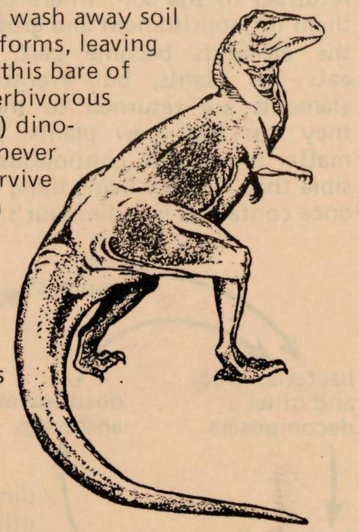
that formed these rocks and millions of years later slowly eroded some of these sediments away. Today, most of the water that reaches this area comes as rain. The clay bedrock causes most of it to drain off and wash away soil as soon as it forms, leaving mounds like this bare of plant life. Herbivorous (plant-eating) dinosaurs would never be able to survive in this region today.



Allosaurus

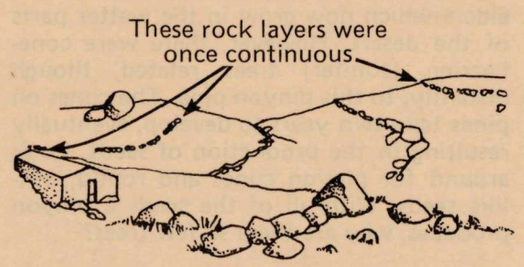
11 How do paleontologists know where to find dinosaur fossils? Unfortunately, seismic tests and X-rays do not reveal dinosaur fossils, and scientists must use the clues that are available. All around you is rock dating from the age of the dinosaurs. The brightly-colored layers of rock usually do not contain fossils, as they represent areas where iron in the sediment was exposed to the air for a long period of time. Animal remains exposed to air usually disintegrate, so few fossils are formed. A paleontologist would probably prefer exploring dull-colored layers, where animals might have been buried quickly. If you find an unusual fossil, please report it to the quarry attendant.

12 Now the trail goes along a wash which during wet periods, can become a stream. DO NOT WALK IN THIS WASH IF IT IS BEGINNING TO RAIN! The fence was constructed to keep cattle, which graze here in the springtime, from altering the natural features of Cleveland-Lloyd National Natural Landmark.

13 This boulder was once part of a bed of sand and gravel, since eroded from an ancient, rocky mountain. Dinosaurs may have walked over the sand, leaving behind gastroliths -- the smooth polished rocks thought to have aided in their digestion. Look closely and you will see smooth rocks within the boulders. How did they become embedded? How did the sand become solid rock?

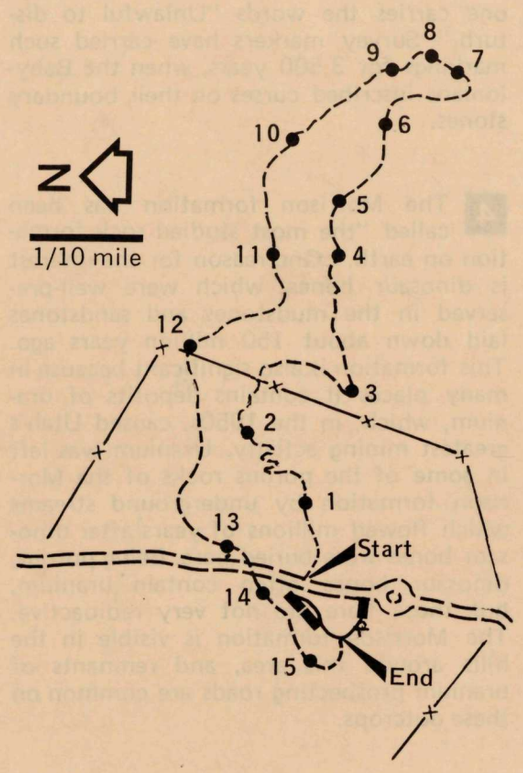
14 This "forest" of fiberglass posts marks drill holes where core samples were taken to determine the extent of the bone deposit, as explained in the quarry building. A graduate student who studied the cores determined that this area was probably a lake when dinosaurs died here, but that the level of the lake may have fluctuated widely. She also interpreted the cores as indicating a climate of alternating wet and dry seasons 148 million years ago.

15 Nearly all the rock layers visible from here were laid down flat, then carved by erosion. Therefore, it is possible to follow distinctive layers from hill to hill. The orangey ridge which protrudes to the



right of the beginning of the trail is the same layer as the limestones just above the bone layer in the quarry. You can also follow other rock layers between their outcrops.

This is the last marked stop on the rock walk. Soon the trail will intersect with the route to the visitor center. If you have questions about what you've seen, the ranger there will be happy to try answering them. Please returns this brochure; our supply is limited.



Canyonlands Natural History Association

125 W. 200 South • Moab, UT 84532 • 801-259-6003

Cleveland–Lloyd Dinosaur Quarry

ROCK WALK

Nature Trail Guide

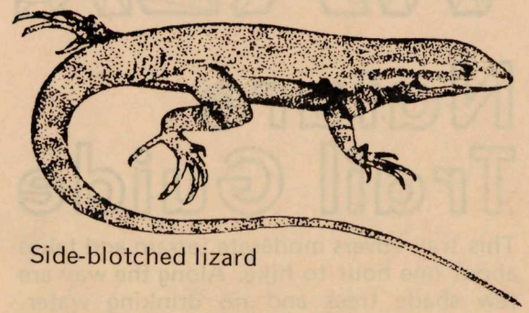
This trail covers moderate terrain and takes about one hour to hike. Along the way are few shade trees and no drinking water. Comfortable walking shoes and a full canteen are recommended.

Please do not begin walking the trail within one hour of closing time. The gate across the road to the quarry is locked at that time.

The trail begins by the quarry sheds and ends near the picnic area. As you walk from the sheds to the trailhead, you will step over the site where most of the Cleveland-Lloyd bone collection was unearthed. This area was excavated through 1965.

Underneath your feet along the trail is rock of the Morrison formation, a rock type which frequently contains dinosaur bones but rarely in such large accumulations as at this quarry. The Morrison formation was deposited during the Jurassic period, about 150 million years ago.

1 Embedded in the rock ledge to your left is a partial rib of a large sauropod dinosaur. Isolated fossils like this cannot tell us much alone, but are important in contributing to interpretation of the entire quarry deposit. This rib is in a rock layer below that which contains the main quarry; therefore, it probably was buried before the bones in the quarry were. The rib has been treated with a type of resin to protect it from weathering and moisture. If water filled its pores, the rib would crack when temperatures drop below freezing. Please do not touch it as it is very fragile.



Side-blotched lizard

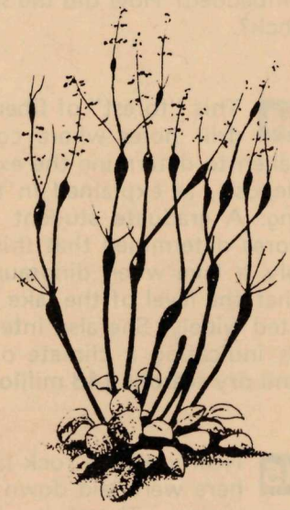
2 While the "terrible lizards" (dinosaurs) were dominating the earth, another type of lizard appeared. These were true lizards, small and similar to those you may see along the trail. After millions of years, dinosaurs became extinct -- but lizards lived on. No one knows precisely why lizards -- though never as dominant as dinosaurs -- were able to survive conditions that proved fatal to their now-fossilized cousins. Lizard varieties you may see here are: side-blotched, sagebrush, western whiptail, short-horned, and eastern fence lizard.

3 At your feet is a section corner marker, installed by U.S. surveyors to identify land using a rectangular grid system. A "section" is one mile square and, at this point, four section corners meet. For over 200 years the public lands of the U.S. have been laid out in sections, a system recommended by Thomas Jefferson. On the marker is the phrase "cadastral survey," which means that this marker establishes irrefutable boundaries of your public lands. The quarry boundaries were determined from this marker and others. Like most BLM survey monuments, this one carries the words "Unlawful to disturb." Survey markers have carried such markings for 3,500 years, when the Babylonians inscribed curses on their boundary stones.

4 The Morrison formation has been called "the most studied rock formation on earth." One reason for the interest is dinosaur bones, which were well-preserved in the mudstones and sandstones laid down about 150 million years ago. This formation is also significant because in many places it contains deposits of uranium, which, in the 1950s, caused Utah's greatest mining activity. Uranium was left in some of the porous rocks of the Morrison formation by underground streams which flowed millions of years after dinosaur bones were buried here. Being porous, dinosaur bones often contain uranium, but those here are not very radioactive. The Morrison formation is visible in the hills around this area, and remnants of uranium prospecting roads are common on these outcrops.

5 The black dinosaur bones you saw at the quarry were colored by the same mineral that tinted the dark rocks here. Manganese, often used as a coloring agent in paint, has coated the surface of these rocks, which are grayish inside. The black coating is called desert varnish and is common in all deserts where manganese, water, and sunlight affect hard rock surfaces. Prehistoric peoples etched pictures through the dark coating on rocks like these, revealing the lighter rock beneath. These works of art are called petroglyphs.

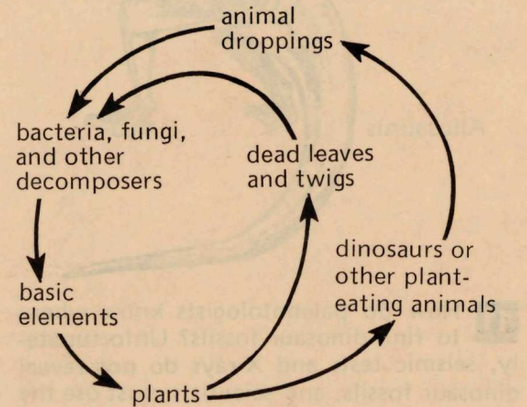
6 This knoll was excavated by paleontologists about 20 years ago. Most of a sauropod dinosaur was removed but fragments of fossilized bone are still visible on the surface. Also visible are bits of plaster used to jacket the fragile bones before removal, keeping them rigid much as a doctor's cast on a broken arm or leg does. (Permits are required to remove these or any dinosaur bones from public lands; violators are subject to a $500 fine and 90 days in jail.)



Tiny yellow flowers adorn the upper thread-like branches of the Desert trumpet, Eriogonum inflatum.

7 When dinosaurs lived here, there were few flowering plants or trees -- nothing like the broad-leaved poplars and box elders which now grow in the wetter parts of the desert. However, there were cone-bearing (conifer) trees related, though distantly, to this pinyon pine. The cones on pines take two years to develop, eventually resulting in the production of seeds. Look around for pinyon cones and round, nut-like seeds. With all of the seeds a pinyon produces, why are there so few trees?

8 Below this juniper tree are fallen needles, twigs, and animal droppings, which break down into smaller parts just as the soft parts of dinosaurs decomposed before their bones were buried. Bacteria, worms, ants, beetles, and fungi all help to reduce this natural litter to basic elements too small to see. These elements are then returned to the soil, where plants can use them for nourishment and growth. Some of the elements become part of whatever eats the plants, but eventually all the elements are returned to the soil where they can feed new plants. In this way, matter is recycled continuously. It is possible that in every living thing is an element once contained in a dinosaur's body.



9 In the distance to the east is a flat-topped range of mountains known as the Book Cliffs. Near the base of the cliffs is a layer of rock called the Blackhawk formation of the Mesa Verde group, from which 75 percent of Utah's coal is produced. In mines, dinosaur tracks are common. From tracks it is sometimes possible to tell that dinosaurs traveled in groups, as several sets of tracks may head in the same direction.

10 Of interest here are dark rocks with a "swiss-cheese" texture. This form occurs when water dissolves softer parts of a rock, leaving the more solid sections behind. This area has been covered by water several times in geologic history. Water brought in the particles (sediments)