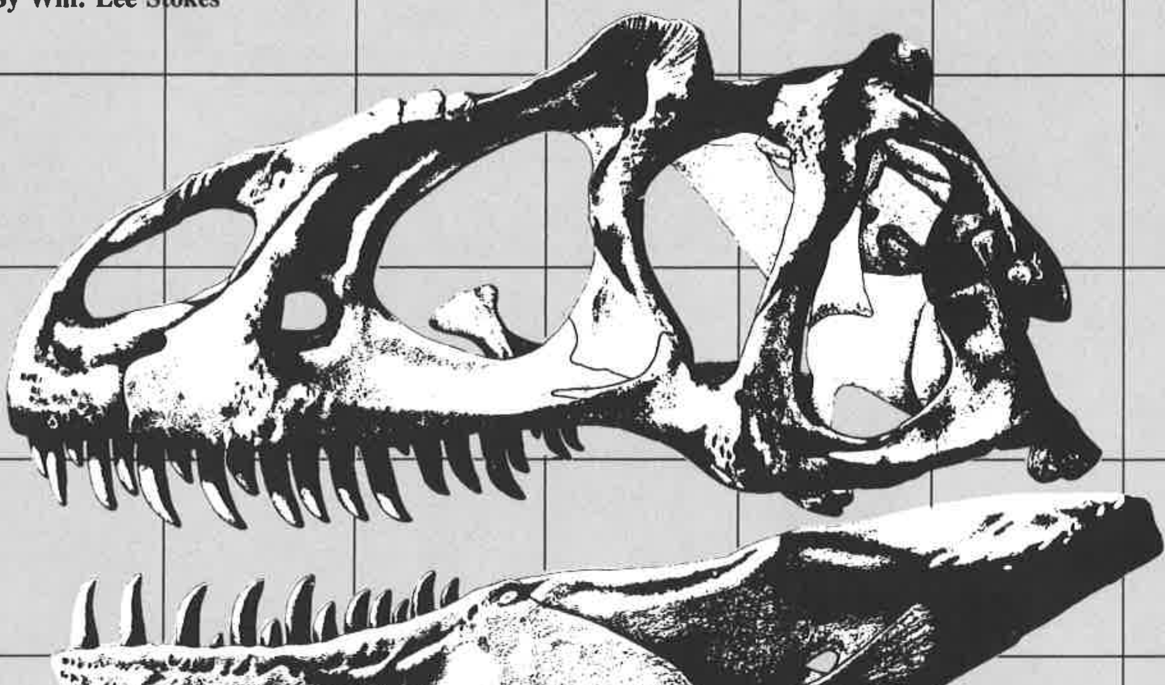
THE CLEVELAND–LLOYD DINOSAUR QUARRY

WINDOW TO THE PAST

By Wm. Lee Stokes



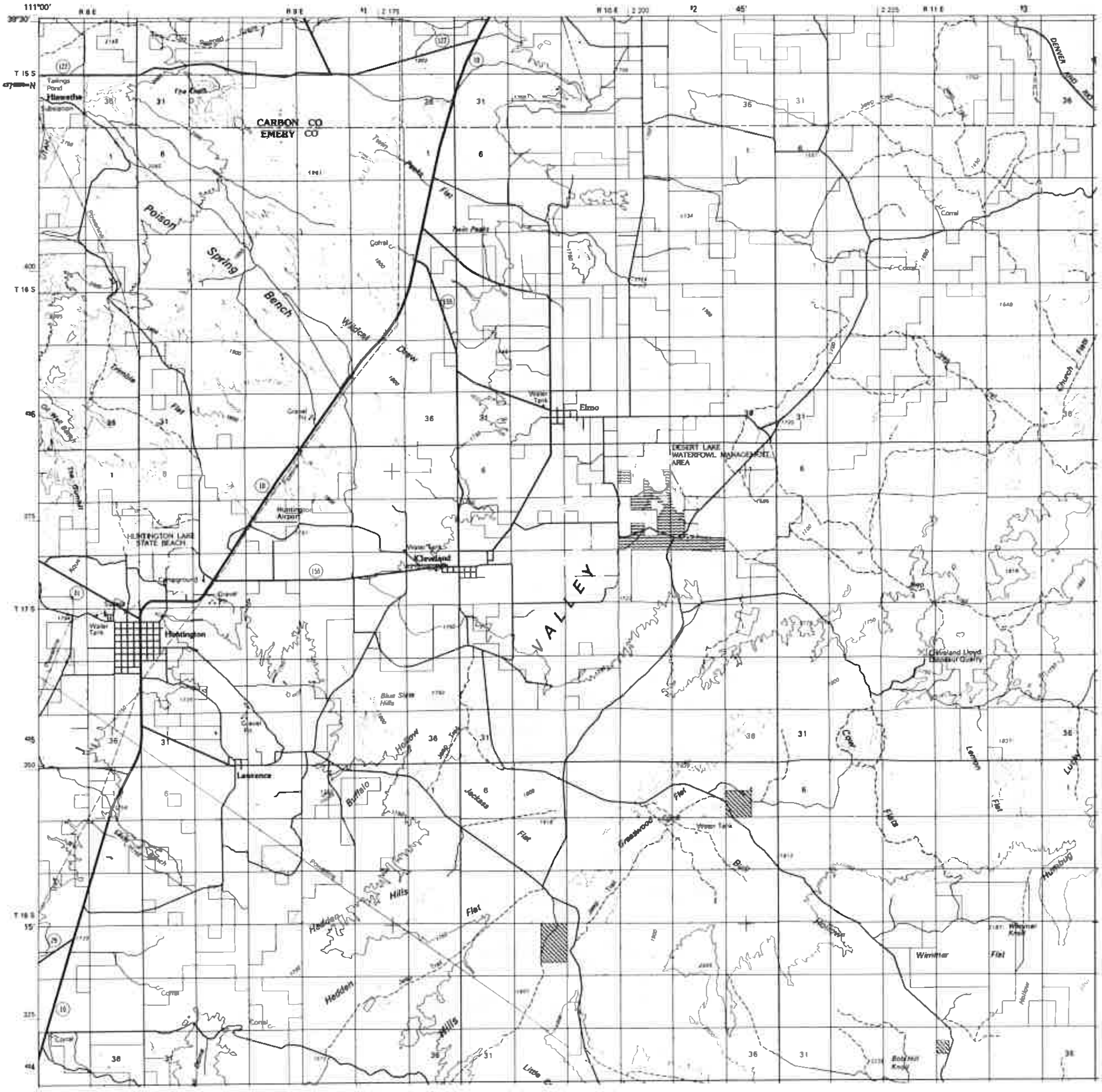
THE DINOSAUR

by Bert Leston Taylor

Behold the mighty dinosaur
Famous in prehistoric lore,
Not only for his power and strength
But for his intellectual length.
You will observe by these remains
The creature had two sets of brains —
One in his head (the usual place),
The other at his spinal base.
Thus he could reason "A priori"
As well as "A posterori."
No problem bothered him a bit;
He made both head and tail of it.
So wise was he, so wise and so solemn,
Each thought filled just a spinal column
If one brain found the pressure strong,
It passed a few ideas along.
If something slipped his forward mind,
'Twas rescued by the one behind,
And if in error he was caught,
He had a saving afterthought;
As he thought twice before he spoke
He had no judgement to revoke.
Thus he could think without congestion
Upon both sides of every question.
Oh, gaze upon this model beast,
Defunct ten million years at least.

First published in the *Chicago Tribune*, 1895.

HUNTINGTON, UTAH



THE CLEVELAND–LLOYD DINOSAUR QUARRY — WINDOW TO THE PAST

Wm. Lee Stokes

GETTING THERE IS A LESSON IN GEOLOGY

A visitor to the Cleveland–Lloyd Dinosaur Quarry must travel eastward from Utah Highway 10 across the barren eroded edges of a number of distinctive sedimentary rock formations. Each formation appears as a recognizable band on the surface and represents a specific ancient environment of deposition. The rock layers are tilted gently westward and consequently get progressively older eastward. Thus, a traveler goes backward in geologic time about 100 million years from the center of Castle Valley to the quarry. Figure 1 is a diagram that will help explain this.

Geologically speaking, the city of Price and the smaller agricultural settlements of Castle Valley are located on the Blue Gate Member of the Mancos Shale, a rather soft and unimpressive formation that is seen in dozens of road cuts and gullies along Highway 10 that runs the length of the valley. The Blue Gate is a drab-gray, muddy formation laid down in a shallow ocean during the Cretaceous Period some 80 million years ago. Fossils of marine shellfish are common. Certain outcrops are littered with broken shells of giant clams and here and there fossil shark teeth are abundant. The tendency of the shale to revert to sticky mud when wet constitutes a hazard to all types of travel.

About five to 10 miles east of Highway 10, depending on which route one follows to the quarry, the road ascends a gentle slope and then descends abruptly over the edge of a cliff and steep slope several hundred feet high. This ridge is made up of the Ferron Sandstone Member of the Mancos Shale. It represents an extensive delta built eastward into the

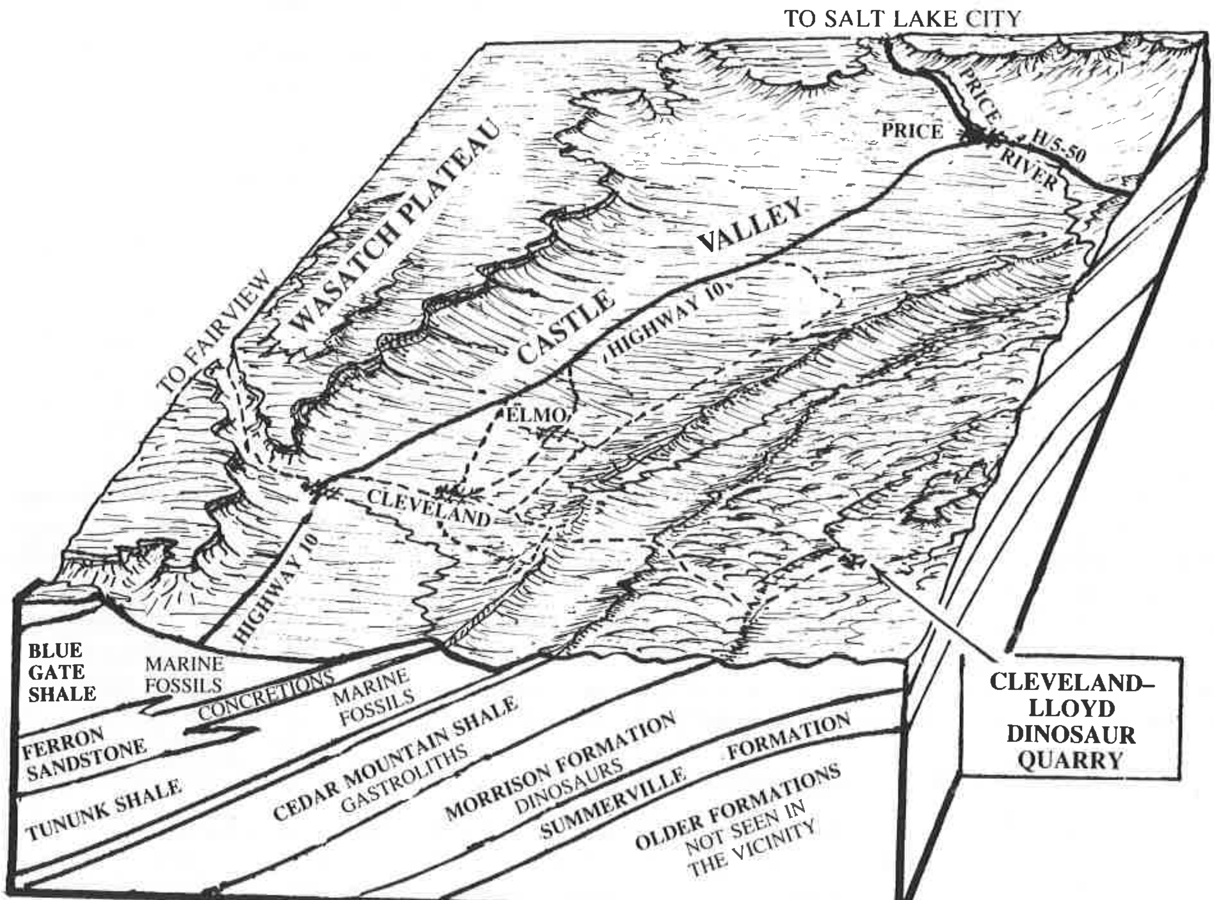


Figure 1. Diagram showing surface and subsurface features relating to the Cleveland–Lloyd Quarry. Front view shows geologic formations as they relate to the surface. Note that the bone-bearing Morrison Formation dips westward and is several thousand feet below the settlements of Castle Valley. Relation of settlements and roads to the quarry site is emphasized. Visitors should follow the signs at road junctions.

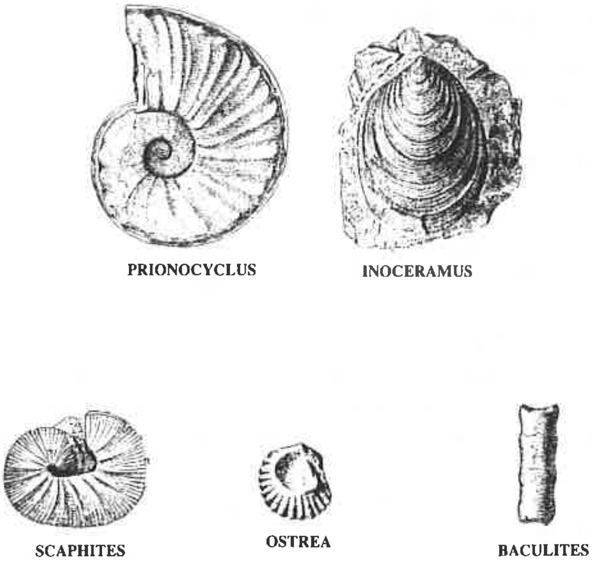


Figure 2. Typical marine fossils of the Mancos shale of Castle Valley. Species shown here have been extinct since the Cretaceous Period. Largest specimen about three inches in diameter.

Figure 3. A large sandstone concretion set free by erosion from the Ferron Sandstone. Many of these in various stages of weathering are seen near the road to the quarry where it crosses the formation. Photo courtesy of Joseph Nellis.

ocean by rivers emptying into the Mancos Sea. Fossils include many species of marine molluscs, bones of fish and reptiles, and remains of plant life washed in from nearby land. Farther south the Ferron Sandstone contains extensive coal deposits. The weathered boulder-like rocks that lie scattered near the high part of the ridge are remnants of giant round concretions that formed in the muddy sediments shortly after they were deposited. A concretion is a solid, rounded mass of material of different composition than the surrounding rock; how concretions form is not fully understood.

After leaving the Ferron Sandstone ridge the road crosses another soft formation, the Tununk Shale Member of the Mancos. Like the Blue Gate, it was laid down as mud in the ancient Late Cretaceous seaway. Beyond the valley-like depression in the Tununk Shale the road crosses the thin Dakota Formation that appears only in large scattered boulders and low ledges of yellowish-gray sandstone. This formation was laid down by sluggish rivers meandering across the wide swampy lowlands that were soon to be covered by the incoming seas that brought the Mancos Shale. In spite of being a very thin formation, the Dakota seems to have taken millions of years to accumulate. It apparently represents a landscape where streams shifted their burden of sediment slowly toward a distant ocean without either building up or tearing down the surface.

Again the scenery changes as the road cuts deeper into the geologic formations. For the next three miles the road winds among barren, rounded, pastel-colored hills and low sandstone-capped mesas of the Cedar Mountain Formation. This has been interpreted as having been built up as a succession of soil-covered plains, perhaps under semi-arid conditions. Literally millions of hard, knobby nodules are strewn over the surface with here and there brightly colored "gastroliths," the hard, polished stones supposedly picked up by dinosaurs as aids to grinding their food.

Next below the Cedar Mountain and deep within the bed-rock wilderness of Cow Flat on the north flank of Cedar Mountain lies the Morrison Formation. As the world's greatest burial ground for dinosaurs and the oldest (lowest) formation seen on a visit to the quarry it deserves a more detailed description.

RECONSTRUCTING THE MORRISON LANDSCAPE

The Morrison Formation is probably the most studied formation on earth. This is because it yields two important geologic products — uranium and dinosaurs. Both of these must be extracted from the earth, but dinosaur bones are said to be quarried while uranium ore is said to be mined. It is not unusual to find dinosaur remains in uranium deposits; bones may be petrified (replaced) with the right combination of minerals to become high-grade uranium ore. No doubt many dinosaurs have contributed their bones to the fuel of atomic reactors and atomic bombs. Fortunately the bones at the Cleveland–Lloyd locality contain very little uranium. Had they contained more they too would probably have been claimed as an ore deposit and hauled to the mills long ago.

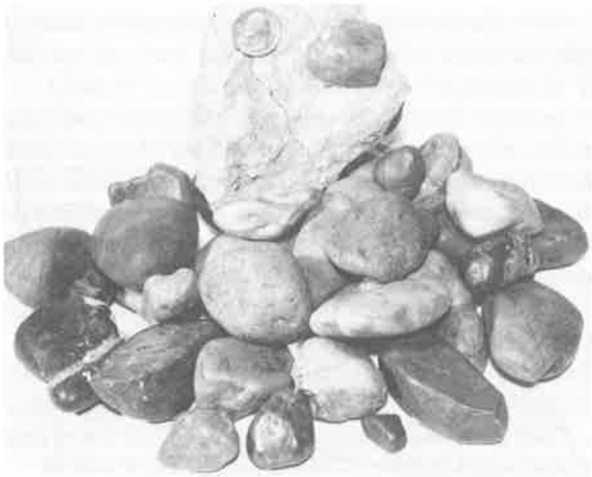


Figure 4. "Gastroliths" from the Cedar Mountain Formation. Evidence is that these hard, colored, highly polished stones were swallowed by certain dinosaurs to aid the digestive process. One is shown embedded in a limy matrix. Note quarter for scale. Photo by James Howell.

The Morrison Formation is a great land-laid deposit produced by rivers and lakes late in the Jurassic Period some 130–150 million years ago (see Fig. 6.). At the time of its formation it covered about 700,000 square miles between central Utah and central Kansas in an east–west direction and between central New Mexico and the Canadian border in the other direction. At this time there were no Rocky Mountains but there were lofty highlands in what is now the Great Basin of Nevada, Arizona, and western Utah. It was from these mountains that the sediments of the Morrison Formation were eroded and spread out across what is now eastern Utah and adjacent states. The rivers flowed generally eastward but they tended to break up into smaller distributaries and may have dwindled away entirely before reaching the ocean which was a thousand miles from their headwaters.

Nothing on earth today closely resembles the environment of the Morrison Formation. Because it was laid down entirely on land, the formation cannot be called a delta in the usual sense and it was very much larger than what geologists call alluvial fans. Morrison rivers were free to wander sluggishly across their flood plains; there were no confining valley walls or highlands for hundreds of miles in any direction except to the west. When deposits along one

Figure 5. Air view of the quarry site. The Morrison Formation makes up the boulder-strewn slope and flats in the foreground. The Cedar Mountain Formation appears above it as a slope with scattered trees. Metal buildings covering the bone deposit are seen right center; the visitors center and parking lot are left center. Photo by James H. Madsen Jr.

Figure 6. The geologic history of the Cleveland–Lloyd bone bed.

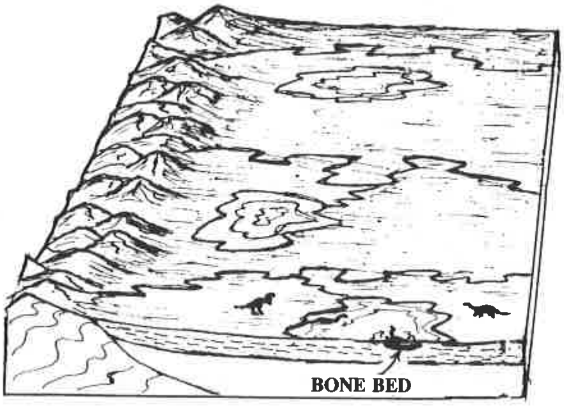


Figure 6A. ***Origin.*** **The Morrison Formation was laid down by shifting rivers on an extensive level plain. Dinosaurs died and were buried at many places. Those preserved at the Cleveland–Lloyd site seem to have died by sinking into a bog individually and over a considerable period of time.**

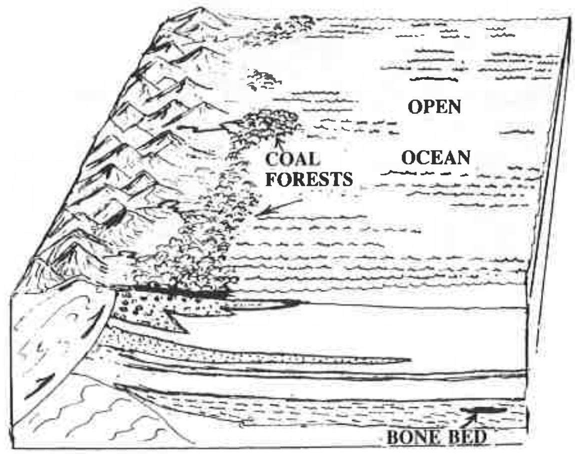


Figure 6B. ***Burial and petrafaction.*** **The Morrison Formation was slowly buried by other deposits including the marine Mancos Shale about one mile thick. During this long period mineral matter, carried by underground water, entered and replaced the bones converting them to stony replicas.**

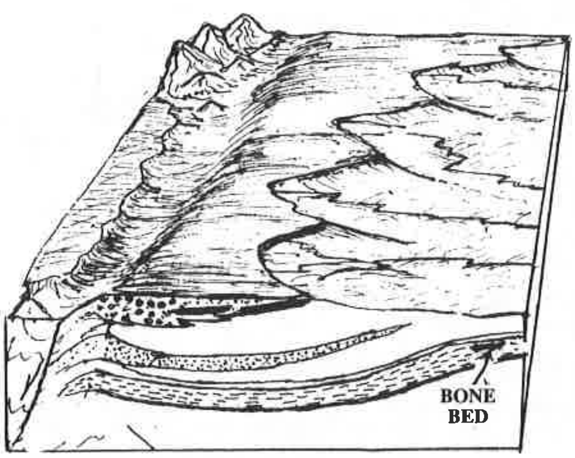


Figure 6C. ***Uplift and early erosion.*** **After the ocean withdrew about 60 million years ago the San Rafael Swell in central Utah was uplifted. Erosion began to cut downward removing and carrying away the successive formations.**

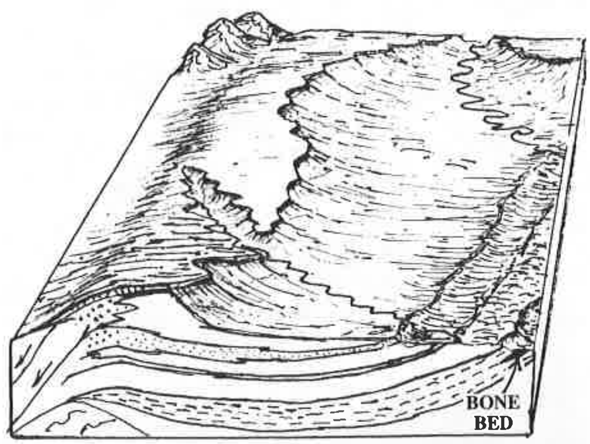


Figure 6D. ***Deep erosion and exposure.*** **The Cleveland–Lloyd bone bed was exposed at a fairly recent date geologically. Erosion is rapid and with time, even without human activity, the bone bed is destined for destruction.**

stretch of a stream were built above the general level the current would suddenly break through to nearby lower ground to create a temporary lake or pond and eventually a new channel. The overall result was to build and keep smooth a vast plain not far above sea level. In total dimensions the Morrison Formation is relatively thinner than a newspaper sheet.

Clues to the climate as well as to the geography should be mentioned. One might imagine from most popular reconstructions of dinosaurs that they lived in steaming swamps or dense jungles. For Morrison dinosaurs this picture is not borne out by the fossil evidence. There are no coal beds and surprisingly few plant remains in the formation. North America seems to have been somewhat farther south than it is today; the equator passed through northern Mexico or the extreme southwestern United States. The climate would have been tropical to semi-tropical, but there is considerable difference of opinion about details. Some say the general scene was arid to semi-arid, others say it tended to relative humidity. No one believes it was as wet as the tropical rain forests of the present time. More evidence as to the climate is being sought.

Regardless of what the climate may have been the plant and animal life was very diverse. Plant life ranged from lowly algae to giant conifers, but none of the advanced flowering plants of the plant world today have been found. Anyone who paints a picture showing dinosaurs on grassy meadows or in waterlily ponds is in error; these advanced plant types had not yet appeared.

Lower forms of animal life were locally abundant. Snails and clams grew in dense colonies in the fresh water along with lowly arthropods such as ostracodes and branchiopods. Even small fresh water sponges have been discovered. Life on the dry land was also diverse; representatives of every class of backboned animals have been discovered in the Morrison. The rare and primitive birds and mammals that have been unearthed are among the earliest of their kind. There are also fish and amphibians adapted to life in fresh water environments. But the reptiles reigned supreme, for this was the very height of their age and conditions were ideal. Remains of lizards, turtles and crocodiles are known from the Morrison Formation and they are not greatly different from their living descendants. Most abundant and famous of ancient reptiles are the dinosaurs; they left bones by the thousands, some in concentrations so great that they have been set aside as scientific treasures and tourist attractions. Not to be overlooked are the aerial relatives of the dinosaurs, the pterosaurs, or winged reptiles. A few bones and tracks of these delicate animals are also known from the Morrison Formation.

Putting all the evidence together gives a picture of a vast plain with meandering rivers and scattered lakes extending from horizon to horizon. Perhaps the vegetation and animal life was concentrated around the water bodies leaving wide barren strips between. It is conceivable that the lakes were so muddy and lifeless that little could live in them. The wonder may not be why life was so diverse on the Morrison plain, rather it may be why there was not more of it.

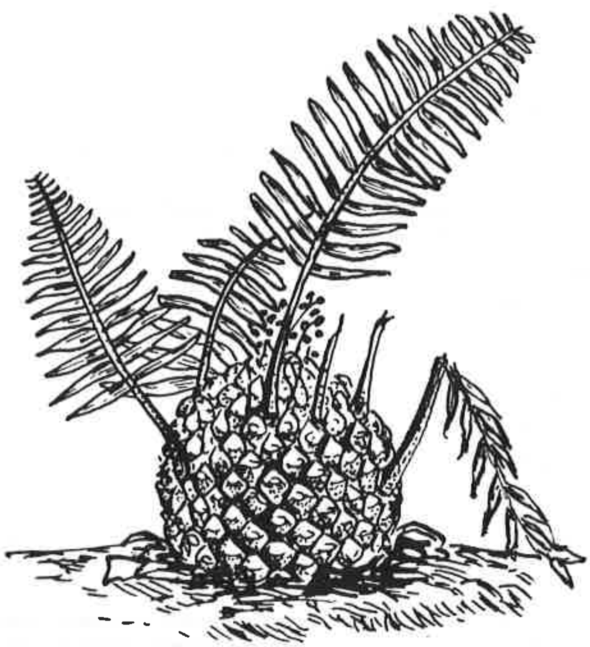


Figure 7. Dinosaur food? A cycad, common plant of the Jurassic Period. Specimens have been found in the Morrison Formation but not at the Cleveland–Lloyd Quarry.

DEATH TRAP

When the bones of many large animals are found concentrated in great graveyards the question of how they died and were gathered together comes naturally to mind. Did the animals congregate of their own free will and die peacefully of old age as the elephants of Africa were once thought to do? Did they die one at a time over many years or decades or did they perish all at once huddled together in the face of a sudden deadly natural catastrophe? Were they drawn to their doom because something attracted them in an irresistible way? Were they trapped as groups or as individuals by something they unsuspectingly blundered into like rabbits into snares? Finally, did they actually die on the spot or were they scattered here and there to have their remains picked up and carried to a central locality by some natural agent such as a flood of water?

Each of the possibilities appears to be represented somewhere in the fossil record and no two graveyards are the same. Only occasionally is there enough evidence to give definite answers to the problem of natural concentrations such as that of the Cleveland–Lloyd Quarry. Since we have no eye witnesses and only indirect evidence about what went on in the distant past all we can do is speculate within the framework of what can still be observed. Naturally, more than one explanation has been given for the Cleveland–Lloyd dinosaur graveyard. What follows is merely one man's opinion.

The simple facts are these: (1) dinosaurs of all but the very smallest size (youngest) are represented; (2) there are many more carnivorous types and individuals than there are herbivores; (3) the bones are separated and mingled together, but individual bones are not broken, gnawed or visibly weathered; (4) the bones are buried in fine clayey water-deposited sediments associated with fresh-water organisms.

Putting these facts together, a first conclusion must be that this graveyard has something to do with water. Either the dinosaurs died on the surface and were covered immediately by water-deposited mud or they sank into the mud after it was deposited but while it was still very soft and at the surface. Since the bones are not distributed in distinct layers, are not spread very widely, and show little evidence of having been exposed on the surface, I conclude that the dinosaurs sank into the sediment so that it enclosed them rather than being deposited on top of them.

Any naturally water-saturated area where a heavy object such as a large animal may sink below the surface is by definition a bog. In my opinion the Cleveland–Lloyd site represents a prehistoric bog into which dinosaurs sank on an individual basis over a considerable period of time.

Objections to this theory come to mind and some of these objections may be strong enough to prove it wrong. If the dinosaurs sank one by one into the mud, why didn't they remain intact or at least show less scattering of the bones? My answer is that, as the bodies inevitably decayed, the bones were released and dispersed by the internal movement or "working" of the bog. Yes, bogs do "work." They slowly bubble and boil due to the circulation of water rising into

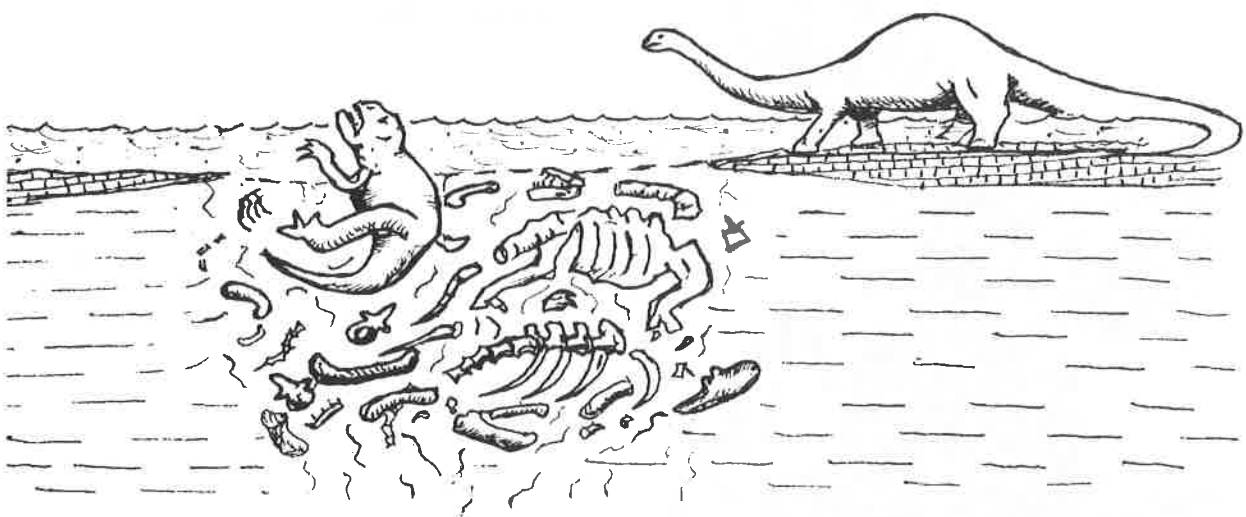


Figure 8. Imaginary sketch of how the Cleveland–Lloyd bone deposit may have originated. Dinosaurs are shown accidently walking into a boggy spot hidden under a shallow pond. Once submerged and drowned their bodied decayed to free the bones which were then thoroughly disarticulated and scrambled. Minerals brought in by underground water replaced the original bony tissue to produce the more durable petrified replicas.

Figure 9. Typical appearance of bones in process of removal. Here among other bones, two jaws with teeth are coming to light. Of course, the original bones were white, the color of petrified hard parts depends on the minerals that enter and replace them.

them. This is familiar to those who know bogs on a first-hand basis and is a fact that may justifiably be taken into account in explaining the Cleveland–Lloyd deposit.

It is worth pointing out that this is not strictly a quicksand situation. The matrix is clay and limestone with no sand whatsoever. But the action of quicksand does tell us one thing that helps our theory: animals may easily be trapped and sink out of sight in sediment that has already been deposited. Whether remains entombed in quicksand (or ''quick-clay'') are even seen again is a matter of time and geologic circumstance.

There is another problem: if complete living dinosaurs were sallowed up, why are many individuals so incompletely represented? We have tried to assemble the skeletons like jigsaw puzzles, but there simply aren't enough pieces of some of them. As a matter of fact, the representation ranges from what appears to nearly complete preservation in the case of some of the carnivores to only one tooth in the case of a large herbivore. Possibly this tooth reached the site in the stomach of another dinosaur.

Many bones have been broken up and carried away by weathering and erosion in the past few thousand years, many more may lie buried in the hillside. Maybe all parts of the animals were present to begin with and much that is missing may still be recovered. Also, the process of petrifaction is notoriously unreliable and selective. Unless conditions are just right a bone may not be replaced with mineral matter and thus leaves no record at all.

One more question: If there was a bog and it was a dangerous place to be around, why did so many dinosaurs of so many different kinds sink into it? We might answer this by saying that dinosaurs were too stupid to stay out of trouble. The spectacle of one of their kind sinking out of sight may not have been comprehensible as a warning of danger. But this may be too far-fetched. It is easier to believe that they couldn't see the danger until it was too late. The bog was probably hidden under shallow water; it was probably a relatively small spot in the bottom of a pond or lake. There is good evidence that such a water body existed and we continue to study the complete geology of the area to discover what the landscape may have looked like when the dinosarus sank into their graves.

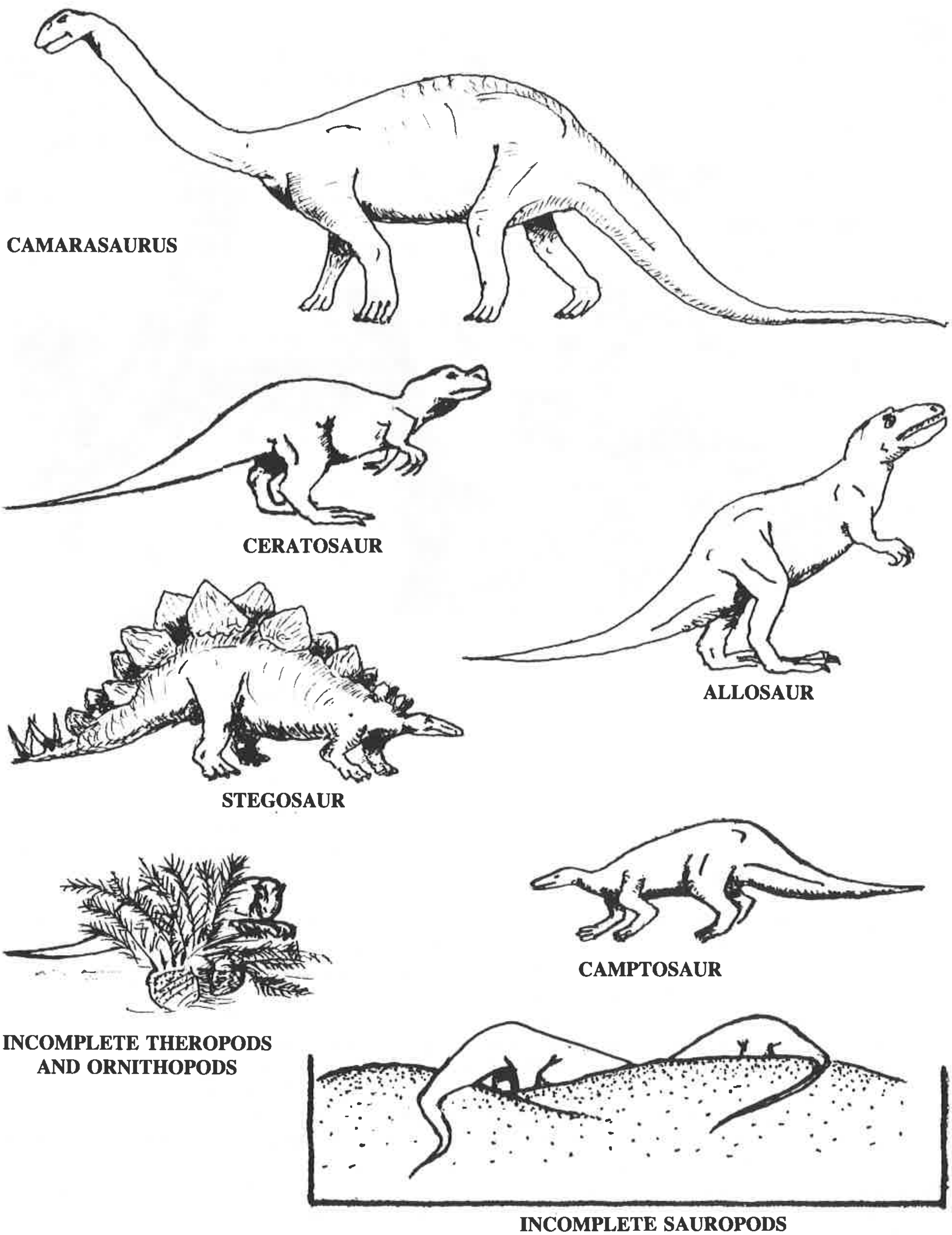


Figure 10. Chief dinosaurs of the Cleveland–Lloyd Quarry. Those illustrated have been found also in other deposits in Utah, Colorado, and Wyoming. The proportion of types is different from quarry to quarry; Cleveland–Lloyd is distinctly a graveyard of carnivorous species.

THE TIME SCALE

How old are they? This question is asked frequently by visitors as they view the dinosaur bones in their stony graves. Those who study dinosaurs and other fossils take the same question very seriously. To say we don't know how old the bones are satisfies no one — even to date them vaguely at millions of years isn't scientific or specific enough. Until about five years ago the best we could do was to date the origin of the deposit as being somewhat over 135 million years ago.

Now, owing to a fortunate discovery in the quarry, a more precise estimate is possible. The clue is locked in barely visible crystals of black mica (biotite) scattered in the light colored clay layers just above the bones. This material containing the biotite is called bentonite, a substance known to originate from the dust and ash of volcanic eruptions. Evidence is that the dust drifted in from volcanoes centered somewhere to the west, perhaps in Nevada or California.

Mica contains a variety of the element potassium (K) which is radioactive, meaning that it is unstable and changes spontaneously to another element, namely argon. The change is steady and predictable — as it progresses the amount of potassium decreases and the amount of argon increases. By extremely delicate analysis carried on at UCLS, Berkeley the ratio of potassium to argon has been determined and an age of 147 million years established for the Cleveland–Lloyd dinosaur deposit. This fits well with other estimates and is a landmark discovery in the study of dinosaurs.

THE HUMAN INVOLVEMENT

A natural question that arises in connection with the bone bed is: who found it? This is much like asking who discovered America. Bones on the surface of the ground were probably noticed first by ranchers who began to graze their cattle and sheep on the open range when nearby towns were settled in the 1880s. The real discoverer, be he cowboy or sheep herder, will never be known but in any western community there are generally a few persons interested in outdoor things and this concentration of giant, odd-shaped petrified bones was certainly a subject worthy of note to more than one curious individual.

I know this much from my own experience as a boy growing up in Cleveland. My father, William P. Stokes, told me how to get to the spot in 1928, and he in turn was informed of it by a younger man, Louis Owen Buffmire. Mr. Buffmire died in 1979 and what he knew about the subject unfortunately died with him. He was an avid amateur collector and naturalist who, among other things, obtained many fossil dinosaur tracks from the coal mines in Carbon County where he was employed.

Figure 11. Oldest known photograph of the quarry site. Golden York, University of Utah, relaxes with packages of bones from his shallow diggings. Photo taken in the late twenties or early thirties.

Figure 12. L. Grant Stokes, left, and Don A. Hansen accomplished much of the work of the Princeton project in 1940. Starting from the surface they excavated a six-foot deep pit to reach the bottom of the bone layer.

Figure 13. Tools of the trade at Cleveland–Lloyd Quarry. Awls, geologist's picks, mason's trowels, whisk brooms and shovels are adequate to remove the relatively soft mudstone.

Early Work of the University of Utah

Before 1928 nothing was taken from the bone deposit except broken ''souvenirs'' that had weathered out on the surface. The first serious excavations were by small parties directed by Golden York from the Department of Geology, University of Utah.

Mr. York, a native Utahn, had worked for several years for the Carnegie Museum and the University of Utah at the great bone deposit at what is now the Dinosaur National Monument near Jensen, Utah. He was employed by the University from 1924 until his death in 1977. According to information supplied by him he carried on excavations at the Cleveland–Lloyd site for short intervals in 1928, 1929, and 1931. About 500 bones were taken out, prepared, and stored at the University. This was an important contribution and the perfectly preserved uncrushed bones that had been obtained a few inches beneath the surface furnished a strong incentive to further digging.

The Princeton Project

The second phase of activity at the deposit was initiated by the writer, William Lee Stokes, for Princeton University in 1939. My first visit came slightly after the University of Utah crew left the site. Their pit and campground were still fresh. I recall picking up many petrified fragments from the surface of the ground including foot bones, teeth, and pieces that were incomprehensible to me at the time. That a great deal of material in much better condition, lay under the surface was obvious, but to obtain it was, at the time, an unthinkable dream.

Things took a turn in 1938 when I went to Princeton University to study geology. I observed that the small but excellent geology museum there had no dinosaurs. I asked my major professor, Dr. Glen L. Jepsen, why such important exhibits were lacking and his reply emphasized the phrase ''they are too rich for our blood.'' For some reason the going price for a dinosaur in those days was said to be $50,000, obviously too much for any but the most well-endowed museum. However, I frankly informed Dr. Jepsen that I knew how he could get a dinosaur for a lot less than this. He was naturally not convinced. How could a farm boy from Utah know an economical way to break into the dinosaur business? But something happened that can be described only under the heading of pure serendipity. A very wealthy individual, Mr. Malcom Lloyd, a genuine Philadelphia lawyer and a graduate of Princeton appeared on campus and announced that he would like to provide Princeton with a dinosaur! It was by combining the name of this benefactor with that of nearby Cleveland that the quarry received its name. Opportunity met capability and Dr. Jepsen gave me $1,000 to see what I could do. My upbringing on a marginal, irrigated farm in the nearby town of Cleveland (where frugality and inventiveness were the basis of existence) came in handy. I enlisted the services of my younger brother, L. Grant Stokes, then 18 years old, as my poorly paid assistant and we went to work. Our chief purchases included a couple of shovels, a gasoline stove, and a set of aluminum cooking utensils. We camped under an overhanging rock and commuted over a practically non-existent road in my father's 1927 Model T. Ford pickup truck.

According to my notes our first shovelfull of earth was taken out June 19, 1939. We chose to begin work on what turned out to be the southeast portion of the deposit. One side of our pit joined the small previous diggings of the University of Utah. From the first day, luck favored the uninitiated. The bones of this deposit are virtually in a first-class state of preservation and can be easily removed with the most simple of tools, including ice-picks and pointed mason's trowels. We tried and soon abandoned the time-honored method of taking out bones in plaster-of-paris jackets. We didn't need to coat each bone with shellac either. These bones do not crumble or fall into small fragments and are in no natural order that must be kept intact. We learned to take them out individually, to wrap each section of each bone carefully, and made sure that pieces of any one bone were not included with pieces of other bones. We kept a map of our findings from the first day and although this chiefly verifies the thoroughly scrambled nature of all the skeletons, it has been added to over the years and is one of the most informative products of our excavation.

Mr. Lloyd contributed and Dr. Jepsen allocated funds to continue our work during the 1940 season and the addition of Don Hansen, teen-age son of Dr. George H. Hansen, then chairman of the Geology Department, Brigham Young University, increased the crew from two to three. Don was to be paid in fossil specimens from Princeton for his father's department. We improved our primitive road and several hundred bones were added to our growing collection. The individual bones were shipped to Princeton in wooden dynamite boxes. My father could get plenty of these as they were discarded from the coal mines where he worked.

World War II now came to disrupt everyone's life and a period of several years of inactivity ensued in the dinosaur business. The plan of having a dinosaur for exhibit at Princeton was not entirely abandoned, however. I continued my studies at Princeton and received a research fellowship, the duties of which included the cleaning and preparing of dinosaur bones from Utah. When I left in 1942 we had many of the bones of a medium size *Allosaurus* but whether or not these were sufficient to reconstruct a museum exhibit was not apparent at the time. Al the *Allosaurus* was not to be on his feet until 1960.

Operations Under the University of Utah Cooperative Dinosaur Project

The third phase of excavation, and by far the most productive, began in 1960 and was again under the auspices of the University of Utah. I was hired as an instructor in 1947 and became head of the Geology Department in 1958. Naturally the great untapped store of dinosaur bones in the wilds of Emery County frequently came into my thoughts. It occurred to me that many museums and universities might need dinosaur exhibits, but either could not afford to purchase them or had no idea of how to go out and collect their own individual specimens. I felt that we could, with a very minimum of expense, provide specimens if we could enlist enough interested parties. I described my plan to James H. Madsen Jr., graduate student, and we organized the University of Utah Cooperative Dinosaur Project, which became operative in 1960. Our first step was to send letters to institutions we thought might be interested. We

Figure 14. The Princeton University excavators lived under the overhanding edge of a large boulder and in a small canvas tent.

Figure 15. Preparator, Arnie Lewis, working on the Princeton Allosaur in his laboratory at Yale University. A dinosaur from Utah, assembled in Connecticut, is on display in New Jersey.

Figure 16. Al the *Allosaur,* now standing on his feet in Princeton's Guyot Hall, was the first Cleveland–Lloyd specimen to go on display.

guaranteed nothing but our most diligent efforts and told potential customers that we thought we could get them a mountable dinosaur skeleton for the price of "a good car," then about $2,000.

The Dinosaur Project was a success, but always operated on a financial shoestring. Although we applied for aid through the National Science Foundation on a regular basis we were turned down every time. The University of Utah gave us space for storage and acted as our financial agent in securing and dispensing funds, but could do little more. Ours must be the only pay-as-you-go, self-supporting scientific project of its kind.

The history of events at the Cleveland–Lloyd Quarry since May 1, 1960, when it was reopened under auspices of the University of Utah, is well documented. Two separate, but related stories might be told. One pertains to the quarry as such, the other to the specimens after their removal from the site.

This pamphlet deals chiefly with what went on at the quarry, the preparation, disposition and study of the bones will be mentioned only briefly. A chronological summary of the development of the quarry follows:

1960: Quarrying was commenced May 1 under the direction of L. Grant Stokes, the writer's brother, who had gained essential experience during the Princeton project. Activities were financed by contributions of several museums and universities and an official permit to excavate had been obtained from the Smithsonian Institution. An average of four persons were employed until operations were suspended, August 10. About 100 cubic yeards of matrix was excavated and 1500 bones recovered. Cooperating institutions receiving specimens were Yale University, Buffalo Museum, Brigham Young University, California Academy of Sciences, and the Exhibit Museum at the University of Michigan.

1961: With a renewed permit and continuing financial support from cooperating institutions, work was resumed May 1 under direction of L. G. Stokes and James H. Madsen Jr. An average of four persons was employed until August 12, an area of about 45 feet by 20 feet was excavated, and 1750 bones recovered. Partial composite skeletons suitable for mounting were selected for shipment to the College of Eastern Utah, University of Nebraska State Museum, Royal Ontario Museum (two specimens), and the National Museum of Canada.

Bones of the rare carnivorous dinosaur, *Ceratosaurus,* were positively identified for the first time and parts of two large sauropods were recovered. In spite of poor roads, over 3,000 persons visited the site. The skeleton of *Allosaurus,* obtained on a piecemeal basis in 1939, 1941 and 1942, was put on display at Princeton University early in the year. It was assembled by preparators at Yale University.

1962: Excavations were carried on from May 1 to September 7 under the same plans as in the previous year. An average of three persons was employed and 2050 bones were taken out. Emery County officials donated equipment and personnel to grade the road and hundreds of visitors came to view the operations. Three skeletons were selected for shipment to the Los Angeles County Museum, and two to the National Science Museum of Japan in Ueno Park, Tokyo.

1963: Work commenced June 1 and continued until August 3. Three persons were employed and about 1000 bones were removed from an area about 25 feet by 36 feet. Applications for cooperative efforts declined, the market for dinosaurs seemed to have been almost saturated.

1964: The quarry was opened June 1 and worked until July 17. Three experienced workers were employed full time, but the season was short because of limited funds. Six hundred twenty-five bones were recovered from an area 30 feet by 30 feet. Specimens were delivered to Los Angeles County Museum and to Earlham College in exchange for a mastodon. For $5,000 the cooperative project purchased about 1000 bones from Princeton University and they crossed the continent a second time to rejoin the Utah collections.

Figure 17. William Lee Stokes initiated both the Princeton and second University of Utah project. He is retired from teaching geology at the University of Utah and lives in Salt Lake City, Utah.

Figure 18. L. Grant Stokes spent more time at the quarry than anyone else during the Princeton and second University of Utah projects. He is retired from his profession as a cabinet maker and lives in Mapleton, Utah.

Figure 19. James H. Madsen Jr. has worked at the quarry for all or part of 15 seasons. He was also in charge of all laboratory work for the University of Utah Cooperative Dinosaur Project and is responsible for the preparation and assembly of more than two dozen skeletons on display throughout the world. He is presently Utah State Paleontologist.

Figure 20. During the 1960 season living quarters were a small cramped mobile trailer.

Figure 21. Dr. Dwayne Stone, now professor of geology at Marietta College, Marietta, Ohio, takes a measurement on the quarry floor.

Figure 22. Alan Staker packages bones in plaster-of-paris. He was at the quarry during the University of Utah project and is now executive vice president of Explor Energy Corporation of Denver, Colorado.

Figure 23. William Michael Stokes worked at the quarry during the University of Utah project. He is now an independent land consultant living in Santa Fe, New Mexico.

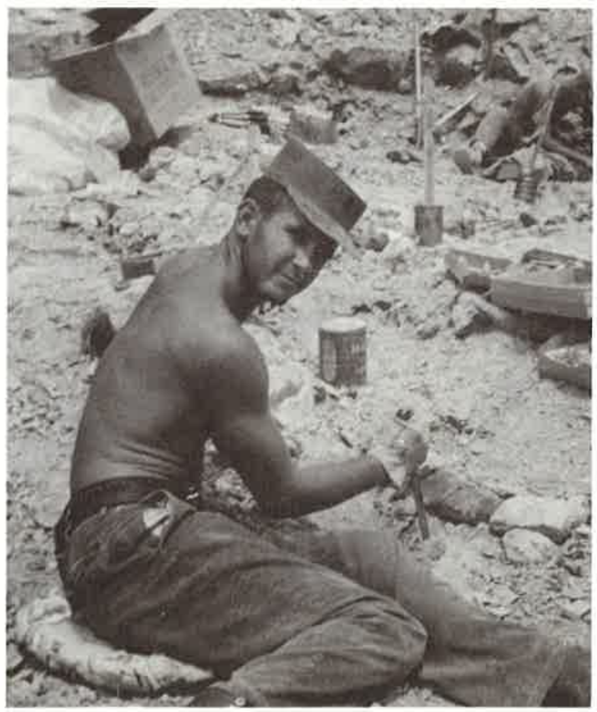


Figure 24. Kermit Horn, University of Utah graduate in geography, worked at the quarry during the University of Utah project. He is now an administrator with the Oregon State Department of Education.

Figure 25. John Hale getting close to his work. John's labor was part payment for a dinosaur skeleton shipped to Yale University in 1961.

Figure 26. A prefabricated 12-foot by 16-foot wooden building housed excavators during the 1964 and 1965 seasons.

Figure 27. Working under the shade of movable parasols moderated the desert heat which frequently exceeds 100 degrees Farenheit.

Representative Lawrence Burton, without consulting project personnel, introduced a bill in Congress to have the quarry site set aside as a National Monument. This status was deemed to be unwarranted, but in December the site was officially declared a U.S. Natural Landmark. This is a grade below a Monument and not supervised by the Park Service. The first indication of this to the University group was a newspaper article after the transfer had become an accomplished fact. From this point onward operations were under supervision of the Department of the Interior, Bureau of Land Management.

Operations Under the United States Bureau of Land Management

1965: Nothing was done at the quarry, but work was intensified in the laboratory at the University of Utah repairing and segregating specimens.

1966: Plans were announced to develop the quarry area as a recreational site under the auspices of the U.S. Bureau of Land Management. Excavations were suspended, but laboratory work continued. Two museum specimens were sent to Kagoshima, Japan, one each to Modena and Milano, Italy and one to Seattle, Washington.

1967: A 873-square-foot visitors' center, parking area, camp facilities and foot-paths were under construction by corpsmen of the Castle Valley Job Corp with headquarters near Price, Utah. Native stone was used in the building and a series of exhibits, including a mounted *Allosaurus,* were installed by James H. Madsen Jr. for the Bureau of Land Management.

Specimens were sent to Fort Worth, Texas; Edinburgh, Scotland; St. Paul, Minnesota; and Lubbock, Texas.

1968: The visitors' center was dedicated September 21, 1968. A plaque designating the site as a Registered U.S. Natural Landmark was presented and the facilities opened to the public. One museum specimen was sent to Cleveland, Ohio.

1969 to 1974: No excavations were carried out during the period from 1969 to 1974. However, the visitors' center was kept open during the summer tourist season. Mrs. Ann Wissler, a resident of nearby Castle Dale, served as caretaker–guide. Visitors ranged from 2,000 to 3,000 per season.

The University of Utah Cooperative Dinosaur Project was officially terminated in 1966. Chiefly because of the insistence of James H. Madsen Jr., University of Utah, the Bureau of Land Management agreed to erect two adjoining steel Butler Buildings over an unexcavated portion of the deposit which would provide for protection and indoor viewing of excavation in progress. The purchase of the buildings was financed by the project.

1975: Two weeks of field work, under supervision of James H. Madsen Jr. recovered 380 bones and squared up the quarry in preparation for the erection of the protective shelter.

1976: Six days' field work directed by Madsen was carried out by 26 students from Utah State University and Foothill

Figure 28. Home on the range where the dinosaurs once roamed. Kermit Horn at a musical moment.

Figure 29. Flash flood. The normally dry gully between the camp and quarry becomes a turbulent river during a thunderstorm. Needless to say such events were damaging to the open quarry.

Figure 30. Bulldozer covering the quarry site. This operation was carried out yearly to lessen the possibility of vandalism. There were no known damages by souvenir hunters during the entire period of operations.

Figure 31. Dedication of the Cleveland–Lloyd visitors center, September 21, 1968. Dr. William Lee Stokes is explaining the origin and history of the site.

Figure 32. Scene in the "Bone Barn" on the University of Utah campus. Here specimens from the quarry were cleaned, repaired and segregated. The University of Utah Cooperative Project was terminated in 1966.

Figure 33. James H. Madsen Jr. displays an allosaur skull reconstructed by him from Cleveland–Lloyd quarry remains. Madsen's products are on view in more than two dozen museums throughout the world.

Figure 34. Robert Randolph repairs an *Allosaur* hip bone in the "Bone Barn" at the University of Utah. He is now mining law specialist with the Salt Lake office of the Bureau of Land Management.

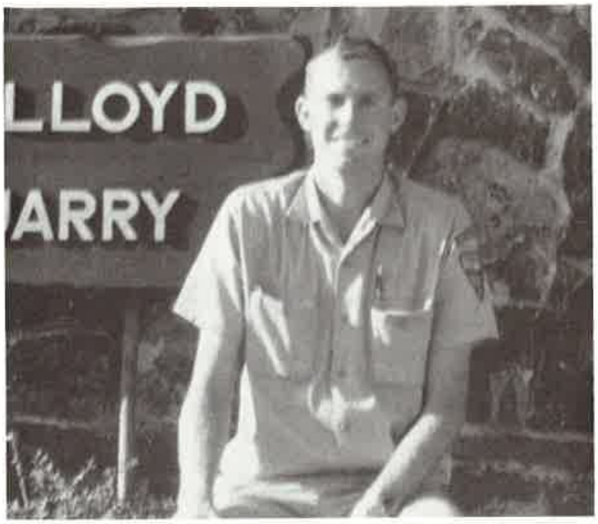


Figure 35. Glen Ungerman, caretaker–guide at the quarry 1969–70. He is now a preparator for the Utah Museum of Natural History, Salt Lake City, Utah.

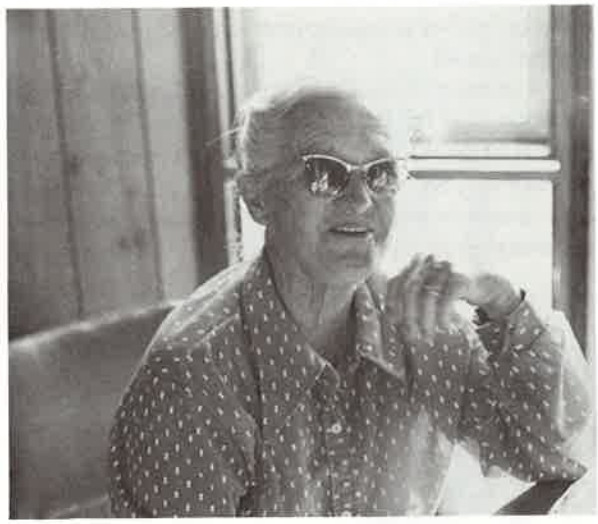


Figure 36. Mrs. Ann Wissler, caretaker–guide at the Cleveland–Lloyd Quarry visitors center for the period 1978–1981. She is retired and lives in Castle Dale, Utah.

Community College of California. Two hundred and seven bones were recovered. The protective buildings were erected late in the fall.

1977–1980; Activity in the quarry was limited chiefly because flood waters entered the building in the winter of 1978 and filled much of the working area. Damage to exposed bones was considerable. With the help of students from Foothill Community College, 168 bones were removed later in the summer. During three weeks in June, 1980, a small party working with Madsen repaired the damage done by flooding and a suitable exhibit of bones in place was completed.

From 1980 to 1985 only a few bones were taken from the deposit. Routine caretaker duties were performed by the Bureau of Land Management and the State Paleontologist. In 1982 the Bureau of Land Management, Moab District Office, carried out a core drilling program west of the quarry to determine whether or not the deposit continues beyond present workings. Eighteen holes averaging 20 feet in depth were put down. Bone material was found in six holes.

THE PICNIC GROUNDS

A visitor to the Cleveland–Lloyd quarry cannot fail to notice the great number of very large boulders just south of the quarry. Several picnic tables are situated in the shade of these rocks. The boulders constitute a geological novelty worth a passing note of explanation. Those who take a close look at them will see they are made chiefly of millions of

Figure 37. Picnic tables near the visitors center are in the shade of giant conglomerate boulders fallen from nearby cliffs.

Figure 38. In this photo, taken in 1940, the large block on the skyline was in place in the cliff. Later, with no witnesses, it crashed to join other boulders below. All boulders near the camp originated by the same process.

small white or gray pebbles cemented together to make up light-colored conglomerate. It may also be observed that these lie strewn across several acres of ground below a 15-foot cliff that caps a prominent point southwest of the visitors' center.

It requires no stretch of the imagination to perceive that these great boulders have fallen from the cliffs above and that after they fall they gradually become smaller and smaller as their individual pebbles loosen and separate. The process of boulder formation was dramatically illustrated during the 1960 to 1964 field season. Although no one actually witnessed it, a great block fell from the cliff and crashed among other pieces below. We have before-and-after photographs to prove this event. Personally I shudder to think of how I stood on this block and sat in the shade under its overhanging edge oblivious to the fact that it was undermined and ready to fall!

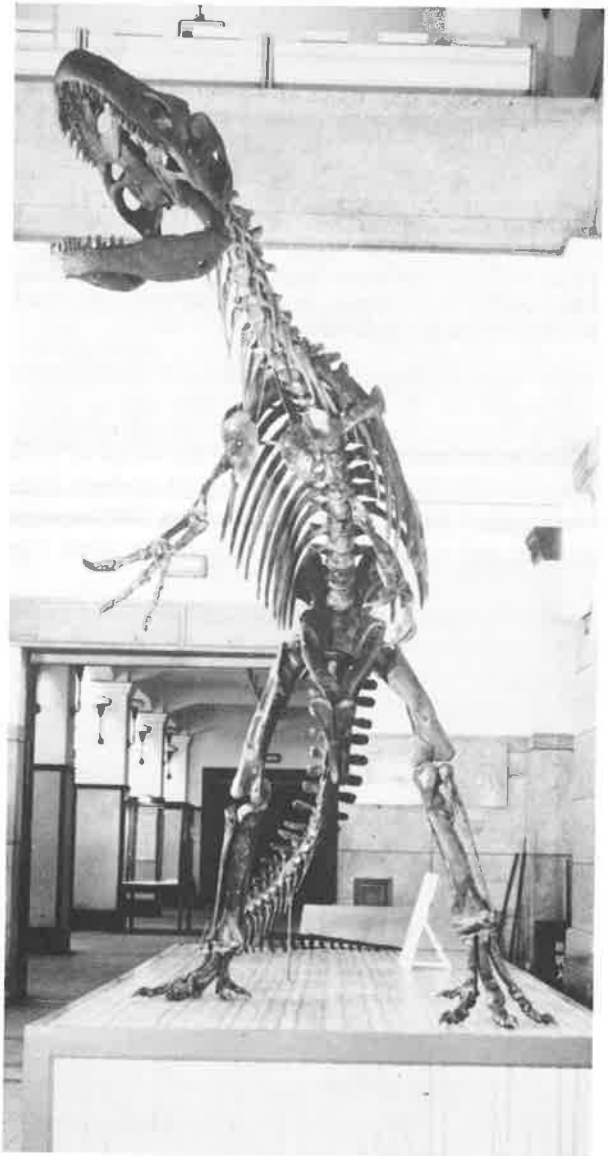


Figure 39. ***Allosaur*** **skeleton mounted in the National Science Museum, Ueno Park, Tokyo was the first dinosaur exhibited in Japan. The Japanese are fascinated by dinosaurs and like to see them reconstructed in aggressive poses.**
Courtesy National Science Museum, Tokyo.

CONTRIBUTIONS

New Facts and Theories

Many great fossil graveyards are known. Most famous in North America are the La Brea Tar Pits in Los Angeles, California and the Dinosaur National Monument quarry near Vernal, Utah. The Cleveland–Lloyd deposit is comparable with both of these. It is in the same formation and has many of the same species as Dinosaur National Monument. Differences lie mainly in the manner in which the death trap operated and the nature of the victims. At the Monument

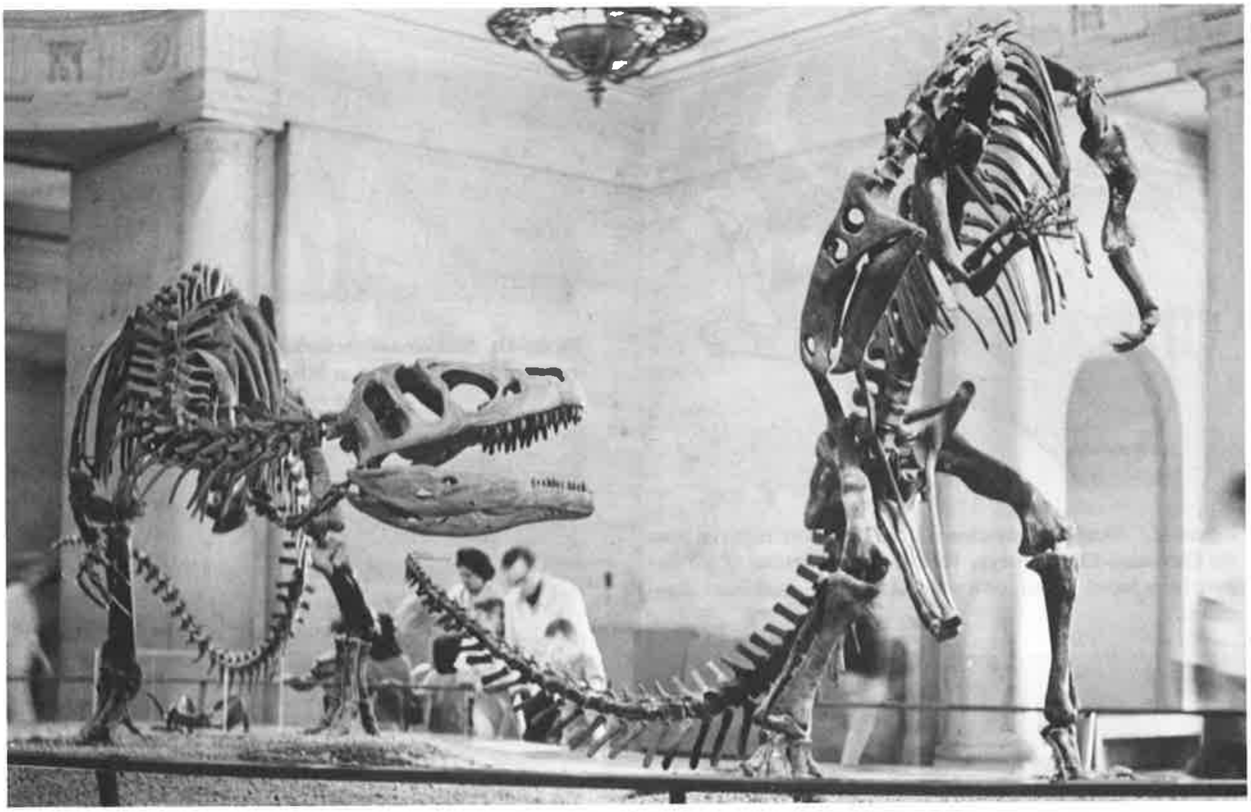


Figure 40. Another contribution from Cleveland–Lloyd. *Allosaur* attacks *Camptosaur* in the Los Angeles Museum. This is one of the most photographed dinosaur exhibits in the United States.

the bones are encased in sandstone thought to have originated as a sand bar on the margins of a fairly large river. Most of the bones pertain to the water-loving, heavy-bodied, long-necked sauropods such as *Camarasaurus*. The Cleveland–Lloyd remains, by contrast, are buried in clay and are thought to represent animals mired in a small lake or pond. Here the victims are chiefly carnivores. This last-named fact calls attention to the similarities to the La Brea Tar Pits, where the most common animal is the great saber-tooth cat, *Smilodon*. It seems safe to conclude that in both cases the flesh eaters were enticed to their death by the posibility of a free meal on animals mired in tar or clay. This similarity has caused some workers to refer to the Utah deposit as the Cleveland–Lloyd Clay Pits.

The most important scientific contributions of the Cleveland–Lloyd quarry have to do with *Allosaurus*, the great two-legged flesh-eater of the Jurassic Period. Judged by the number of thigh bones taken out over the years, at least 44 of these animals died here. Arranged from smallest to largest, these specimens constitute the most complete series of growth stages of any known saurischian dinosaur. A comparable series of growth stages of the ornithischian dinosaur *Protoceratops* was obtained in Mongolia in the 1920s. Speaking in human terms, *Allosaurus* from the Cleveland–Lloyd deposit ranged from mere youngsters weighing less than 100 pounds to giant four-ton, 30-foot long oldsters. As a matter of fact, it may be that the largest allosaur rivals even *Tyrannosaurus rex* in size. Evidence from the quarry reinforces the thought that dinosaurs, like modern turtles and crocodiles, grow throughout life and the size of any individual is a fair gauge of its age.

Based on the contributions of the Cleveland–Lloyd quarry *Allosaurus* has become the best-known of all dinosaurs. Every one of the approximately 296 bones in its body and the 64 bones of its skull have been found, measured, pictured, and described. The 163-page monograph on *Allosaurus* by James H. Madsen Jr., has become a standard to which workers throughout the world refer. Bones from the Cleveland–Lloyd quarry have added a great deal to our knowledge of another, less abundant, carnivore, *Ceratosaurus*. As a matter of fact, the quarry specimen may be a new species. Perhaps even more important is the discovery of two smaller carnivores, *Marshosaurus* and *Stokesosaurus*, unknown from any other locality. Again, one is reminded of La Brea where several felines, smaller than *Smilodon*, are found. Cleveland–Lloyd certainly furnishes a standard for study of carnivorous dinosaurs of all kinds and geologic ages.

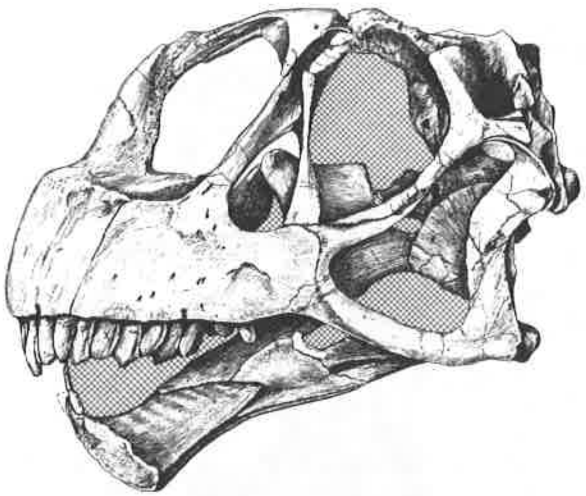


Figure 41. Skull of *Camarasaurus lentus* based on material from the Cleveland–Lloyd quarry. Various interpretations of the diet have been based on the teeth which are unlike most other dinosaurs.

Figure 42. Skeleton of the herbivorous dinosaur, *Camptosaurus*, mounted in the museum at Milano, Italy.

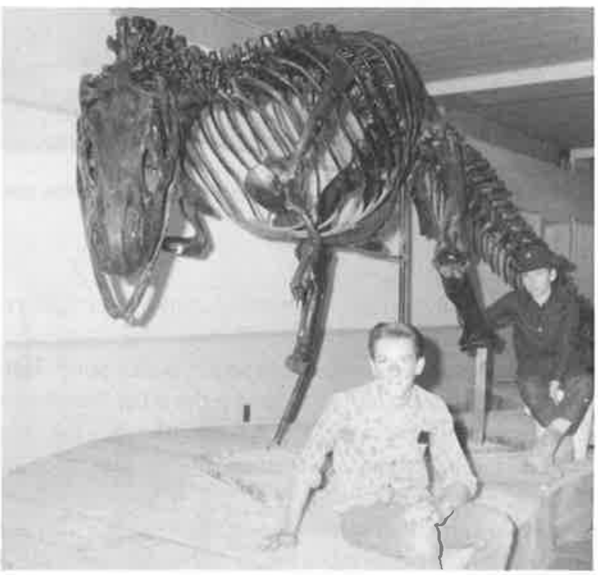


Figure 43. *Allosaur* displayed at the College of Eastern Utah Prehistoric Museum, Price, Utah. If present plans are carried out the Prehistoric Museum may eventually have the most complete representation of Cleveland–Lloyd dinosaurs in existence.

Figure 44. Buildings erected by the Bureau of Land Management. The Visitors Center, with exhibits, is in the foreground. Two metal buildings, erected over the bone bed are on the right. These are intended to protect the deposit and to allow visitors to view excavations in progress.

Specimens of noncarnivorous dinosaurs are also important. Even though sauropod bones are relatively rare, the Cleveland–Lloyd specimens give important information on the skull and teeth of *Camarasaurus*. Although the single tooth of *Mongolosaurus* may have arrived in the stomach of another dinosaur, it is an important clue to the distribution of this form. Another species, represented by too few bones, may be an ancestor of the spectacular armored dinosaur *Ankylosaurus* of the Cretaceous Period.

The Cleveland–Lloyd fauna will continue to be studied intensively as a prime example of paleoecology and the study of how animals die and are buried. The ratio of carnivores to herbivores is much higher than the natural one suggesting that the death trap was selecting its victims. Also, less easy to explain, is the predominance of bipeds over quadrupeds.

Minor matters awaiting more detailed investigation are evidences of disease and injury; there are a number of pathological specimens. We may expect more studies on dinosaur habits, growth rates, diets, how to distinguish the sexes, and most important of all, why the Cleveland–Lloyd bone bed is where it is.

CONTRIBUTIONS

Another Morrison Biota

Generic names only. Question marks designate tentative identifications.

Plants
- Thallophytes
  - charophytes (lime secreting algae)
    - *Aclistochara*
    - *Latochara*
    - *Stellatochara*

Animals:
- Mollusca (shell-bearing molluscs)
  - gastropods (snails)
    - *Amplovalvata*
    - *Amplovoluta*
    - *Valvata*
    - *Viviparus*

- Chordata (backboned animals and kin)
- Chelonia (turtles)
    - *Glyptops* (primitive turtle)

- Saurischia (dinosaurs with lizard-like pelvis)
  - Sauropods (four-legged, five-toed, long-necked, long-tailed dinosaurs)
    - *Amphicoelius*? (known from one femur only)
    - *Barosaurus* (large heavy sauropod)
    - *Camarasaurus* (medium-length sauropod)
    - *Haplocanthosaurus* (rare sauropod)
    - *Mongolosaurus*? (one tooth only)
  - Theropods (''beast-footed'' bipedal carnivores)
    - *Allosaurus* (common Late Jurassic carnivore)
    - *Ceratosaurus* (single horn on nose)
    - *Marshosaurus* (small, rare carnivore)
    - *Ornitholestes*? (slender, ''bird robber'')
    - *Stokesosaurus* (small, rare carnivore)
- Ornithischia (dinosaurs with bird-like pelvis)
  - Ornithopods (''bird-footed'' herbivores)
    - *Camptosaurus*
    - *Stegosaurus*
    - ankylosaurid (may be new species)

CONTRIBUTIONS

Display Specimens

The Cleveland–Lloyd Quarry was not designated a U.S. Natural Landmark without ample reasons. It qualifies for the distinction because of the unusual number and variety of both exhibition and research specimens taken from it. Organized professional excavation yielded about 10,000 individual bones. From these bones more than 70 individual animals representing at least 14 species have been identified. This great profusion of remains has been the basis for more public exhibits than the products of any other dinosaur quarry on earth. Specimens for display were obtained chiefly through the University of Utah Cooperative Dinosaur Project whereby cooperating institutions received specimens in return for financial contributions. Recipients and the names of specimens received by them are listed below. A key to the notations following the institutional name includes: A = *Allosaurus* and the femur length giving size; C = *Camptosaurus;* c = cast specimen; o = original specimen in part; S = *Stegosaurus;* Ca = *Camarasaurus.*

Albuquerque Museum of Natural History, Albuquerque, New Mexico (No. 33A/c, C/c, S/c, Ca/c).
Brigham Young University, Provo, Utah (No. 30A/o, C/c).
Buffalo Museum of Science, Buffalo, New York (No. 25A/o).
Bureau of Culture Center, Kagashima, Japan (No. 22A/o, C/o).
U.S. Bureau of Land Management, Cleveland–Lloyd Dinosaur Quarry, Emery County, Utah (No. 22A/o).
California Academy of Sciences, Golden Gate Park, San Francisco, California (No. 33A/o).
City of Liverpool Museum, Liverpool England (No. 22A/c, C/c).
College of Eastern Utah Prehistoric Museum, Price, Utah (No. 27A/o, C/c, Ca/o, S/o).
Emery County Museum of Natural History, Castle Dale, Utah (No. 22A/c).
Exhibit Museum, Ann Arbor, Michigan (No. 30A/o).
Fort Worth Museum of Science and History, Fort Worth, Texas (No. 22A/o, C/c).
Brazosport Museum of Natural History, Freeport, Texas (No. 33A/c).
Museum of Western Colorado, Grand Junction, Colorado (No. 33A/c).
Hokkaido Centennial Office, Hokkaido, Japan (No. 33A/c).
Institute for Breeding Research, Tokyo University of Agriculture, Tokyo, Japan (No. 33A/c, C/c).
Joseph Moore Museum, Richmond, Indiana (No. 27A/o).
Los Angeles County Museum of Natural History, Los Angeles, California (No. 27A/o, C/o, S/o).
Mineral Research and Exploration Institute, Ankara, Turkey (No. 33A/c).
Ministry of Education, Kuwait, Arabia (No. 33A/c, C/c).
Museo Civico di Storia Naturale, Milano, Italy (No. 22A/o, C/c).
Museum d'Histoire Naturelle, Geneva, Switzerland No. 33A/o, C/c).
Museum National d'Histoire Naturelle, Institute de Paleontologie, Paris, France (No. 33A/c).
Museum of Natural History, University of Wisconsin, Stevens Point, Wisconsin (No. 22A/c).
National Museum of Canada, Ottawa, Canada (No. 25A/o).
National Science Museum, Ueno Park, Tokyo, Japan (No. 27A/o, C/c).
Natural Science Museum, Cleveland, Ohio (No. 33A/o).
New England Paleontological Society, Barre, Massachusetts (No. 22A/c).
Osaka Museum of Natural History, Osaka, Japan (No. 33A/c).
Panhandle Plains Museum, Canyon, Texas (No. 33A/c).
Peabody Museum of Natural History, Yale University, New Haven, Connecticut (No. 22A/o).
Life Sciences Museum, Pierce College, Woodland Hills, California (No. 22A/c).
Louisiana State University, Baton Rouge, Louisiana (No. 33A/c).
Royal Ontario Museum, Toronto, Canada (No. 33A/o, No. 33A/c, C/o).
Royal Scottish Museum, Edinburgh, Scotland (No. 27A/o).
Saito Ho-on Kai Museum of Natural History, Sendai, Japan (No. 33A/c).
Science Museum, St. Paul, Minnesota (No. 22A/o).
Texas Technological College, Lubbock, Texas (No. 30A/o).
Thomas Burke Museum, Seattle, Washington (No. 25A/o).
Tyrrell Museum of Paleontology, Drumheller, Alberta, Canada (No. 33A/c, C/c, Ca/c, S/c).
University of Nebraska State Museum, Lincoln, Nebraska (No. 35A/o, No. 17A/o).
Vines Environmental Science Center, Houston, Texas (No. 33A/c).
Virginia Polytechnic Institute and State University, Blacksburg, Virginia (No. 22A/c).
Weber State College, Ogden, Utah (No. 22A/c, C/c).

CONTRIBUTIONS

Publications

Carey, M. A. and J. H. Madsen, Jr., 1972. Some Observations on the Growth, Function, and Differentiation of Sauropod Teeth From the Cleveland–Lloyd Quarry. Utah Academy Proceedings, v. 49, part 1, p. 40–43.

Dodson, Peter, and James H. Madsen, Jr., 1981. On the Sternum of *Camptosaurus*. Journal of Paleontology, v. 55, no. 1, p. 109–112.

Madsen, J. H. Jr., 1969. This Business of Dinosaurs. Geological Society of America Abstracts, Part 5 (Rocky Mountain Section). p. 48–49.

__________, 1973. On Skinning a Dinosaur. Curator, v. 16, no. 3, p. 225–226.

__________, 1974. A New Theropod Dinosaur From the Upper Jurassic of Utah (*Stokesosaurus*). Journal of Paleontology, v. 48, no. 1, p. 27–31.

__________, 1976a. *Allosaurus fragilis:* A Revised Osteology. Utah Geological and Mineral Survey Bulletin 109, 163 p.

__________, 1976b. A Second New Theropod Dinosaur From the Late Jurassic of East Central Utah (*Marshosaurus*). Utah Geology, v. 3, no. 1, p. 51–60.

Madsen, J. H. Jr., and I. Obata, 1964. A General Discussion of the Cleveland–Lloyd Quarry and the University of Utah Cooperative Dinosaur Project (in Japanese). National Science Museum, v. 31, no. 9–10, p. 133–139.

Madsen, J. H. Jr., and Wm. Lee Stokes, 1963. New Information on the Jurassic Dinosaur *Ceratosaurus*. (abstract). Geological Society of America Special Paper 73, p. 90.

__________, 1972. University of Utah Cooperative Dinosaur Project: A Progress Report. Utah Academy of Science, Arts, and Letters Proceedings, v. 49, part 1, p. 48–50.

__________, 1977a. University of Utah Dinosaur Project: A Final Report. Encyclia, v. 54, part 2, p. 68–70.

__________, 1977b. *Allosaurus* and Synonomy. (abstract). Encyclia, v. 54, part 2, p. 103.

Peterson, K., J. I. Isakson and J. H. Madsen, Jr., 1972. Preliminary Study of Paleopathologies in the Cleveland–Lloyd Dinosaur Collection. Utah Academy of Science, Arts, and Letters Proceedings, v. 49, part 1, p. 44–47.

Stokes, Wm. Lee, 1944. Jurassic Dinosaurs from Emery County, Utah. Utah Academy of Science, Arts, and Letters Proceedings, v. 21, p. 11.

__________, 1945. A New Quarry for Jurassic Dinosaurs. Science, v. 101, no. 2614, p. 115–117.

__________, 1961. Dinosaur Quarry Near Cleveland, Utah. Utah Academy of Science, Arts, and Letters Proceedings, v. 38, p. 132–133.

__________, 1963. Cleveland–Lloyd Dinosaur Quarry, Emery County, Utah. (abstract). Geological Society of American Special Paper 73, p. 96.

Stokes, Wm. Lee and J. H. Madsen, Jr., 1962. Progress Report on Excavations at the Cleveland–Lloyd Dinosaur Quarry, Emery County, Utah. (abstract). Utah Academy of Science, Arts, and Letters Proceedings, v. 39, p. 200.

__________, 1967. Status and Contributions of the University of Utah Cooperative Dinosaur Project. Utah Academy of Science, Arts, and Letters Proceedings, v. 44, part 1, p. 385–386.

__________, 1977. Utah — The Dinosaur State. Encyclia, v. 54, part 2, p. 75–78.

Works in Preparation

Madsen, J. H. Jr., John S. McIntosh, and Dale S. Berman. Comparative Osteology of the Skull of *Camarasaurus* Cope.

Madsen, J. H. Jr., Samuel P. Welles, and Lance Erikson. The Revised Osteology of *Ceratosaurus*.

Acknowledgments

I am indebted to James H. Madsen Jr. for many bits of information and illustrative material that have made this account as complete as it is.

Both of us would like to express appreciation to all who worked with Cleveland–Lloyd specimens. In one way or another, to greater and lesser degrees, we all helped bring the Cleveland–Lloyd dinosaurs to life. With apologies for using the names by which we know each other here is the list: Megan Anderson, Dave Atkinson, Susan Barnhill, Trisha Bizuk, Mary Cary, Sam Garry Jr., John Hale, Don Hansen, Kermit Horn, Debbie Hopkins, James Howell, Tawny Isakson, Glen Jepsen, Dianna Jones, Prudence Jones, Lori Kepner, Malcolm Lloyd, Jim Madsen, Pam Hengeveld, Bob Randolph, Kristen Peterson, Russ Peterson, Bryce Tripp, Alan Staker, Grant Stokes, Lee Stokes, Mike Stokes, Bill White, Phillis Wilkin, Jack Winkler, and Ann Wissler.

Finally, apologies to any we should have included, but failed to remember.

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