Sedimentology and Diagenesis of Mississippian (Kinderhookian and Osagean: Tournaisian and Visean) Reefs in Southwest Missouri, Northwest Arkansas, and Northeast Oklahoma

Beau T. Morris
Faculty: Salvatore J. Mazzullo

Department of Geology

Abstract. Reefs within the Kinderhookian Compton and basal Osagean Pierson formations are interpreted to have formed on aggradational to progradational distally-steepened ramps, respectively. Pierson reefs are mainly layered bafflestones, containing abundant fenestrate bryozoans and crinoids, capped by crinoid grainstones. They are interpreted to have been deposited in a relatively shallow, high-energy environment. Compton reefs are hybrid mud-dominated lithoherms/fenestrate bryozoan-crinoid muddy bafflestones. Interpreted to have been deposited in low-energy, deeper-water environments than the Pierson reefs. The lithoherm/bafflestone reefs were uplifted and subaerially exposed in mid-Compton time. Meteoric-dissolution vugs formed and were floored by crystal silt and occluded by coarse calcite cement. Then the reefs were dislodged and redeposited to the north within thick sections of upper Compton that downlapped an intraformational exposure surface.

INTRODUCTION

Reefs are components of many carbonate depositional systems. The origins, biotic composition, site of formation, and diagenesis of modern and ancient reefs have been described by many workers (e.g., [2]; [4]; [5]). Such modern and ancient reefs are of significant disciplinary value owing to the facts that carbonate production is basically organic [5], and reefs record vast amounts of sedimentologic, paleontologic, and geochemical data [4]. Furthermore, reefs of various ages (including Mississippian) with the appropriate architecture buried within the subsurface contain a disproportionately large amount of oil and gas reserves compared to other sedimentary deposits [4]. Hence, interpreting sedimentologic and diagenetic attributes of reefs is important in evaluating whether they may be viable petroleum exploration objectives.

Study Area

Reefs of Kinderhookian and lower Osagean age are present within a broad outcrop belt of Mississippian age strata in my tri-state study area of southwest Missouri, northwest Arkansas, and northeast Oklahoma. The reefs cropout along highway road-cuts, presenting a two-dimensional view for study, and primarily in an east-west (E-W) trending belt throughout the study area.

METHODS OF STUDY

In my tri-state study area a total of fifteen reefs have been analyzed and described in detail. This was accomplished by measuring reef thickness, and sampling beds directly underlying, overlying, and adjoining the reefs. Reefs were then further described based upon their lithology, biota, and any vertical or lateral changes evident on the outcrop. Representative samples of the reefs and associated facies were collected for detailed characterization of texture and particle type and for thin-section petrographic study.

In the carbonate lab at Wichita State University samples were cut and polished for assistance in further description, fabric analysis, and interpretation. As such, thin-sections were made from appropriate samples and studied petrographically: (1) for detailed interpretation of biota and microbiota; (2) rock textures; and (3) the presence of marine or meteoric cements.

Discussion

Compton Reefs

Reefs present within the Kinderhookian age Compton Formation are interpreted to have formed in low-energy moderately, deeper-water environment on an aggradational, distally-steepened ramp (DSR). They are inferred to be hybrid mud-dominated lithoherms/fenestrate bryozoan-crinoid muddy bafflestones that are associated with nodular-bedded, shaly mudstones. These reefs were uplifted in association with syndepostional fore-bulge tectonism during mid-Compton time in an E-W trending belt within the study area. Furthermore, the reefs were subaerially exposed forming meteoric-dissolution vugs of laminoid and irregular fenestrae shape [3]. The formation of these vugs eroded some former high magnesium calcite (HMC) bladed marine cements and biotic

particles, generating internal vadose crystal silt [1]. The vugs, some of which are floored with crystal silt that has been replaced by dolomite and hematite-rimmed dolomite, were later occluded with coarse pore filling calcite (PFC) cements. Then the reefs were dislodged and redeposited to the North within thick sections of upper Compton that downlap an intraformational exposure surface. One reef within the study area is a stromatactis-type reef, with abundant marine cement filled vugs, and shows no evidence of being dislodged.

Pierson Reefs

Basal Osagean Pierson Formation reefs are interpreted to have formed on a progradation DSR, in shallower-water, higher-energy environments than Compton reefs. Pierson reefs as well are exposed in an E-W trending belt within the study area, and are classified as layered bafflestones, containing abundant fenestrate bryozoans and crinoids capped/overlain by crinoidal grainstone crestal deposits that are locally oil saturated. According to [5], these reefs developed as sediment accumulated from the baffling of fenestrate bryozoans causing a topographic rise to form on the sea floor; crinoids reaching into wave base would have then colonized the topographic rise, and as sea level raised the reefs would have been stranded, permitting reef and crinoid growth. These reefs show no evidence of being dislodged, however they were subaerially exposed during Pierson time forming some meteoric-dissolution vugs. Ongoing petrographic analysis of these reefs has led to the identification of abundant former HMC bladed marine cements, precipitation of pendant shape radiaxial fibrous calcite of vadose origin, occlusion of pore space by coarse pore filling calcite cements, and locally diagenetically altered siliceous (chert & chalcedony) fabrics.

Conclusion

Reefs of Kinderhookian and basal Osagean age exposed in my tri-state study area are interpreted to have been deposited on aggradational to progradational DSR. Compton Formation reefs are classified as hybrid mud-dominated lithoherms/fenestrate bryozoan-crinoid muddy bafflestones. They contain laminoid and fenestrae shaped meteoric-dissolution vugs in association with being subaerially exposed, some of which, are floored with vadose crystal silt that is dolomite replaced, and later occluded with coarse PFC. These reefs have been dislodged and redeposited to the north within thick sections of upper Compton strata (nodular-bedded shaly mudstones) downlapping an intraformational exposure surface. One Compton age reef shows no evidence of being dislodged, and is a stromatactis-type reef with abundant marine cement. Reefs within the Pierson are interpreted to be deposited within shallower-water, higher-energy environments than those of Compton age. They are inferred to be layered bafflestones, with abundant fenestrate bryozoans and crinoids, capped by crinoidal grainstone crestal deposits that are locally oil saturated. Likewise, these layered bafflestones have been subaerially exposed, as ongoing petrographic study would indicate the presence of meteoric-dissolution vugs, abundant former HMC marine cements, radiaxial fibrous calcite cements of vadose origin, and locally silicified fabrics.

The sedimentary architecture, depositional and diagenetic history along with temporal analysis of reefs in outcrop provides a model for recognizing reefs and potential reef belts within the subsurface of Kansas and northern Oklahoma. Whereas, these belts are mappable by thickness trends, detailed lithologic interpretation, and the use of three-dimensional seismic survey these reefs may prove to be a frontier exploration play in Kansas and Oklahoma.

Acknowledgements

This study was funded in part by grants from the Geological Society of America, Kansas Geological Foundation, and American Association of Petroleum Geologist, and I gratefully acknowledge the donors of GSA, KGF, and AAPG for their support. A sincere thanks to Dr. S.J. Mazzullo, Wichita State University for his continued advice, expert opinion, and guidance on the subject, as this research would not have been possible without him. I would also like to extend my gratitude to Brian Wilhite, Woolsey Operating Company and Darwin Boardman, Oklahoma State University for their additional support and collaboration on concepts and ideas. Thanks, to Robert Turner, Wichita State University and Zach Poland, Oklahoma State University for their support in the field.

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