Sedimentology and taphonomy of a shell bed assemblage from the Upper Cretaceous (Maastrichtian) Hell Creek Formation of eastern Montana
by Bentley Edward Shoup

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Earth Sciences
Montana State University

Abstract:
Aggregate shell bed accumulations within coastal marine sediments are numerous and . have been thoroughly studied. In contrast, terrestrial shell bed assemblages have received less attention due to their paucity within the existing strata. Such terrestrial shell bed assemblages provide a wealth of data concerning paleoenvironments, paleobiology, potential hydrocarbon reservoirs and diagenetic processes. A channelized shell bed discovered in the Upper Cretaceous Hell Creek Formation contains thousands of specimens representing 8 genera with 20 recognized species. This shell bed provides valuable insight into the paleoecologic and sedimentologic systems of the Hell Creek Formation.

Field data was collected during the summer of 2000. Geologic data was collected for regions laterally and vertically contiguous with the shell bed. Seventeen different lithofacies were identified in the study area on the basis of grain size and sedimentary structures. Lithofacies associations were subsequently determined for the characterization of depositional environments. Architectural element analysis was employed to aid in the recognition of discrete depositional facies. Taphonomic data was collected within the shell bed with a primary focus on the molluskan fauna present. Data collection included taxonomic identification, shell articulation and modification, and shell orientation.

Three distinct deposystems are recognized within the study area. The first is a fluvially dominated channel belt with tidal influence. Moving up-section, the second deposystem is characterized by a transgressing lacustrine system with subsequent clastic infilling. The youngest deposystem represents anoxic small lake and backswamp environments with limited clastic input and significant organic accumulation. The shell bed represents the basal member of a channelized turbidite sequence. Taphonomic and geologic data suggest that the shell bed formed from an event concentration with minimal time-averaging. A high degree of preservation is recorded by a vast majority of the shells.

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APPROVAL

of a thesis submitted by

Bentley Edward Shoup

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

Aggregate shell bed accumulations within coastal marine sediments are numerous and have been thoroughly studied. In contrast, terrestrial shell bed assemblages have received less attention due to their paucity within the existing strata. Such terrestrial shell bed assemblages provide a wealth of data concerning paleoenvironments, paleobiology, potential hydrocarbon reservoirs and diagenetic processes. A channelized shell bed discovered in the Upper Cretaceous Hell Creek Formation contains thousands of specimens representing 8 genera with 20 recognized species. This shell bed provides valuable insight into the paleoecologic and sedimentologic systems of the Hell Creek Formation.

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CHAPTER 1

INTRODUCTION

Studies of large shell bed accumulations in coastal marine deposits are numerous (Fursich and Flessa, 1987; Kidwell and Bosence, 1991; Kidwell,1991). However, in the terrestrial realm large accumulations of shelly fauna receive less attention. This is unfortunate, in that such shell deposits may provide a wealth of information regarding depositional environments (Elliot, 1978), implications for paleobiologic populations (Hartman and Kihm, 1996), and even reservoir data in exploration for hydrocarbon resources (Chatfield, 1972). Terrestrial depositional settings lack extensive lateral continuity of individual deposits. For this reason, large shell bed accumulations are inherently useful as both stratigraphic position markers and tools for unraveling deposystems (Russell, 1976). However, the paucity of literature dealing with terrestrial shell beds may simply be a reflection of the scarcity of such deposits. Taphonomic processes that affect such shell accumulations play a commanding role in their potential for preservation.

The taphonomic history of a shell accumulation is successfully reconstructed by interpreting specific features of the shells themselves, in addition to characterizing the depositional environment (Behrensmeyer and Kidwell, 1985). A confident interpretation of the depositional environment begins with a detailed lithofacies analysis of the shell-bearing unit, as well as all the surrounding strata (LaRock, 2000). Associations of these lithofacies are subsequently used to characterize the depositional setting of the shell accumulation. In understanding the processes of accumulation, inferences may be made

concerning paleo-ecosystems. In an attempt to obtain the most useful information from the assemblage, detailed investigation of the shells must be undertaken while they remain *in situ*.

Individual shells and small shell assemblages are common in the Upper Cretaceous Hell Creek Formation (Maastrichtian) of Montana. Many of these occurrences were initially described in the early 1900's when the geology and paleontology of the formation was first explored (Brown, 1907). However, large cumulate shell beds are much less common, especially when associated with vertebrate remains and a noticeable amount of organic material. To date, little to no work has been done on large shell accumulations in the Hell Creek Formation with respect to paleoecologic implications. In the 1999 field season of the Hell Creek Project in association with the Museum of the Rockies, a very conspicuous shell assemblage was discovered. Such an assemblage provokes interest in the sedimentary processes that occurred, taphonomic features responsible for preservation, and implications for the paleoecology of the system.

The purpose of this study is to determine the depositional environment and taphonomic processes responsible for the accumulation of the shell bed. In specific, goals addressed by this research include determining: (1) the depositional environment of the shell bed as well as laterally and vertically contiguous strata by implementing detailed lithofacies analysis, (2) the stratigraphic position of the shell bed with respect to the K-T boundary (Z-coal), (3) degree of shell modification, (4) process(es) responsible for the shell accumulation, (5) amount of time represented by the assemblage.

Location and Geologic Setting

The shell bed is located on Bureau of Land Management property adjacent to the Charles M. Russell Wildlife Refuge in Garfield County, approximately 24 miles north of Jordan, Montana and about 3.5 miles south of the Hell Creek Recreation Area on Fort Peck Reservoir (Figure 1). The shell bed is exposed in badlands topography at the base of a large domed hill immediately to the west of the unimproved School Section Divide Road (Figure 2).

Stratigraphically, the shell bed is located in the Upper Cretaceous (Maastrichtian) Hell Creek Formation, deposited during the final stages of the Cretaceous Period (Figure 3). The formation is exposed around the Fort Peck Reservoir in eastern Montana (Figure 4), and represents a regressive systems tract of the Western Interior foreland basin in terms of sequence stratigraphy of continental strata (Kaufman and Caldwell, 1993; Shanley and McCabe, 1994). During the transition from Cretaceous to Tertiary time, a combination of forced regression and loss of accommodation space limited sediment progradation. Sediments within the Western Interior basin began to aggrade. The sediment supply to the basin also decreased during this transition, reflected by an increase in organic sedimentation with the respective decrease in terrigenous clastic sedimentation (Ayers, 1986). A paleoenvironmental change is observed in the stratigraphy from a fluvially dominated to a swampy lacustrine system in the upper third of the section.

The Hell Creek Formation as whole is time-transgressive, demonstrating minimal lateral continuity of strata. The formation is bounded below by the Cretaceous Fox Hills Sandstone and above by the Tertiary Tullock Formation in eastern Montana (Figure 3).

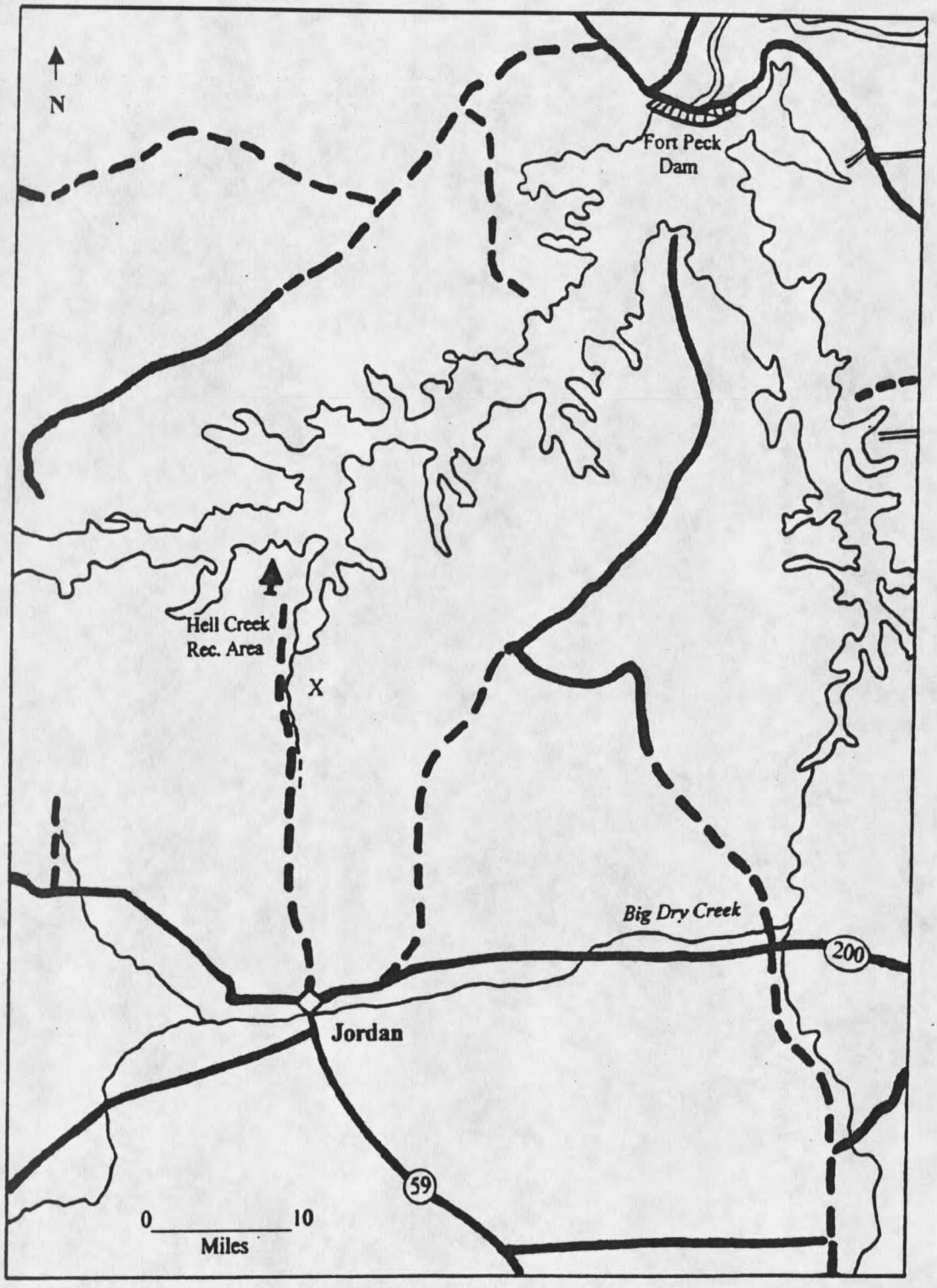

Figure 1. Regional location of the shell bed (X) in eastern Montana.