

UNUSUAL CARBONATE BUILDUPS IN THE UPPER MANSFIELD AND BRAZIL FORMATIONS, VANDERBURGH COUNTY, INDIANA

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ABSTRACT: Unusually thick limestone is present in the Upper Mansfield and Brazil Formations within and adjacent to the Vaughn Consolidated Field (T7S, R11W), Vanderburgh County, Indiana. Continuous carbonate buildups exceeding 40 feet in the Mansfield and 60 feet in the Brazil extend from the SW $\frac{1}{4}$ Sec. 15 into the NE $\frac{1}{4}$ Sec. 21. Examination of well samples shows that echinodermal-brachiopodal-bryozoan grainstones and packstones dominate continuous limestone intervals more than 30 feet thick. Maps based on 125 wells show the distribution of net thickness of both limestone and sandstone and document complex facies relationships and changes of loci of carbonate accumulation through time.

KEYWORDS: Brazil Formation, carbonate buildups, Mansfield Formation, Pennsylvanian.

INTRODUCTION

Unusually thick intervals of limestone occur in Lower Pennsylvanian rocks in and adjacent to the Vaughn Consolidated Field in southwestern Vanderburgh County, Indiana. Petroleum production from Lower Pennsylvanian and Mississippian reservoirs began in 1941, and some production history is given in Keller (1995). The study area (Figure 1) of approximately eight square miles is located in all or parts of 12 sections centered in T7S, R11W. The Indiana Geological Survey maintains electric logs for 125 wells in the study area and samples from 63 of these wells drilled when the Survey was requesting samples for every well drilled. A microscopic study was made on sample sets from those wells in which limestone was abundant. For comparison, a less thorough examination was made of sample sets from wells containing thin or no limestone intervals. In the samples examined, major emphasis was placed on determining identifiable biotic constituents from the fragmented limestones.

STRATIGRAPHY

A recent study (Droste and Furer, 1995) traced the outcrop stratigraphy of the Staunton, Brazil, and Mansfield Formations throughout the subsurface in southwestern Indiana. These correlations were utilized to establish stratigraphic relationships in the study area. Much of the formation stratigraphy along the

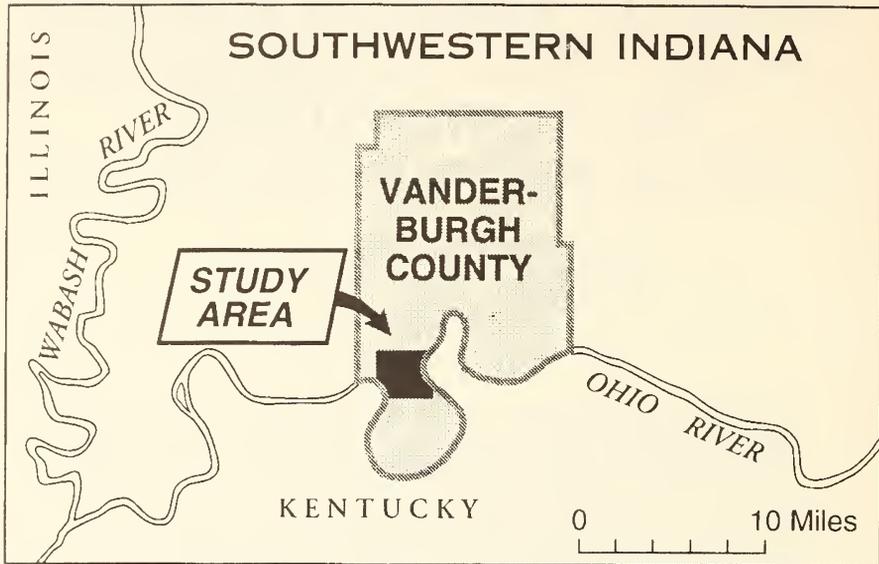


Figure 1. Map showing the location of the study area.

outcrop is based on the position of coals and a few limestone members (Figure 2). In the subsurface of the study area, no coals were identified in the samples studied, and the correlated positions of the coals are generally occupied by intervals of limestone and/or marine shale. Electric logs from three wells (Figure 3) in Sec. 15, T7S, R11W illustrate the lateral variation in lithologies over lateral distances of no more than 0.5 miles between wells.

Brazil Formation. The top of the Brazil Formation is placed at the base of either the Perth Limestone or the sandstone occupying the stratigraphic position of the Perth. Because the Perth is not recognized in the study area, the base of the sandstone in the Perth position marks the top of the Brazil Formation (Figure 3). Along its outcrop, the base of the Brazil is placed at the base of the Lower Block Coal (Figure 2). However, the Lower Block Coal is not present in the study area, and limestone, shale, or sandstone occupies its stratigraphic position. In this study, the base of the Brazil Formation is placed at the correlated stratigraphic position of the Lower Block Coal (Figure 3). The Brazil ranges in thickness in the study area from 90 to 110 feet.

In many places in the study area, the position of the Buffaloville Coal is occupied by limestone (e.g., its occurrence in the #2 Kamp and Happe Well (Figure 3)). In the #2 Kamp and Rollette well (Figure 3), the interval correlated with the Upper and Lower Block Coals is continuous limestone, but in the Bell and Sirkle well, this interval is all sandstone. The net thickness of limestone and sandstone in the Brazil (Figure 4) is discussed below.

Mansfield Formation. Because the Mansfield Formation is more than 800 feet thick in the subsurface of Indiana, the formation was divided informally

FORMATION	MEMBER
STAUNTON	
	PERTH LIMESTONE
BRAZIL	BUFFALOVILLE COAL
	UPPER BLOCK COAL
	LOWER BLOCK COAL
MANSFIELD	
	LEAD CREEK LIMESTONE
	MARIAH HILL COAL
	BLUE CREEK COAL
MISSISSIPPIAN (undifferentiated)	

Figure 2. Chart of stratigraphic nomenclature used in this report.

into upper, middle, and lower divisions (Droste and Furer, 1995). The interval of thick limestone in southern Vanderburgh County occurs in the upper division. The top of the Mansfield is placed at the stratigraphic position of the base of the Lower Block Coal (Figure 2), and the base of the upper Mansfield is placed at the stratigraphic position of the top of the Blue Creek Coal (Figure 2). The Mariah Hill Coal (Figure 2), exposed along the upper Mansfield outcrop, is replaced by limestone in many places in the subsurface of southwestern Indiana, and its position marks the lowest position of limestone in the upper Mansfield of the study area. The upper Mansfield ranges in thickness from 110 to 130 feet in this area. The three well records in Section 15 (Figure 3) document the

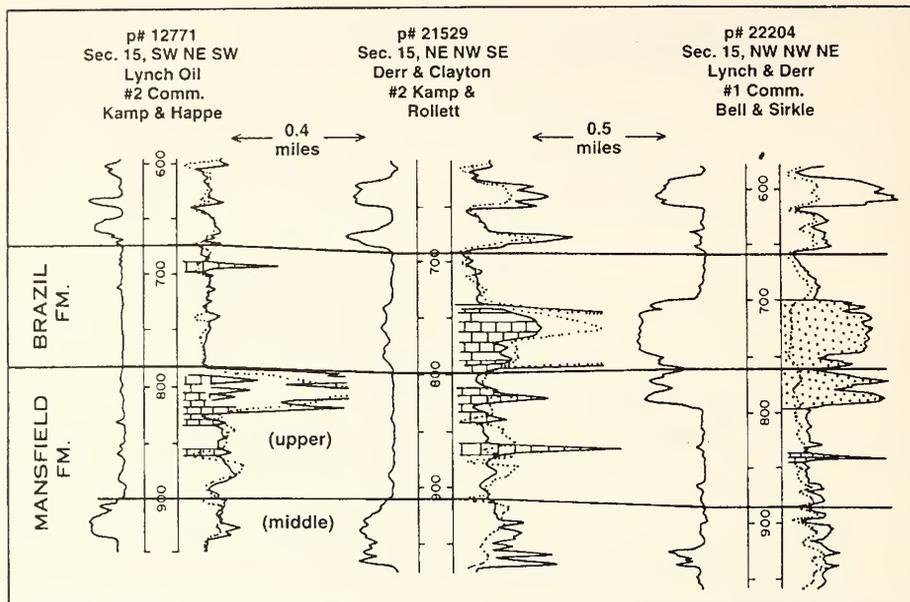


Figure 3. Electric logs from three wells showing marked lithologic differences in the Brazil and Mansfield Formations.

facies changes that occur from well to well within no more than 0.5 miles. The net thickness (Figure 5) of limestone and sandstone in the upper Mansfield are discussed below.

DISCUSSION

The same kinds of sandstone, limestone, and shale occur in both the Brazil and the upper Mansfield Formations. Very fine- to fine-grained, moderately to well-sorted quartz grains compose the sandstone. The shales are typically medium to dark gray in color and are sparingly to moderately silty. The limestones range from wackestones to grainstones. Debris of echinoderms, brachiopods (including productid spines), and bryozoans has been observed in various samples of the carbonate lithologies. This typical late Paleozoic faunal association is interpreted as occurring on shallow marine shelves (Lane, 1992).

Available samples (cuttings) and sample intervals (typically 10 feet) limit detailed interpretations. However, limestones present in single intervals less than 10 feet thick are mostly wackestones. In thicker limestone intervals, wackestones appear to be most abundant in the lower part of the interval and packstones and grainstones increase upwards. In the thickest limestone intervals, grainstones are dominant in the upper limestone beds.

The area of greatest net limestone thickness in the upper Mansfield (Figure 5A) extends from the southern half of Section 15 southwestward into Sections 21 and 20, and net thicknesses greater than 20 feet generally fall within a zone

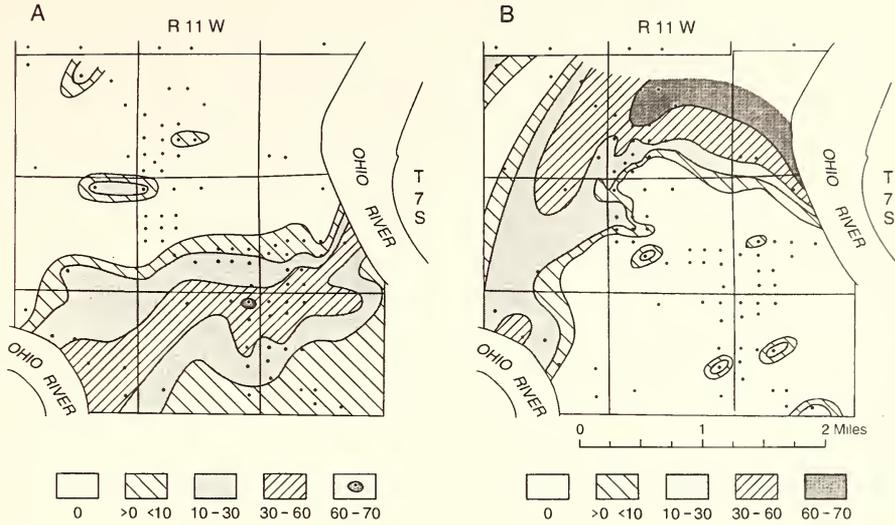


Figure 4. Maps showing net thickness in feet of limestone (A) and sandstone (B) in the Brazil Formation.

about 0.5 miles wide. The area of greatest net limestone thickness in the Brazil (Figure 4A) overlies that of the Mansfield. However, the width of the zone containing more than 20 feet of limestone increases by approximately 50% in the Brazil.

Zones of thicker sandstones in the Mansfield lie both to the north and south of the zone of thicker limestones (compare Figures 5A and 5B), and no sandstone is present in the upper Mansfield in much of the zone of thicker limestone.

The thicker sandstone in the Brazil lies in a zone generally north of the zone of thicker limestone, and a shale facies generally lies between the limestone and sandstone thickenings. In the northwest quarter of Section 20, sandstone is present in the lower part of the Brazil and is in facies relationship with limestone in the southeast quarter.

The available information does not suggest that the carbonates represent wave-resistant reefs. The typical Upper Paleozoic marine faunal association is interpreted as living on or within the areas of carbonate deposition, including calcareous sands or bars among which were quieter waters that yielded carbonate muds.

The authors are unaware of any literature describing intervals of limestone ten or more feet thick in the Mansfield or Brazil Formations in the subsurface or surface in Indiana. Why are these thick limestones in southernmost Vanderburgh County? We suggest that crinoids, bryozoans, and brachiopods colonized local sea floor highs that resulted from slight variations in regional rates of subsidence. These sea floor highs were probably above storm wave base so

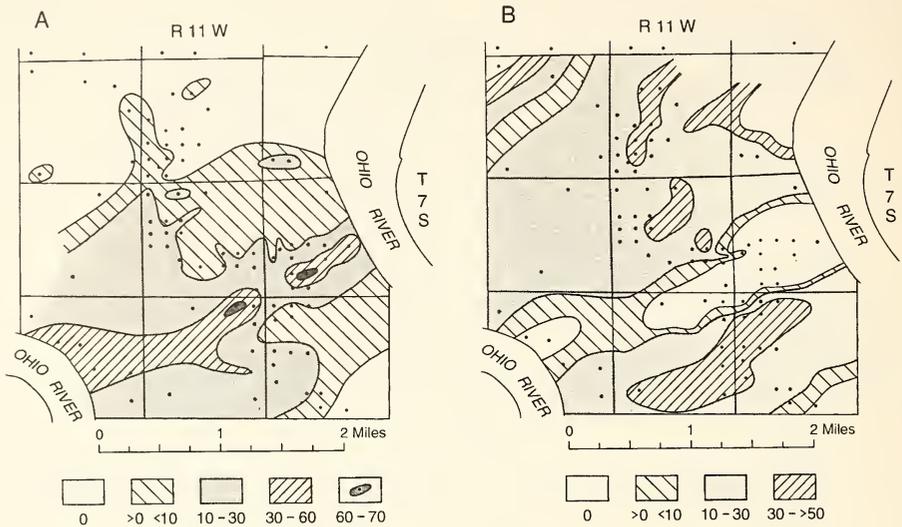


Figure 5. Maps showing net thickness in feet of limestone (A) and sandstone (B) in the upper part of the Mansfield Formation.

that terrigenous sand and mud was winnowed from or bypassed the highs, and crinoid thickets developed. As the fauna flourished, it continually contributed carbonate debris to the buildup. If the rate of accumulation exceeded the rate of subsidence, the thicket remained above storm wave base. Limestone deposition ceased because subsidence exceeded accumulation or deposition of terrigenous sediments exceeded deposition of carbonate debris possibly because of shifting currents and/or shifting sources of terrigenous sediments.

Several well logs from western Kentucky were studied that contained ten to thirty feet of limestone in the Brazil equivalents. We will continue to examine well logs in southern Indiana and western Kentucky to discover other locations of thick limestones in Lower Pennsylvanian rocks.

CONCLUSION

In the study area, shallow water marine deposition occurred during the interval from the Blue Creek Coal through the Buffaloville Coal. In some areas, the absence of the smothering effects of terrigenous sands and muds permitted inferred crinoidal thickets to dominate sedimentary processes and produce thick limestones. However, the location of crinoidal accumulations shifted somewhat through time.

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