Depositional Patterns and Stratigraphic Relationships in a Sag Basin: Middle Jurassic Gypsum Spring, Piper and Sundance Formations, NW Wyoming

Clark Gilbert
Faculty: William Parcell

Department of Geology

Abstract. The Middle Jurassic Gypsum Spring, Piper and Sundance Formations of Wyoming are marine and evaporite deposits formed in a shallow epeiric sea east of an overthrust belt that existed near the western margin of North America. Lithofacies distribution was influenced by sag basin tectonics related to this continental collision. Resolving the stratigraphic relationships within these units provides insight into the interaction between global sea level change, regional tectonics, and local depositional facies distribution. Through the integration of lithostratigraphy, allostratigraphy and sequence stratigraphy, we seek to determine the origin and distribution of lithofacies and unconformities to better understand the timing of deposition as it relates to sea level change and tectonism.

Introduction

Intracratonic sag basins are structural features created by water and sediment loading that flexes the lithosphere downward to accommodate the load [1]. Jurassic tectonic features like the Sheridan Arch and the Black Mountain High (Nevadan Orogeny effects) may have affected deposition resulting in localized stratigraphic variability and pinchouts. Critical to resolving the stratigraphy of these units is the recognition of regional horizons marking times of erosion or nondeposition (unconformities). To date, the location and origin of unconformities in these units have proven difficult to resolve. Locating these unconformities will provide insight into the relationship between the timing of these tectonic events and deposition of the strata. Such information provides a better framework for studying Jurassic paleoenvironments and paleoclimate.

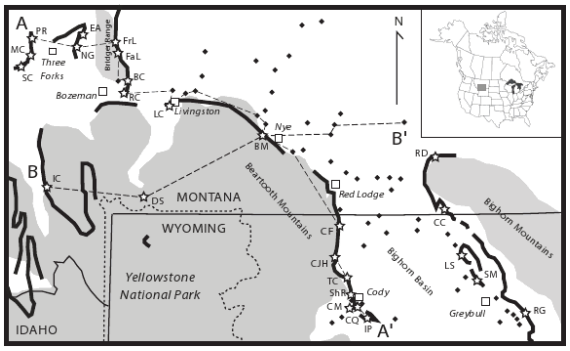

Figure 1: Map of study area.

Discussion

The Gypsum Spring Formation has three distinct members with differing lithologies. The lower member consists of soft red shale and mudstone interbedded with gypsum, with a thick layer of gypsum at its base separating it from the Triassic Chugwater Formation below. The middle member consists of thin layers of grayish green shale and limestone, often fossiliferous. The Piper Formation is similar to the lower member of the Gypsum Spring with soft red shale but only minor amounts of gypsum. The Sundance Formation is organized into two members and the base is a thin oolite layer displaying transgressive surface. The lower Sundance is composed of soft, light greenish-yellow marine shale with some thin beds of limestone, oolites and sandstones. The upper Sundance is mostly yellow, calcareous, glauconitic cross-bedded sandstones, but lies above the Middle Jurassic section.

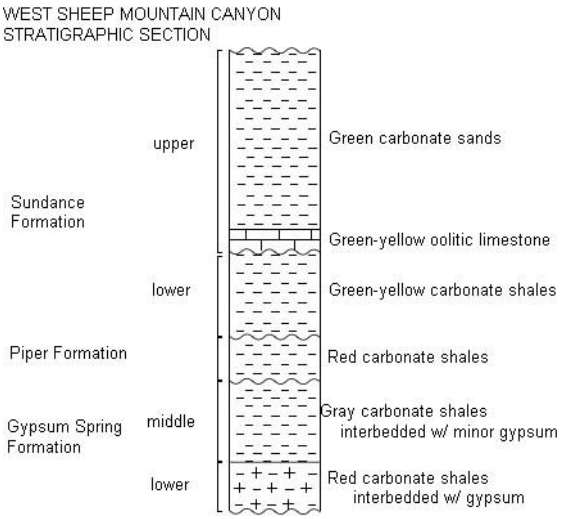

Figure 2: Stratigraphic column of the Gypsum Spring, Piper and Sundance Formations at West Sheep Mountain Canyon outcrop.

The shales of the lower member of the Gypsum Spring Formation were deposited in sabkhas and shallow marine waters on the western edge of the continent. Intense evaporative conditions were present which allowed the precipitation of large gypsum deposits. The middle member and Piper Formation represent a minor marine transgression [2]. The Sundance Formation represents marine transgression, with the depositional environment fluctuating between near shore shallow marine and occasional supratidal environment. The presence of ooids represents high energy conditions in certain areas.

Within the section exists four unconformities which previous workers have named J_1-J_5 (J_3 not present in the Bighorn Basin) [3]. These unconformities represent fluctuations in eustatic sea level or tectonic uplift of the underlying strata. Many of them are difficult to indentify in outcrop and have been disagreed upon for decades.

Conclusions

The lithofacies changes in the studied section represent fluctuating eustatic sea level. The section studied on average shows transgression of a Jurassic sea onto the continent. These changes and the minor oscillations represented by cycles in the section show possible changes in paleoclimate from greenhouse to icehouse conditions. Also, some of the unconformities represent uplift and erosion due to tectonics. The time represented by the section displays the basin shape changing from a symmetrical intracratonic sag basin into a more asymmetrical foreland basin showing the effects of a collision with an island arc on the western margin of the North American continent. With future studies, we hope to gain additional insight into the relationships between tectonics, paleoclimate and sedimentation during the Middle Jurassic.

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References

[1] Allen, P. A. and J. R. Allen (1990). Basin analysis: principles and applications, Wiley-Blackwell.
[2] Schmude, David E. "Interplay of Paleostructure, Sedimentation and Preservation of Middle Jurassic Rocks, Bighorn Basin, Wyoming." The Mountain Geologist 4th ser. 37.October (2000): 145-55. Print.
[3] Kvale, E. P., A. D. JOHNSON, et al. (2001). "Middle Jurassic (Bajocian and Bathonian) dinosaur megatracksites, Bighorn Basin, Wyoming, USA." Palaios 16(3): 233.
Figure 1: Taken from Parcell, W.C., and Williams, M.K.*, 2005, Mixed-sediment deposition in a retro-arc foreland basin: Lower Ellis Group (M. Jurassic), Wyoming and Montana, U.S.A.: Sedimentary Geology, v. 177, p. 175-194.