8. WIDESPREAD DEPOSITIONAL PATTERNS

LOCATION

The five formations designated in the illustration below are widespread and can be viewed from many localities in the western United States. Figure 1 below is from the eastern shore of Steinaker Reservoir north of Vernal, Utah.

FIGURE 1. Five formations viewed above the eastern shore of Steinaker Reservoir. The lowest is the top part of the Jurassic Morrison Formation; the four formations lying above are Cretaceous.

DESCRIPTION

Some formations are small and local in geographical extent. On the other hand some are huge and extremely widespread. The five formations illustrated above are in the medium to very large range and all are examples of unusually widespread distribution.

MORRISON FORMATION

The Upper Jurassic Morrison Formation is most famous for its dinosaur remains. Its variegated (multicolored) mudstones and white, tan, and gray sandstones are characteristic. It can reach up to 450 m (1500') in thickness, although through most of its expanse it is more like 100 m (300') thick. It is spread over 1,000,000 km^2 (400,000 mi^2) (Fig.2). It has been divided into lateral and

Figure 2. Distribution of the Morrison Formation.

vertical subunits (Craig et al. 1956, Peterson and Roylance 1982, Peterson and Turner-Peterson 1987).

Fossils are rare in the Morrison. Dinosaur bones are found in localized massed accumulations mainly in some 20 localities such as the Cleveland Lloyd Quarry and Dinosaur National Monument. Other animal fossils include: crocodiles, turtles, fishes (primarily lungfish), frogs, salamanders, ostracods, snails, clams, and small primitive mammals. Plants are also rare and include large conifers (mainly logs) and small plant fragments. Palynomorphs (pollen and spores), which are also rare, suggest gingkos, ferns, lycopsids, and algae.

The Morrison is considered to represent a past environment of rivers and floodplains with possibly an increased tendency toward more lakes and deltas in later periods (Peterson and Roylance 1982). Some deposit by wind has also been suggested. There is no agreement as to whether there was a humid, dry, or varied climate in Morrison time (Dodson et al. 1980). Source of sediments for the Morrison is generally considered to have come from hills in the west, which included a volcanic arc. On the other hand, Yingling and Heller (1987) suggest a southwest source.

THE CEDAR MOUNTAIN AND BURROW CANYON FORMATIONS

Stokes (1944) proposed formational status to the Lower Cretaceous Buckhorn Conglomerate and also the Cedar Mountain Formation which are similar to the Morrison, and lie between the Morrison and the Dakota in the central-western part of the formation. To the east, formational status has been proposed for a Burrow Canyon Formation that is very similar to the Cedar Mountain Formation, and also lies between the Morrison and Dakota, but the difference between the two has been disputed. However, see Tschudy, Tschudy and Craig, 1984 for pollen differences.

From the standpoint of the depositional pattern we will consider these two similar deposits as one unit. They cover some 130,000 km^2 kilometers (50,000 mi^2). Thickness varies, but averages less than 60 m (200').

The Cedar Mountain-Burrow Canyon complex is considered to have been deposited by rivers. Fossils are rare and include snails, ostracods, dinosaurs, mammals, and a few plants, etc.

THE DAKOTA SANDSTONE (Formation or Group)

This Lower Cretaceous formation is very thin, often around 30 m (100') thick, with a maximum up to 220 m (700'). It is very widespread (Fig. 3), extending from Iowa to Arizona and

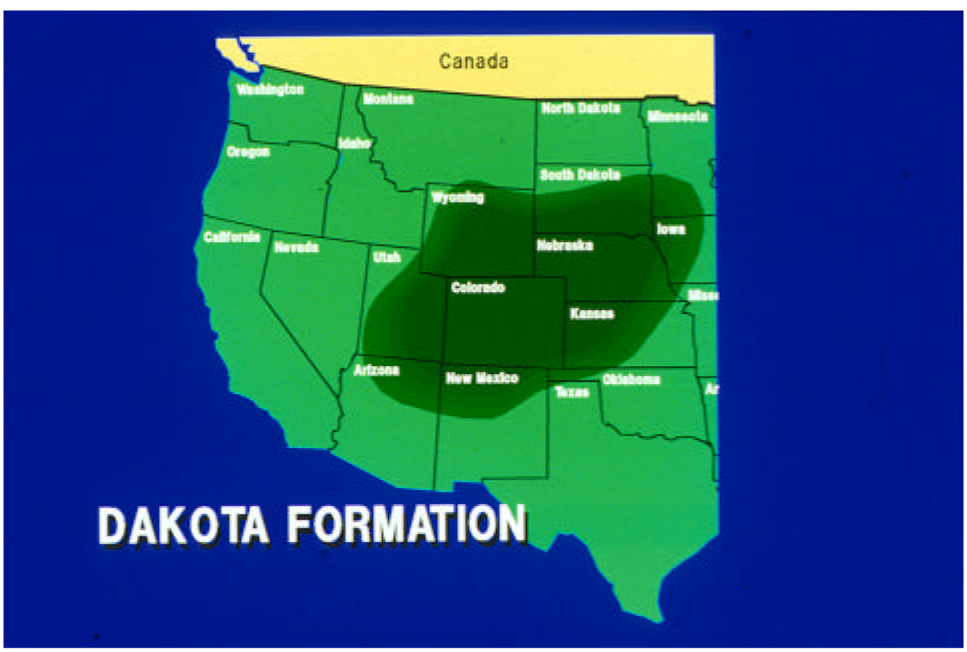

FIGURE 3. Distribution of the Dakota Formation.

from Montana to New Mexico, covering some 815,000 km^2 (315,000 mi^2). It is a mixed marine-and-land formation containing a great variety of fossil types such as leaves, coal, wood, dinosaurs, mammals, sharks and invertebrates.

The Dakota Formation is assumed to have been deposited in a variety of environments such as transgressive sea, river, lagoonal, and tidal environments. In the southwest it tends to consist of three units, a shale layer between two sandstone layers. It is a very thin layer and represents unusually flat depositional environments. Unusual energy levels may be necessary for such widespread distribution.

THE MOWRY SHALE

This Lower Cretaceous formation is characterized as a silver gray to tan shale that contains an abundance of fish scales. It is spread over much of Wyoming and beyond, covering some 250,000 km^2 (90,000 mi^2). Thickness varies from 10-300 m (30-1070') (Keroher et al. 1966, p. 2644-2646).

Fossils include fish, ammonites, foraminifera, worm tubes, marine reptiles, ferns. The Mowry is interpreted a having been deposited in an ancient sea associated with a large seaway to the east. It is part of the vast group of Cretaceous black shales now found on both continents and ocean floors that suggests a "Cretaceous anoxic event." It has also been proposed that the sandstone layers may have been deposited during sea level falls (Davis 1987).

FRONTIER FORMATION

This Upper Cretaceous formation consists of large tan sandstone units separated by gray shale units. It is up to 3000 m (10,000') thick, but mostly only a few hundred meters thick. It is spread over much of Wyoming, eastern Idaho, and beyond, covering some 300,000 km^2 (100,000 mi^2). Fossils include many marine invertebrates, and sharks' teeth; commercial coal beds in the eastern part reflect abundant plant material. It is interpreted as having been deposited in beach, near-shore marine, and coastal swamp environments. Deltas and proximal volcanic sources are also postulated. Marine sediments increase to the east. Its thinness and widespread distribution pattern represent an unusually flat environment unlike our usual continental deposits.

A CREATION-FLOOD PERSPECTIVE

The Morrison poses a number of puzzles which would be alleviated by a catastrophic flood model. These include:

1. For a unique continental (land) deposit the Morrison is very widespread (Figure 2). Could local deposition produce such a special thin, widespread formation? This seems very unlikely. Dodson et al. (1980) point out:

> *The enormous area covered by the Morrison sediments and the general thinness of the sedimentary sheet (being in most areas less than 100 m in thickness) indicate that the sediments were distributed by widespread flowing water.*

While the authors do not entertain the suggestion of a worldwide flood, their mode of spread reflects the type of activity expected for such an event.

2. Ancient channels of *major* rivers, which would help distribute the sediments over a wide area, have not been found in the formation.

3.The Morrison Formation appears to represent a vast but incomplete ecological system. It has been one of the world's richest sources of dinosaur fossils, yet plants are rare, especially in the vicinity of dinosaur remains (Dodson et al. 1980). What did the behemoths eat? The paleontologist Theodore White (1964) comments that "although the Morrison plain was an area of reasonably rapid accumulation of sediment, identifiable plant fossils are practically nonexistent." He further muses that by comparison to an elephant an apatosaurus dinosaur "would consume 3 ½ tons of green fodder daily." If dinosaurs were living there for millions of years, what did they eat if plants were so rare? Other investigators (Herendeen et al. 1994, Peterson and Roylance 1982, Peterson and Turner-Peterson 1987) have also commented on this lack of plant fossils. Brown (1946) states that the Morrison in Montana "is practically barren of plant fossils throughout most of its sequence," and others (Dodson et al. 1980) comment that the absence of evidence for abundant plant life in the form of coal beds and organic-rich clays in much of the Morrison Formation is puzzling." These investigators also express their "frustration" because 10 of 12 samples studied microscopically were essentially barren of the "palynomorphs" (pollen and spores) produced by plants. With such a sparse source of energy, one wonders how the large dinosaurs could survive the assumed millions of years while the Morrison Formation was being deposited.

4. To explain the dilemma, some have suggested that plants existed but did not get fossilized. This idea does not seem valid, since a number of animals and a few plants are well preserved. Perhaps the Morrison was not a place where dinosaurs lived. Instead, it might have been a flood-created dinosaur burial ground with plants sorted and transported by water elsewhere.

Paleontologists (Factovsky et al. 1997) report a similar situation for the dinosaur Protoceratops found in the central Gobi Desert of Mongolia. These investigators, studying various aspects of these Cretaceous deposits, conclude that "the abundance of unambiguous herbivore (protoceratops) and a rich trace fossil fauna [probably tubes made by insects] reflect a region of high productivity. The absence of evidence of well-developed plant colonization is, therefore, anomalous and baffling."

5. Also puzzling for a long ages model is the general absence of fish remains and diverse molluscan assemblages in deposits interpreted as "clearly lacustrine [lake] in origin" (Dodson et al. 1980).

A model of a worldwide flood with gradually rising and receding waters provides some answers to these questions. The flood-waters provided the widespread distribution of the sediments, and the animals did not live in the inhospitable environment inferred from the fossil picture.

It is difficult to appreciate how widespread these formations are compared to their thickness. The Morrison and the Dakota are especially intriguing. This can be illustrated by noting that proportionately for the maps of Figures 2 and 3, each formation would average less that 1/8 the thickness of the sheet of paper the map is printed on. Such incredibly thin layers, spread over such a wide area seem to indicate "widespread flowing water" as suggested by Dodson et al. (1980) for the Morrison. Also on a long-ages model for Earth, one has difficulty thinking of such a stable (flat) environment for the millions of years postulated to accommodate the deposition of these formations. During that time continents would be moving, and uplift and subsidence is suggested around the region to provide a source of sediment for the deposits and varied environments of final deposition. Also, one wonders if over many millions of years some erosion through these layers would not tend to break the widespread continuity and sequence we see for these five formations. Furthermore, laying such relatively thin and widespread layers requires incredibly flat topography to begin with, the likes of which we do not find anywhere on our present continents. Here we see evidence of activity of a different nature and scale than is common at present. High-energy factors and rapid action seem to have been involved in such widespread distribution of thin, unique sedimentary units.

A few geologists recognize the problem. Carlton Brett (2000), who believes in long geologic ages, states that "beds may persist over areas of many hundreds to thousands of square kilometers precisely because they are the record of truly extraordinary, oversized events. … The accumulation of the permanent stratigraphic record in many cases involves processes that have not been, or cannot be observed in modern environments. … there are the extreme events … with magnitudes so large and devastating that they have not, and probably could not be observed scientifically." This is specifically the kind of activity we would expect during the Genesis Flood.

COAL PARTINGS

Another widespread geologic feature, however on a much smaller scale, is coal partings. An example is the thin light colored layer at the tip of the red arrow in Figure 4. These partings are thin layers of grainy sediment that are found in the midst of much thicker coal seams. These coal partings challenge the commonly held view that our coal beds come from vegetation that grew where the coal is found. This is in contrast to the view that coal comes from transported vegetation. This latter interpretation is what would be expected during the Genesis Flood. One would not expect that our coal seams, and the coal partings we find therein, should have such horizontal continuity if the coal came from locally growing vegetation.

Steve Austin (1979) reports on how widespread these coal partings can be. In some of the coal mines in Kentucky, he reports on six coal partings that extend over 1,500 km^2 (580 mi^2). The

FIGURE 4. Coal parting, i.e. the fine gray layer at the tip of the red arrow within the thicker dark coal seam. The coal seam is about 40 centimeters (16 inches) thick.

FIGURE 5. Pebbles in a coarse portion of the Shinarump Conglomerate. The largest pebbles are in the 2 centimeter (1 inch) range.

widespread distribution of such thin layers requires extreme conditions such as we would expect during the Genesis flood.

THE EXTREMELY WIDESPREAD DISTRIBUTION OF SOME COARSE DEPOSITS

Also very anomalous are coarse deposits that would require extremely powerful forces to distribute them over the very wide areas we find. The Triassic Shinarump Conglomerate (sometimes called a member or formation) of the southwestern United States is an outstanding example. It covers over 250,000 km^2 (100,000 mi^2). Figure 5 illustrates some of the coarse pebbles one finds in the Shinarump, but it needs to be kept in mind that in some places it consists of only coarse sand. How did such a coarse deposit get distributed over such a wide area? The pebbles would have to be transported many hundreds of miles. Geologists usually state that the Shinarump was formed by rivers and streams, but how are rivers or streams going to carry pebbles over hundreds of miles when you have very little gradient. The Shinarump is usually less than 30 meters (100 feet) thick suggesting a very smooth topography over a very wide area. It appears that you are going to have to have catastrophic conditions to spread the Shinarump Conglomerate over such a wide area.

Other problematic deposits include the Buckhorn Conglomerate, the basal conglomerate of the Cloverly Formation in Wyoming and the Dakota Sandstone (Dakota Formation) which has a more varied lithology than the Shinarump, but is much more widespread. The geologist William Stokes (1960) has addressed this problem and suggests that these deposits may represent pediments. Pediments are the coarse deposits that accumulate at the base of mountains as debris from the mountains accumulates over time. This is no solution. The tiny pediments that we normally find at the base of mountains are no match for the extremely flat thin widespread coarse sedimentary units we find in the sedimentary record. Catastrophic activity, such as we might expect during the Genesis Flood is a more likely explanation.

REFERENCES

Austin S.A. 1979. Evidence for marine origin of widespread carbonaceous shale partings in the Kentucky No. 12 Coal Bed (Middle Pennsylvanian) of western Kentucky. Geological Society of America, Abstracts With Programs 11(7):381-382.

Brett, C.E. 2000. A slice of the “Layer Cake”: The paradox of “Frosting Continuity.” Palaios 15:495-498.

Craig, L. C., C. N. Holmes, R. A. Cadigan, V. L. Freeman, T. E. Mullens, and G. W. Weir. 1956. Stratigraphy of Morrison and related formations, Colorado Plateau region, a preliminary report. U.S. Geological Survey Bulletin 1009.

Dodson, P., A. K. Behrensmeyer, R. T. Bakker, and J. S. McIntosh. 1980. Taphonomy and paleoecology of the dinosaur beds of the Jurassic Morrison Formation. Paleobiology 6:208-232.

Fastovsky, D.E., D. Badamgarav, H. Ishimoto, M. Wataabe, and D. B. Weishampel. 1997. The paleoenvironments of Tugrikin-Shireh (Gobi Desert, Mongolia) and aspects of the taphonomy and paleoecology of *Protoceratops* (Dinosauria: Ornithischia). Palaios 12:59-70.

Herendeen, P. S., P. R. Crane, S. Ash. 1994. Vegetation of the dinosaur world. In: Rosenberg, G. D. and D. L. Wolberg, editors. Dinofest. Paleontological Society Special Publication No. 7. Knoxville, Tenn.: Department of Geological Sciences, University of Tennessee, pp. 347-364.

Keroher, G. C. et al. 1966. Lexicon of geologic names of the United States for 1936-1960. Part 1, A-F. U.S. Geological Survey Bulletin 1200.

Peterson, L. M. and C. E. Turner-Peterson. 1987. The Morrison Formation of the Colorado Plateau: recent advances in sedimentology, stratigraphy, and paleotectonics. Proceedings of the North American Paleontological Conference IV. Hunteria 2(1):1-18.

Peterson, L. M. and M. M. Roylance. 1982. Stratigraphy and depositional environments of the Upper Jurassic Morrison Formation near Capitol Reef National Park, Utah. Brigham Young University Geology Studies 29(2):1-12.

Stokes, W. L. 1960. Pediment concept applied to Shinarump and similar conglomerates. Bulletin of the Geological Society of America 61:91-98.

Stokes, W. L. 1944. Morrison Formation and related deposits in and adjacent to the Colorado Plateau. Geological Society of America Bulletin 55:951-992.

Tschudy R. H. Tschudy B. D. and Craig L. C. 1984. Palynological Evaluation of Cedar Mountain and Burrow Canyon Formations, Colorado Plateau. U.S. Geological Survey Professional Paper 1281.

White, T. E. 1964. The dinosaur quarry. In: Sabatka, E. F. editor, Guidebook to the geology and mineral resources of the Uinta Basin. Salt Lake City: Intermountain Association of Geologists, pp. 21-28.

Yingling, V. L. and P. L. Heller. 1987. Sedimentation prior to, and during, initial thrusting in the Sevier orogenic belt, east-central Utah. Geological Society of America Abstracts with Programs 19:344.