges to the black chunks. Green plant matter of that size that is broken by a flood usually exhibits frayed ends. Rotten wood and charcoal, however, can be broken more easily to resemble the samples in Figure 5.

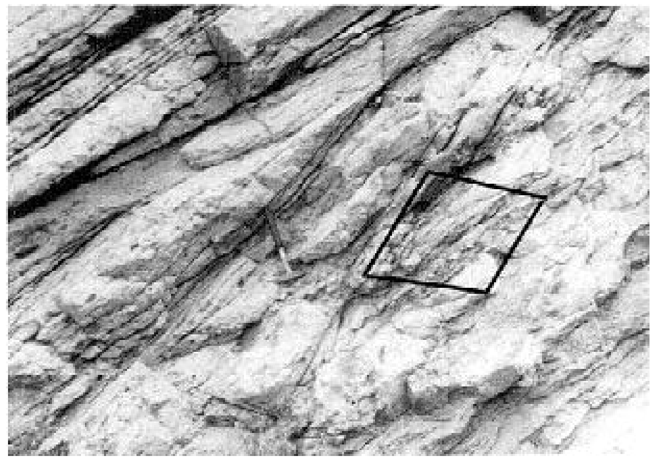


Figure 3. Cross bedding in the sandstone containing plant fossils at Stop 7. The location of Figure 4 is shown by the black outline.

A sandstone sample from Stop 7 that contained plant matter casts up to centimeter sizes, was easily crushed with finger pressure and examined under the microscope. Many sand grains were then observed to move violently when the sharp point of a straight pin was brought near, indicating possible piezoelectric charges lasting several minutes. Small clusters of sand grains were easily broken apart with a light touch of the pin point. There was only a small amount of a white powdery matrix holding the clear, yellowish quartz grains together. Most of the sand was in grains of 0.2-0.3 mm diameter with only slight blunting of grain edges. A lesser series of grains were in the 50-100 micrometer

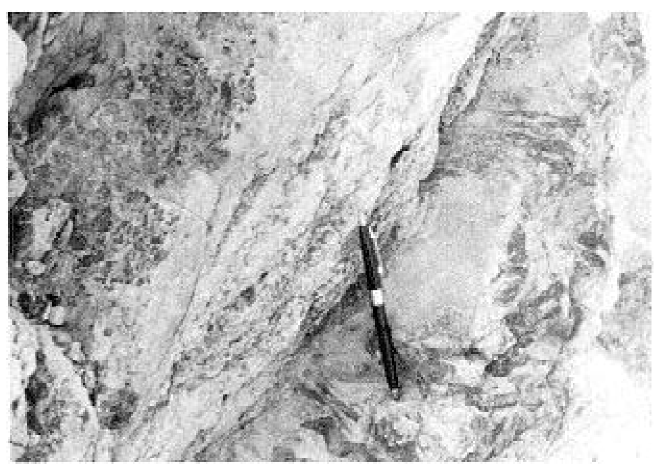


Figure 4. Carbonized plant matter from the Dakota Formation at Stop 7, Dinosaur Ridge, north of Morrison, Colorado. The view is down onto the strata rather than the edge view of Figure 3.

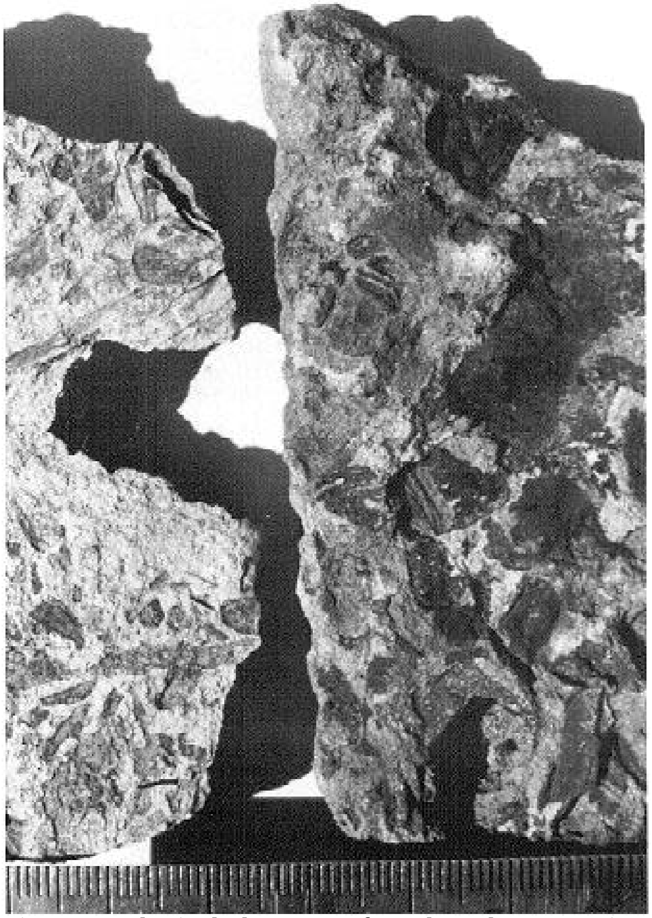


Figure 5. Carbonized plant matter from the Dakota Formation southwest of Montrose, Colorado.

range. In some places the matrix contained 10-25 micrometer particles. There were a few black grains of the size of the largest quartz grains. They were easily crushed by the pin point to the texture of a black paste. Apparently those were pieces of carbonized plant matter. No search was made for pollen in the crushed sandstone.

A working scenario was formed suggesting that the Dakota deposits might represent charcoal and sand washed from a slope denuded by a forest fire. The presence of the same texture over 300 km away on the other side of today's Continental Divide suggests that the same formation mechanism was likely to have been active there as well. To check the applicability of this scenario an actual forest fire site was visited. The examinations were made both before and after the Spring runoff season nearly two years after the major 1989 forest fire on Sugarloaf Mountain, west of Boulder, Colorado. In particular, the creek bed in Black Tiger Gulch was studied near 40° 0' 22"N 105° 23' 3"W, 2020 meters above mean sea level. There was still an abundance of charcoal falling from the dead ponderosa pine trees, as shown in the upstream view of Figure 6.

There were numerous places adjacent to the creek bed where stream overflow deposited sand since the fire. Occasionally there were charcoal pieces on top of the sand. Numerous pits were dug into the sand to look for buried charcoal, searching for a mixture of sand and charcoal resembling that found at Dinosaur Ridge. Figure 7 shows one such pit with a pen for scale. Charcoal was never found within the sand layers. Sand bars just beyond small waterfall plunge pools were excavated, but no buried charcoal was found. Downstream the creek passes under a highway. Debris apparently choked the culvert in the past, forming a pool that filled with fresh sand. The culvert has since been cleaned, but layers of stratified sand still remain at the former sides of the pool. These recent strata, 1 to 2 meters thick, were searched for charcoal pieces but none were found within the sand.

A charcoal/sand mixture similar to that at Stop 7 at Dinosaur Ridge was not found at this forest fire site in the several environments checked. This is easy to understand. There is a large specific gravity difference between sand (2.65 for quartz) and wood or charcoal (perhaps 0.2 to 1.0, depending on waterlogging). The latter will tend to float in water (1.0) while the sand will sink. Only a turbulent flow will keep them mixed. Perhaps a consistency like a mud slurry or pancake batter would be sufficient to prevent buoyancy separation. Apparently the flow speeds, bulk density, and turbulence in even Spring runoff are inappropriate to deposit sand and plant matter together in a mixture resembling Figure 4 and 5.

Figure 6. Trees killed by the Sugarloaf Mountain fire in 1989 still shed an abundance of charcoal two years later.

The scenario must therefore be revised. Individual deposition layers vary greatly in thickness at Stop 7, as shown in Figures 2 and 3. Some shale bands are only millimeters in thickness. Just below the plant fossils there is the large uniform sandstone lens over 3 meters thick. The fossils themselves are frequently in bands 10-30 cm thick. The revised scenario is that a thick turbulent slurry of sand and plant debris was laid down so rapidly that the plant matter had no chance to float away. Residual water was later squeezed out by an increasing overburden, but the sand and broken plant matter were trapped together. This scenario requires that each entire band be laid down in a span of several minutes. A more precise sedimentation rate can be determined in laboratory simulations using sand grains similar to those found with the fossil plant matter. There might have been interludes between the deposition of successive bands, but they were not long enough for root establishment or homogenization of the strata by worms.

Under the revised scenario the entrapment of the fragmented plant matter with the sand indicates a very rapid deposition of the entire sequence of strata. Hours of direct deposition can be accounted for by these strata. Adding possible interludes can stretch the sequence to perhaps decades at most.

The upper Dakota strata, containing ripples and dinosaur footprints, must also have had periods of rapid burial for preservation of those features. There is no evidence there for interludes longer than decades. The lower Dakota strata of sandstones and shales do not have this texture of enclosed plant matter, ripples, or footprints. Some of the layers, especially the shales, certainly had slower deposition rates. Other layers are similar to those above that indicate rapid sedimentation. Again there is no evidence for interludes longer than decades. The entire Dakota sequence of about 100 meters thickness can therefore be accommodated within a year at high rates of deposition to possibly centuries if long interludes of no deposition are invoked. But there is no room at Dinosaur Ridge for multi-millions of years. The physical evidence speaks strongly of rapid sedimentation for the Dakota Formation.

Discussion

The efforts of Friends of Dinosaur Ridge to make this hogback more open to the public and to highlight the famous excavations of the last century are commendable. This allows thousands to visit the site each year and see the evidences themselves and perhaps learn something new about the past. Most volunteer speakers probably talk from the uniformitarian/evolutionary framework in which they were trained. Yet the presence of fossils speaks of catastrophic burial processes.

The plant fossils of Stop 7 are broken beyond recognition and disappointing to view. It is therefore appropriate to discuss pollen analysis for determining plant types. The abundance, large size, and distinctive shape for modern pine pollen makes it a worthy example for microscopic demonstration. Showing the photograph of fossil pine pollen completes the connection to the past. Together, the fragments and pollen make an interesting brief story for the casual visitor.

However, when the source of the fossil pollen (Precambrian Hakatai shale from the bottom of the Grand Canyon) is acknowledged, then it indicates that pine trees were growing back when the evolutionary time scale says that only primitive life forms should have been present. Furthermore, pine tree pollen has not evolved to a different morphology during that time. The observed variations are relatively minor.

Estimating average sedimentation rates during the deposition of the Morrison and Dakota Formations gives answers that are about six orders of magnitude smaller than those necessary for the preservation of dinosaur bones or footprints. Physical evidence for long quiescent interludes between the deposition of distinct layers is not present. The multi-state geographic extent of those formations indicate that the mechanism for their formation was nearly continental in size. Gentle piedmont and seacoast scenarios are usually invoked for these formations. The preservation of the fossils, however, necessitates catastrophic processes. These processes cannot be simply due to local floods, earthquakes, or volcanoes but must operate catastrophically over the 1000 km scale of the formations. Morton (1984) elaborates on the implications of such large extents throughout the geologic record.

A charcoal deposition scenario was presented and revised according to the findings of field examinations. The conclusion was that a turbulent slurry with deposition in minutes is probably necessary for laying down

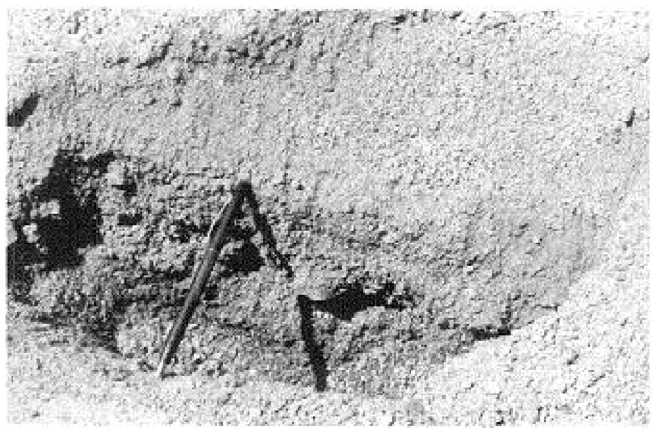


Figure 7. Pits dug into recent sand deposits along the Black Tiger Gulch show sand only. Charcoal pieces were occasionally on the surf ace but never mixed into the sand.

a mixture of sand and broken plant material like that found at Stop 7 and near Montrose. The suggestion of charcoal deposition indicates that carbonization occurred before burial. This is not vital to the deposition rate argument. Hydraulic sorting of the plant matter from the sand would occur just as easily with rotting wood fragments or pieces of green woody plants. Then the carbonization would have occurred after burial. The charcoal scenario came about because the fossil material visually resembles charcoal; no chemical tests were made, however. The charcoal scenario also resulted in an easy field check at a forest fire site. The important parts of the scenario are that 1) the plant material was broken up beyond recognition, requiring an adequate mechanical agent such as a major flood; and 2) normal floods do not mix sand and chunks of plant matter in the texture observed in the fossils. Catastrophic burial from a turbulent slurry is suggested as a mechanism.

Some of the arguments used in this report have logical weaknesses. They claim that something is missing: charcoal mixed into sand, soil layers, deep erosion cuts, meteorites, unbroken plant fossils. The search obviously did not examine every possible location because that would require dismantling the entire ridge boulder by boulder. Only readily available exposures were examined in a non-destructive way, and even then the search was not comprehensive.

These observations at and near Dinosaur Ridge challenge the evolutionary and uniformitarian scenarios for the geologic history of the Morrison and Dakota Formations at this hogback. Though the champions for those scenarios raise their objections when we meet at Stop 7, the general public tends to be sympathetic to the catastrophic scenarios. They can see the pollen samples with their own eyes and notice that the fossil pollen from the Hakatai shale looks similar to the modern pollen under the microscope. They can relate an average sedimentation rate over millions of years to the size of the pollen they are examining. They can see the mixture of plant matter and sand in the rocks and can relate to the density differences between plant matter, water, and sand. There is no problem envisioning the plant matter floating away under uniformitarian conditions. They can relate to the rapid decay and scavenging of dead animals along highways and to the obliteration of footprints at seashores, playgrounds and feedlots, necessitating rapid burial if preservation is to occur.

Dinosaur Ridge is considered by some as a monument promoting the evolutionary scenario and the passage of millions of years. The physical evidence, however, speaks more loudly in favor of catastrophic processes. The contrast between the scenarios can give rise to sharper reasoning skills as one considers the evidence supporting each side.

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HYDROTHERMAL VENTS AT DEEP SEA SPREADING RIDGES: MODERN-DAY FOUNTAINS OF THE DEEP?

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Abstract

Deep sea hydrothermal vents associated with mid-ocean spreading ridges have implications for both creationists and evolutionists with regard to origins of terrestrial massive sulfides, geochemical flux into ocean waters, heat flow, and dating of mid-ocean rifting events.

Description

Spreading ridge hydrothermal vent systems are areas of emission of heated waters on the spreading ridges of the ocean floors. An explosion of research in recent years, using submersibles and sophisticated recording and collection equipment, has produced a huge amount of data, much of which is of interest to creationists.

Spreading ridge hydrothermal vent systems have been found in the Dead Sea, on slow spreading ridges, in back arc basins, and on fast-to-medium-spreading ridges (Rona, 1983). The term "fast" or "slow" spreading ridge does not refer to measured observations, but rather to assumptions of seafloor ages based on magnetic patterns on the sea floor in relation to radiometrically determined rock ages. The mid-Atlantic ridge is considered to be a slow spreading ridge and the Eastern Pacific ridge to be intermediate to fast.

This paper will concentrate on data gathered from hydrothermal systems located on the Eastern Pacific Ridge (EPR) because these have been the most extensively studied thus far. These vent systems are characterized by massive sulfide deposits (mostly Cu, Pb, and Zn), by high temperature water emissions, often accompanied by particulate (vents may be called "black smokers" or "white smokers"), and by an unusual biota, including sulfur-oxidizing bacteria and odd-looking tube worms.

Although chance played a large part in the discovery of the first hydrothermal vents, the development of more sophisticated models of hydrothermal distribution now predict that hydrothermal activity should be found on topographic highs along the ridge crest (Francheteau and Ballard, 1983). Estimation of the distribution of hydrothermal mineral deposits or high intensity hydrothermal systems capable of producing such deposits range from one such occurrence every 15-100 km along slow spreading centers to every 1-100 km along intermediate-to-fast-spreading centers (Rona, 1983).

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