Sedimentology and Stratigraphy of the Morrison Formation in Dinosaur National Monument

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The objective of this study is to establish a stratigraphic, sedimentologic, and geochronologic framework of the Upper Jurassic Morrison Formation within Dinosaur National Monument, and to tie this framework to the rest of the Colorado Plateau and other important fossil-bearing localities. The study is designed to complement ongoing paleontological inventories of the Morrison Formation within the Monument. During the first field season, emphasis was placed on beginning detailed stratigraphic and sedimentologic work and the collection of samples for various types of analyses.

✦ Methods

The primary tool in stratigraphic and sedimentologic studies is the measured section, in which observations and data are recorded systematically in a vertical transect through the formation. Samples are collected and tied into the sections for precise stratigraphic positioning. During the first field season, two detailed sections of the entire Morrison Formation and one section of the lower part of the formation were measured and described. In addition, one section of the overlying Lower Cretaceous Cedar Mountain Formation was measured. The sections of the entire Morrison Formation were measured near the Quarry, and in Deerlodge Park, near the eastern boundary of the Monument. A partial section of the Morrison was measured in Rainbow Draw, a locality about 16 km northeast of the Quarry. The section of the Cedar Mountain Formation was measured near the Quarry, at the same locality as one of the complete sections of the Morrison. Thicknesses, rock types, colors, textures, bedding types, sedimentary structures, erosion surfaces, and fossil occurrences were recorded at each locality. Localities were chosen for the quality of exposure and for geographic distribution within the Monument.

The types of samples that were collected varied, depending on the purpose. Bentonite beds (altered volcanic ash) were sampled extensively, for the purpose of isotopic dating of mineral grains within these beds. The isotopic dating will provide a more accurate age of the formation and various members within it than is currently known. This will help in correlating to other areas outside of the Monument--one of the goals of the project. Coalified organic matter was collected at several localities for vitrinite reflectance analysis in order to help determine the thermal history of the rocks and the maximum depth of burial that the rocks experienced. Organic-rich mudstones were also collected because these beds often yield spores and pollen that provide biostratigraphic and paleoecologic information. The spores and pollen provide a paleontological means of

dating the Morrison Formation, which will complement the isotopic dates from bentonite beds. Other samples were collected because they contain a variety of invertebrate fossil remains, including gastropods, conchostracans, and charophytes. These samples will be distributed to appropriate specialists for more detailed analysis and interpretation.

Studies were made on crossbedding in fluvial and eolian sandstone beds the Morrison and Cedar Mountain Formations. For the fluvial beds, these studies will show the orientation and direction of flow of the streams. For the eolian beds, the studies will show the direction of prevailing winds during Morrison deposition.

✦ Preliminary Results and Interpretations

During the first field season we were able to recognize four members in the Morrison Formation in the Monument. Based on these data, the Morrison in the Monument can be correlated, on a member by member basis, to the Morrison Formation farther south on the Colorado Plateau and in Wyoming. The members include, from base to top, the Windy Hill, Tidwell, Salt Wash, and Brushy Basin Members. Another result was the recognition of a stratigraphic marker--the welded chert zone in the Tidwell Member--that is recognized in the Morrison Formation throughout much of the Colorado Plateau.

Forty-nine bentonite samples were collected during the first field season, all of which are tied into the two detailed measured sections. Forty-six of the bentonites are from the Brushy Basin Member, which typically contains numerous bentonites. The remaining 3 samples were collected from the Tidwell Member, an interval that typically does not contain bentonites. The discovery of bentonites in the Tidwell should enable us to date the base of the Morrison by isotopic methods, which we had not thought was possible when this study was initiated. The Brushy Basin Member samples, comprising the upper half of the formation in the Monument, will provide dates from the middle and upper parts of the formation. Detailed resolution based on isotopic dating methods, which we had hoped would provide a means of detailed correlation within the Monument, may not be possible based on preliminary age determinations on bentonites elsewhere in the Colorado Plateau region. Preliminary ages determination indicate that the Brushy Basin Member was deposited over such a short time period that isotopic dating techniques may not be able to resolve very fine time increments.

Preliminary results also indicate that bentonite beds at the Deerlodge Park section contain significantly less biotite than the bentonite beds at the Quarry section. We interpret this toindicate a downwind decrease in the abundance of airfall grains in volcanic ashes that were carried eastward by prevailing westerly winds in the Late Jurassic. This is consistent with the observation that the Morrison formation along the Front Range in east-central Colorado, is completely lacking in bentonite beds.

Preliminary examination of low-level oblique aerial photographs of the Morrison Formation suggest that the Brushy Basin Member does not contain a significant amount of fluvial sandstone beds. This observation is consistent with the observations made while measuring stratigraphic sections; and suggests that even though some of the mudstone in the member is overbank or floodplain in origin, some of the mudstone may have been deposited in lake environments. Laminated units within the member seem to confirm this tentative conclusion.

Preliminary examination of crossbedding dip-vector measurements in fluvial beds of the Salt Wash Member suggests that the streams that deposited this member flowed in a southeasterly direction across the Monument area. Preliminary examination of similar measurements, collected from eolian beds in the Salt Wash Member in the Deerlodge Park area, suggest that the prevailing winds were westerly, which is consistent with paleowind directions for eolian beds in the Morrison Formation elsewhere in the Colorado Plateau region.