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BIOCALCARENITES IN SOME UPPER PENNSYLVANIAN LIMESTONES IN ILLINOIS

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Most Pennsylvanian limestones of Illinois are fine grained and, though they contain fossils, their general character suggests that they were deposited primarily as calcareous muds. During an economic study of the Pennsylvanian limestones in 37 commercial quarries of the state, the occurrence of a biocalcarenite at or near the top of the LaSalle, Livingston, and Millersville limestones was noted at a number of places. Each of these limestones has at one time been considered equivalent to one or both of the others (Dunbar and Henbest, 1942; Lamar and Willman, 1934; Newton, 1941; Wanless, 1955; Potter, 1956). A similar stratum also was observed near the top of a few other Pennsylvanian limestones but was not as commonly present or as widespread as the biocalcarenites previously mentioned.

The results of an investigation covering the nature and abundance of the clastic materials in the LaSalle, Livingston, and Millersville calcarenites and an interpretation of their significance in terms of sedimentation conditions and in relation to correlation of the limestones are presented herein.

Locations of the quarries in which the biocalcarenites of these limestones were observed and sampled and of four drill cores in the Millersville limestone from which the calcarenite was sampled, are shown in Figure 1 and listed in Table 1.

Occurrence of Calcarenite

The biocalcarenite at the top of the LaSalle, Livingston, and Millersville limestones is from 6 inches to about 7 feet thick. It is part of an upper limestone unit 6 to 14 feet thick and characterizes the three limestones at many places. The variation in the thickness of the calcarenite bed may be attributed, at least in part, to erosion. Calcarenite was found in each of the four Millersville cores examined and sampled.

Character of Calcarenites

The nature of the calcarenites was investigated by study of thin sections (Fig. 2) and rock slices from each limestone sample cut at right angles to the bedding. The slices were etched with hydrochloric or acetic acid to facilitate study. A binocular microscope was used to estimate the percentage of detritus, its size, range, and average size. The percentage by number of each of the five principal types of clastic material also was determined.

Results given in Table 1 and Figure 3 indicate that the detritus is principally crinoid fragments, shell fragments, foraminifera, oolites, and bryozoan fragments. The matrix of

TABLE 1.—Localities and Size and Percentage of Detritus.

Locality near	Township	Range	Section	¼	¼	Percentage detritus	Size (mm.)	
							Range	Average
		LaSalle limestone						
LaSalle	33N	1E	14	NE	SE	82	0.5-3.0	0.9
Oglesby	32N	2E	6	NE	SW	80	0.1-4.0	1.0
Oglesby	32N	2E	6	NW	SE	80	0.5-4.0	1.0
Pontiac	28N	5E	9	NW	SE	75	0.5-4.0	1.1
					Av.	79	0.1-4.0	1.0
		Livingston limestone						
Casey	10N	14W	4	SE	SE	84	0.1-5.0	1.0
Fairmount	18N	13W	21	SW	SW	75	0.2-5.0	1.2
West Union	9N	11W	29	NW	SW	78	0.1-8.0	1.0
					Av.	79	0.1-8.0	1.1
		Millersville limestone						
Arthur	15N	6E	12	SE	SE	73	0.1-5.0	1.0
Arthur	15N	6E	15	SE	SE	76	0.5-7.0	1.1
Pana	11N	1E	33	NE	NW	82	0.05-3.0	1.2
Ramsey	8N	1E	19	NE	SE	72	0.5-3.0	1.0
Tuscola	16N	7E	36	SW	SE	76	0.1-4.0	1.0
					Av.	76	0.05-7.0	1.1

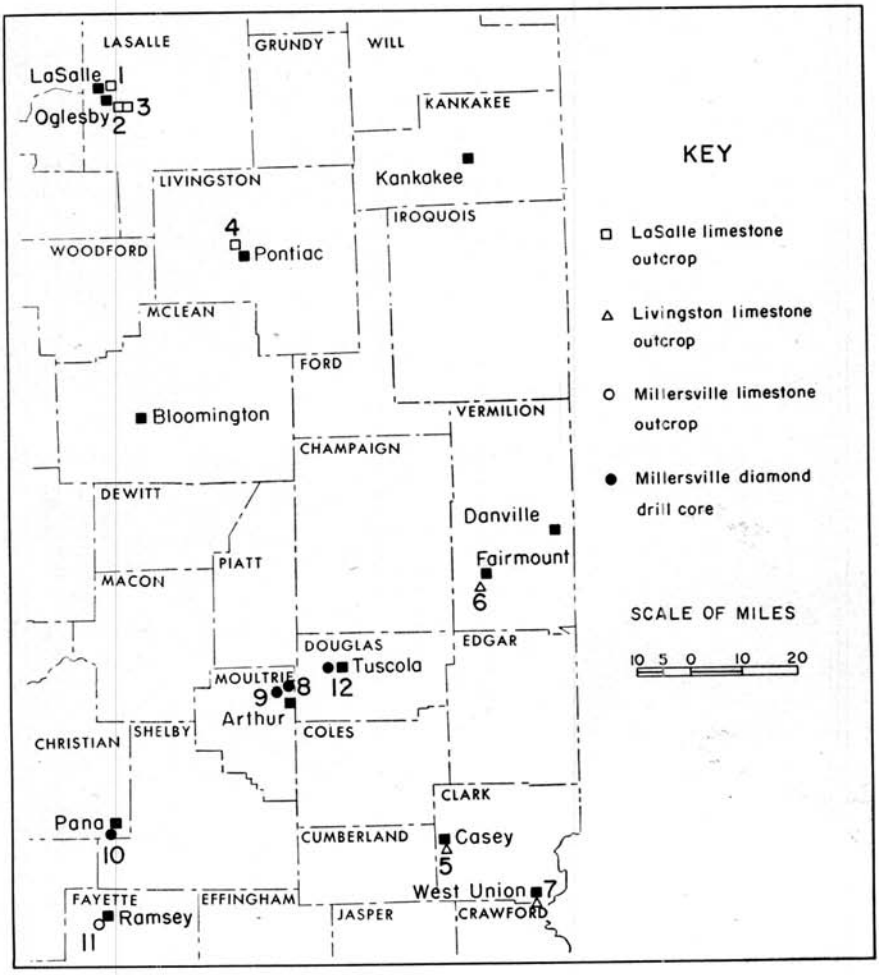

FIG. 1.—Limestone formations sampled and sources of samples.

the calcarenites was not investigated in detail, but it is calcite with a small-to-moderate amount of silt-size quartz in some samples.

The calcareous clastic material comprises 73 to 84% of the samples. Of the five major types of clastic particles, fragments of crinoids and crinoid stems are commonly most abundant, followed in order by shell fragments, foraminifera, oolites, and bryozoa. Average size of the clastic particles is consistently about one millimeter.

Averages for the content of clastic materials according to limestone formations are given in Figure 3. The LaSalle and Livingston calcarenites contain a greater percentage of crinoid fragments than does the Millersville calcarenite. The range in the percentage of shell fragments

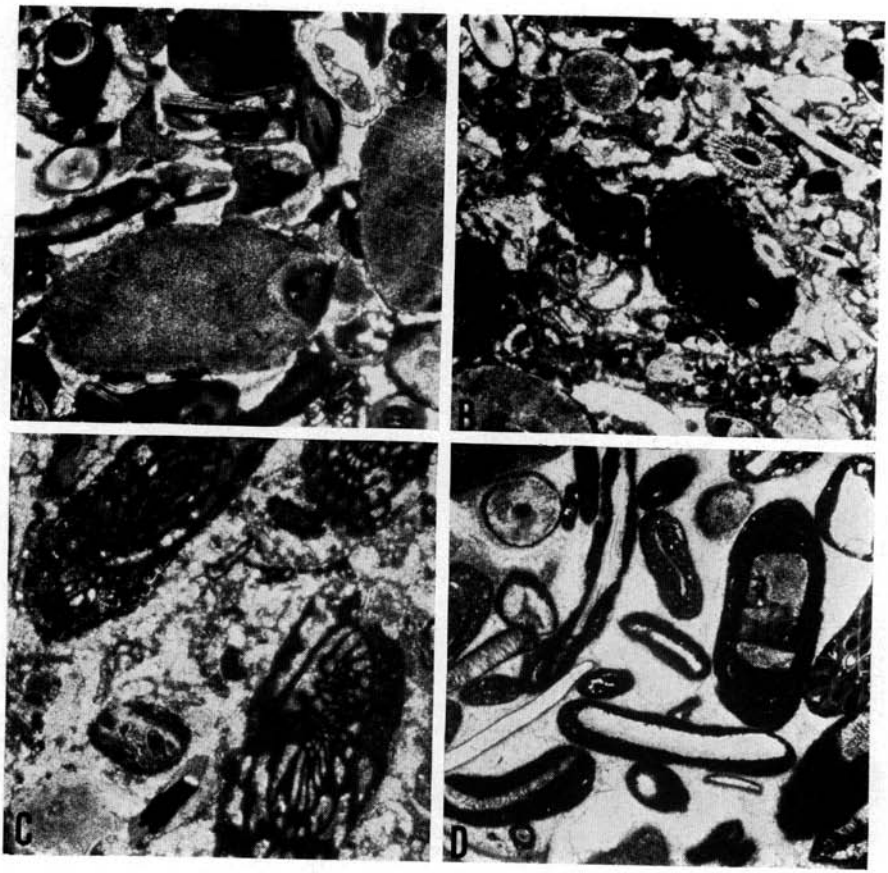

FIG. 2.—Thin sections of biocalcarenites: *A*. crinoid stems and oolites in LaSalle limestone, 9 X; *B*. algal masses, center, and crinoid fragments in Livingston limestone, 9 X; *C*. foraminifera in Millersville limestone, 9 X; *D*. Millersville calcarenite at Ramsey showing elongate nature of particles and dark accreted calcite around grain centers, 6 X.

in the LaSalle and Millersville calcarenites is greater than that in the Livingston, but the average amount of shell fragments is not greatly different. The content of foraminifera in the LaSalle and Livingston calcarenites is strikingly similar; the Millersville shows a greater range in foraminiferan content, and the average content is higher. The average percentage of oolites is similar for the three limestones, as is the range in number of oolites present. However, the Millersville and Livingston calcarenites generally contain more oolites than the LaSalle. The bryozoan content of all three limestones is low, especially so in the LaSalle calcarenite.

To summarize, the LaSalle and Livingston limestones are roughly similar in content of crinoid fragments, shell fragments, and foraminifera, whereas the Livingston

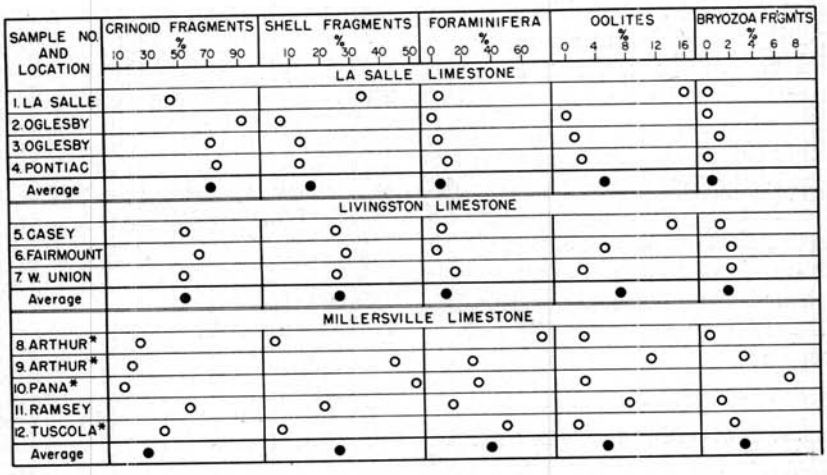

FIG. 3.—Composition of biocalcarenite in percentage by number of clastic particles present.

and Millersville limestones show kinship in number of oolites and bryozoan fragments. Data of this type probably are not an adequate basis for establishing correlations of beds. Insofar as they may be significant in this regard, they would seem to confirm an interrelationship previously suggested by study of the stratigraphic succession, among the three limestones, and to demonstrate a general similarity of the clastic materials in the sea in which the limestones were deposited.

The Millersville calcarenite in the quarry near Ramsey (Fig. 2D) and in the two cores near Arthur is unusual in that many of the fossil fragments are elongate, well rounded, and covered by a coating of carbonate material. It was not possible to establish definitely the origin of this coating, but it is believed to be either algal (Johnson, 1954) or to represent a layer of lime mud accreted to the fossil fragments as they were rolled about on a sea floor or tidal flat. It is also conceivable that the coating may represent the first stage of oolite formation.

Sedimentational Significance of Calcarenites

Those parts of the LaSalle, Livingston, and Millersville limestones below the calcarenite zone generally consist of two or three fine-grained limestone units separated by micaceous gray or black shale. Such deposits most likely were formed by an alternation of relatively deep- and shallow-water conditions involving chemical precipitates on the one hand and the deposition of fine clastic sediments on the other. The calcarenite indicates a change to a different type of deposition during the closing stages of formation of the last of the three limestone units, namely, the deposition of relatively coarse clastics of essentially local derivation composed of fossil detri-

tus and oolites. Crinoids, bryozoa, brachiopods, and foraminifera were abundant in the sea, and sand-size materials became the major type of sediment for the first time during the history of the limestones. It appears likely that the phenomena described accompanied a temporary regressive shallowing of the sea, which was terminated by a readvance that deposited the shales above the LaSalle, Livingston, and Millersville limestones.

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