A Multi-scale Analysis and Stratigraphy of Microbialites of the Lower Ordovician of Central Missouri and Kansas*

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Abstract

Microbialites are useful paleoenvironment indicators as well as proven hydrocarbon reservoirs. This study focuses on the depositional environments and stratigraphic distribution of Lower Ordovician microbialites in central Missouri as outcrop analogs to subsurface reservoirs in Kansas. The units represented in the vicinity of Westphalia, Missouri include the Roubidoux and Jefferson City Formations. To determine the depositional environments suitable for microbialite development, we are currently examining the micro, meso, and macro-scale features of these structures and their relationship to surrounding lithologies.

These microbialites were deposited in a shallow marine environment and are grouped into two cycle types. Type 1 deposits include 1) subtidal deposits of very coarse crystalline dolomite with green shale grading upward to intertidal stromatolites, 2) subtidal deposits of channel sandstones grading upward to intertidal stromatolites, 3) subtidal deposits of oolitic pack/grainstone grading upward to intertidal stromatolites, and 4) subtidal green mudstones that grade upward to intertidal blocky, very fine crystalline dolomite or intertidal deposits of elongated chert nodules. Type 2 deposits include subtidal sediments of medium to fine crystalline, mottled dolomite that grade upward to supratidal deposits containing cauliflower chert (possibly replacing supratidal evaporite) and brecciated chert.

Most Arbuckle reservoirs drilled in Kansas are located in the upper karsted zones. Outcrop analogs indicate that potential microbialite reservoirs
Porosity and permeability studies of Missouri and Kansas microbialites are used to investigate this reservoir quality and conduct a comparison study. Porosity within Missouri microbialites includes intercrystalline, fenestrae, and vuggy porosity. Elevated permeabilities are associated with “laminar” vuggy porosity.
A Multi-Scale Analysis and Stratigraphy of Microbialites of the Lower Ordovician Strata of Central Missouri

ABSTRACT

Microbialites are useful paleoenvironmental indicators as well as proven hydrocarbon reservoirs. This study focuses on the depositional environments and stratigraphic distribution of Lower Ordovician microbialites in central Missouri. A multi-scale approach to subsurface reservoirs is key. The units were identified using the Victoria No. 1 Reservoir and the Jefferson City Formation. For these units, a depositional environment suitable for microbialite development was considered. This was interpreted using the micro-scale and macro-scale features of these structures and their relationship to surrounding terranes.

These microbialites were deposited in a shallow marine environment and are grouped into two major types. Type 1 deposits include: (1) vuggylichens made up of very coarse crystalline dolomite with green algae growing around shell fragments, (2) subtidal deposits of channel sandstones growing intertidally on stromatolites, (3) subtidal deposits of pelagic ooids growing above intertidal stromatolites, and (4) radiolarian crinoidal packstones that grade upward to intertidal blankly very fine crystalline dolomite to intertidal deposits of biogravelly chert. Type 2 deposits include intertidal echinoid and bioclastic packstones that grade upward to intertidal blankly very fine crystalline dolomite to intertidal deposits of biogravelly chert. These deposits are characterized by their presence in the lower Ordovician strata of Central Missouri.

THE MACRO-SCALE (10km²)

Consists of 10-20 individual microbialites. The bigger microbialites are about 300 km² in size. Most microbialites have a large exposed surface with a vertical extent at the center of the microbialite.

THE MESO-SCALE (100m²)

Consists of 5-10 individual microbialites. The Smaller microbialites are about 300 km² in size. Most microbialites have a small exposed surface with a horizontal extent at the edge of the microbialite.

THE MICRO-SCALE (10m²)

Consists of 5-10 individual microbialites. The Smaller microbialites are about 300 km² in size. Most microbialites have a small exposed surface with a horizontal extent at the edge of the microbialite.

INTRODUCTION & GEOLOGICAL SETTING

The study area is a complex of the Rocheuses and Jefferson City formations of the Lower Ordovician time interval. The newly recognized microbialite formations began during the Late Ordovician time interval of the Rocheuses and Jefferson City formations. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri. The study area is located in the Jefferson City area of central Missouri.
THE MACRO-SCALE (10⁻¹ m)

Consists of hemispherical biostromes of stromatolites and thrombolites. According to these microbiotas that outcrop in Missouri, these biostromes range from about 1.7m to 2m width with a depth of about 1m to 3m.

THE MESO-SCALE (10⁻² m)

Consists of SH-C and SH-V type stromatolites. The constant base stromatolitic heads are about 0.1m high and 0.4m wide, while the variable base stromatolites are about 0.2m high and 0.02m wide. The thrombolitic cliffs are about 0.02m to 0.03m in height and width. At this scale-level, stromatolites are laterally laminating and thrombolites are dendritic or columnar.

THE MICRO-SCALE (10⁻³ m)

This is the scale at which the algal laminates and clotting of the microorganisms can be seen. Most of these strata usually occur within dolomitic wackestones to packstones. Laminations of the stromatolites can be seen as alternating dark and light layers or between a micritic layer and coarser dolomite. Some of these layers tend to exhibit "laminate" porosity while others do not. Micro-fossils and silt are what usually get trapped within laminite or clasts, or between microscopic bioturbations.

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The goal of this study was to characterize the different scales at which microbialites occur in Missouri in the Roubidoux and Jefferson City Formations. Thus, based on this study, these microbialites have been much more easily recognizable at the meso-scale level unless you are looking at 3mm high bioherms. However, the micro-scale level is useful in identifying the work of the bacteria or algae as they create algal clots and algal laminae which at the macro- scale and meso-scale, they just look like laminations. Some of the thin sections show presence of Girvanella sheaths that may have helped in the growth of these microbialites.

Further research is being conducted on the surrounding environments that help to understand why these microbialites grow at varying scales and place these microbialites in a sequence stratigraphic framework.

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