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High resolution analysis of the depositional processes, environment, cyclicity and source of sediment of the Juana Lopez Member of the Mancos Shale, New Mexico

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Summary

Global energy consumption is expected to increase 28% by the year 2040, with fossil fuels accounting for more than 75% of this demand. As advanced drilling methods progress, focus has shifted from conventional sandstone and carbonate reservoirs to heterolithic units for oil and gas exploration. These unconventional reservoirs are more recently thought to have a substantial impact on total hydrocarbon exploration. In order to better predict where these reservoirs are lying in the subsurface, one must better understand the depositional processes involved in the formation of these beds. The depositional environment is also a crucial component to this type of research. There is less high-resolution work done on mudstones and therefore they are not as well understood as sandstones. This type of analysis requires mm to cm scale analysis of both outcrops and cores. Ancient deposits are studied to be able to model subsurface predictions of siliciclastic hydrocarbon reservoirs. This is done by characterizing ancient and modern systems, which represent potential reservoir analogues.

This study is a detailed facies analysis of the Turonian Juana Lopez Member of the Mancos Shale in Shiprock, New Mexico. This unit was deposited along the western shoreline of the Upper Cretaceous Western Interior Seaway. Data for this study was collected from three, 50 metre outcrops exposed in the San Juan basin, northwest of Shiprock (figure1). A centimetre scale data collection was performed on all three measured sections and were correlated across 6.35km. The high resolution analysis of the Juana Lopez Member reveals it is dominantly deposited as a result of hypopycnal plumes, hyperpycnites and turbidites. The Juana Lopez Member is identified as being an overall upward coarsening regressive deposit, which is laterally continuous across several kilometres. There are 21 upward coarsening parasequences identified and 11 bentonite beds used as isochronous datums. There is some evidence suggesting the presence of Milankovitch cyclity, however we are currently awaiting absolute dates (+/- 20Ka) from Argon-Argon dating of sanidine crystals extracted

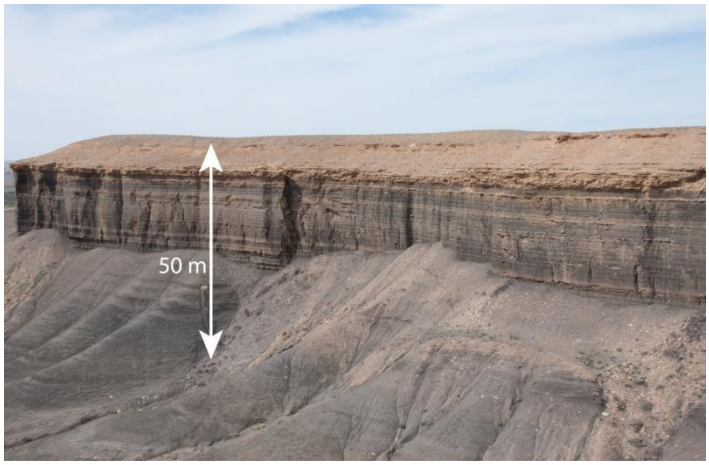

Figure 1: Photo of exposed Juana Lopez Member of the Mancos Shale. Pictured is the MS1 Outcrop Exposure.

from bentonite samples. If confirmed, this would be strong evidence suggesting the presence of ice sheets at the poles during the Cretaceous.

Detailed facies architecture, trace fossils and biostratigraphic analysis of the Juana Lopez Member places this unit in a middle to late Turonian offshore, shallow marine environment, moving into the offshore transition zone and finally moving into a distal pro deltaic facies succession. Ammonite species identified in the biostratigraphic analysis include *Prionocyclus macombi, Prinonocyclus wyomingensis*, and *Scaphites whitfieldi.* Inoceramid species include *Inoceramus dimidius* and *Inoceramid perplexus.* Other notable fossils include teeth from *Ptychodus whipplei*, *Scapanorhynchus rephiodon*, *Squalicorax falcatus* and *Cretodus semiplicatus*. The Notom delta clastic wedge of the Ferron Sandstone is suggested to have had the largest influence on the Juana Lopez Member, based on biostratigraphy and paleocurrent data. It is suggested to have been the primary sediment source as the counterclockwise oceanic current of the Western Interior Seaway carried the sediment south to southeast of the channel mouth and deposited it in the basin. The presence of *S.whitfieldi* in the uppermost portion of the Juana Lopez as well as in the late Turonian tongue of the Gallup Sandstone suggests a second influence on the deposition of the Juana Lopez. The Juana Lopez is likely to have had multiple clastic inputs in the middle to late Turonian forced regression, as it accumulated in the San Juan Basin.

Significance of Research

Understanding how heterolithic units, such as the Juana Lopez, are deposited and their associate paleoenvironment is crucial to understanding reservoir characteristics. This study has broad applications including better predictions of facies architecture from limited data as well as the use of this data in a stratigraphic approach to reservoir modeling and hydrocarbon exploration. It also suggests the presence of Milankovitch cycles in the Cretaceous, which is evidence for the existence of ice sheets at the poles during this period, which remains a very controversial topic.

Future Research

Future work on the Juana Lopez is currently underway focusing on the biostratigraphy and will be extended to include the Gallup Sandstone Formation. This will be a regional biostratigraphy and chronostratigraphy project across the San Juan Basin. Argon-Argon dating of sanidine crystals of the bentonite samples collected throughout the Juana Lopez and the Gallup Sandstone is almost complete, with results coming in early 2019. This will be crucial to this analysis as we will be integrating biostratigraphy with geochronology to place time constraints on the parasequences to help determine Milankovitch cyclicity in the Cretaceous Greenhouse Earth.

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