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Textural Variations in Some Iowa Limestones

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Introduction

Textural properties of limestones assume a large importance in determining the origin of the rocks. Limestones are usually called detrital rocks if they possess oolitic, pelleted or coquoinoid texture (Pettijohn, 1957, p. 401). This criterion as to whether the rock was formed by current-sorted detritus or direct chemical precipitation is valid if, and only if, the rock texture has remained essentially unchanged during diagenesis. Because many of the Mississippi limestones of Iowa display pellet textures, it is desirable to determine, if possible, the true nature of this texture, and its mode of origin, and whether it reflects a depositional or diagenetic environment.

For the purposes of the study, thirteen samples of Gilmore City limestone from the Midwest Limestone Company quarry at Gilmore City, Iowa, were used. The sampling was done by Roy and Thomas in the summer of 1951. Their outcrop description is given below.

Pocahontas, Iowa S.W. S.W. S25 T92N R31W
Midwest Limestone Co. quarry at Gilmore City

Code G.C.

1	Limestone, fine-grained, sub-lithographic, hard, gray to buff, contains pellets, grades downward to unit below. Large styolites at lower contact.	1.2 ft.
2	(Same as above.)	2.2 ft.
3	(Same as above.)	2.0 ft.
4	Limestone, gray, fine pelletiferous at top grading down to coarser clastic and slightly oolitic below, numerous styolites and coarse solution surfaces.	1.8 ft.
5	(Same as above.)	1.4 ft.
7	Limestone, gray, coarse clastic with abundant corals in upper half and grading downward into clastic and oolitic below, stylolitic.	2.0 ft.
8	(Same as above.)	1.5 ft.
9	Limestone, gray, medium-grained clastic and oolitic; thin bedded, corals scattered throughout.	1.8 ft.
10	(Same as above.)	2.0 ft.
11	Limestone, gray, clastic and oolitic, medium-grained.	1.6 ft.
12	(Same as above.)	1.8 ft.
13	(Same as above.)	2.0 ft.
		21.3 ft.

The terms "pellet" and oolite" were used interchangeably in this record because of the inability to distinguish between the two structures in the field (Roy and Thomas, personal communication, 1958).

Methods of Study

The samples were examined in reflected light with the binocular microscope, by etching with dilute acetic acid, and in thin section. A number of ground and polished surfaces were prepared for study in reflected light and etching studies with 1N acetic acid.

Observations of all three types of surfaces in reflected light confirmed the field description of Roy and Thomas, but of course added some details. The pellets, composed of very finely crystallized material resembling calcite, are diversely shaped and tend toward sphericity. They are set in a matrix of clear calcite. Fossils and fossil fragments are present, but are not abundant.

Many of the pellets are completely surrounded by large, clear calcite masses that seem to be single crystals. Etching with 1N

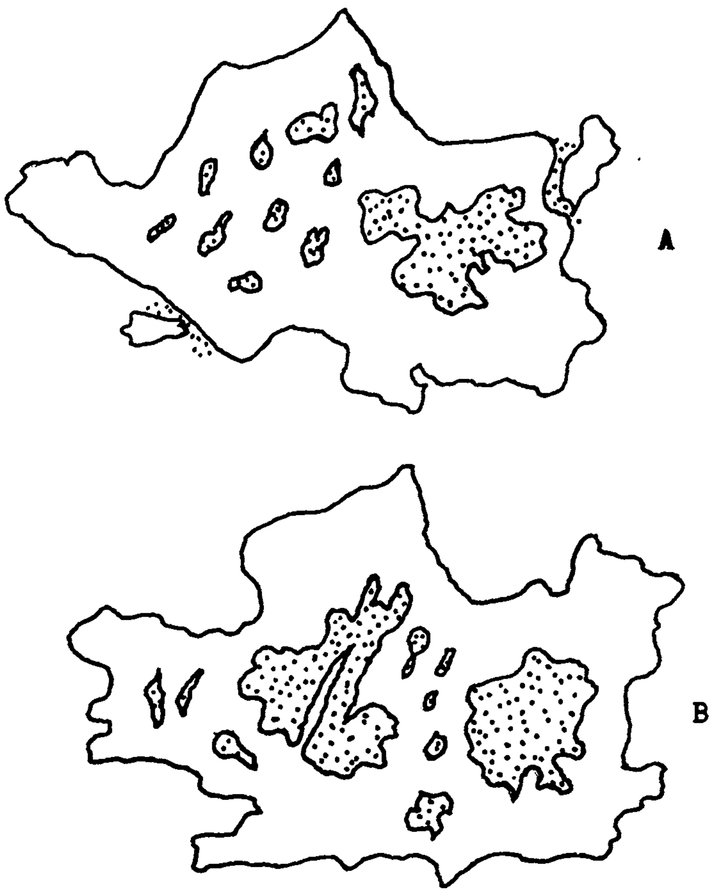

Figure 1. Camera lucida sketch of a single calcite crystal containing pellets. "A", before etching "B", after a thirty-second etch with 1N acetic acid. Stippled, pellet material; plane, matrix calcite.

acetic acid attacks the large crystals very slowly at their boundaries and very little on plane faces. Acid of this strength reacts quickly with the very fine crystals in the pellets. Results of etching showed that many of the enclosing calcite masses were indeed single crystals. Such a crystal is shown in Figure 1.

Further etch tests disclosed the presence of irregular masses of more coarsely crystalline calcite within the pellets. Some of the limestone was partially dissolved in dilute acetic acid. In this investigation, it was again noted that the pellets were attacked much more rapidly than the large, clear calcite crystals. The residue obtained from the partial digestion was composed of irregularly-shaped masses of coarse calcite. Many of these contained pellets that were completely enclosed, and thus not affected by the acid.

Some of the coarse crystals containing pellets were examined by the oil immersion method. When examined without grinding most of the masses were seen to be single crystals. The specimen was then ground and the optical constants determined. Both the coarse fragments and the pellets had the high birefringence of calcite. The pellets are aggregates of very fine-grained material, and thus it was impractical to determine their optical constants. The coarsely crystallized fragments have the optical constants: N_E 1.485, N_W 1.656 opt. (-).

Observations made in other studies are confirmed by thin section examination. The rock is composed of two textural elements. A typical example is shown in Figure 2.

Irregular structureless pellets of fine-grained calcite lie in a matrix of coarse anhedral calcite crystals. Note that many of the light areas, which are coarse calcite in this photomicrograph, contain indistinct dark smudges. These are masses of more or less dispersed fine-grained calcite such as forms the pellet.

The pellets themselves vary from well-rounded to irregular; they are predominantly fine-grained, but in many instances they contain irregular crystals of large size that may include some masses of fine-grained calcite like that shown in Figure 3.

The boundary relationships of the pellets against the large calcite crystals is shown in Figure 4. Here it can be seen that the pellets form sharp to diffuse boundaries against the matrix calcite.
It should also be noted that the pellets are completely structureless. The small calcite crystals composing them are diversely oriented, both in the pellets and in the surrounding coarse calcite.

The pellet size varies widely. Those pellets measured range between 0.05 millimeters and 4 millimeters in diameter. Both larger

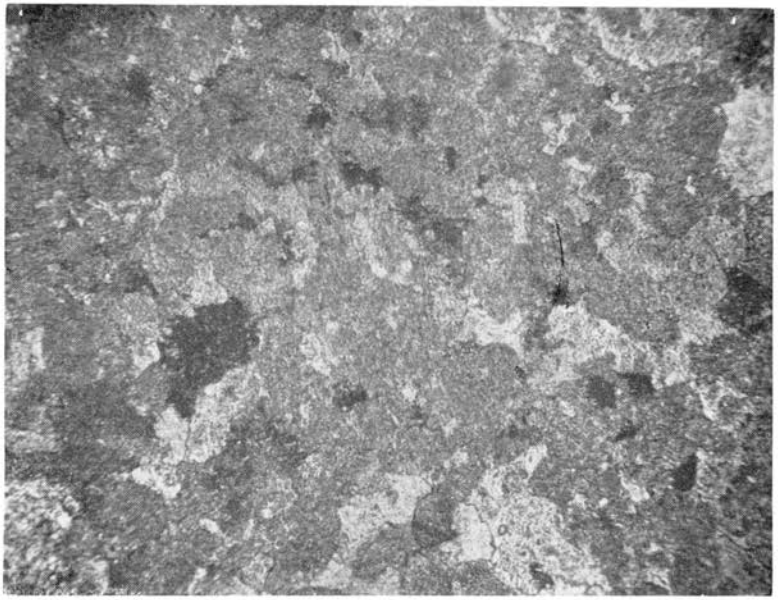

Figure 2. General textural relationships in the Gilmore City limestone. Indistinct gray masses, pellets; light areas and black patches, matrix calcite. Crossed nicols, 79x.

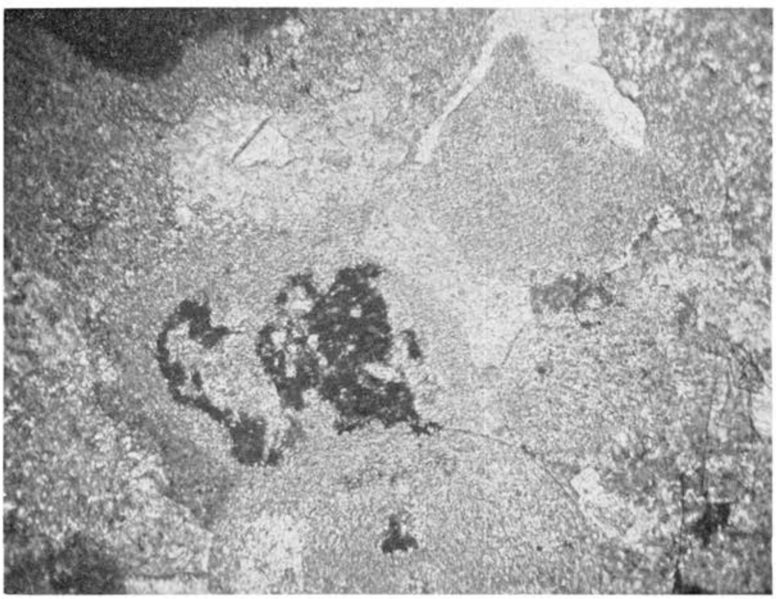

Figure 3. Pellets showing inclusions of irregular coarse calcite. Light areas are matrix calcite, gray areas are pellets, and black area is an inclusion in the central pellet. Crossed nicols, 155x.

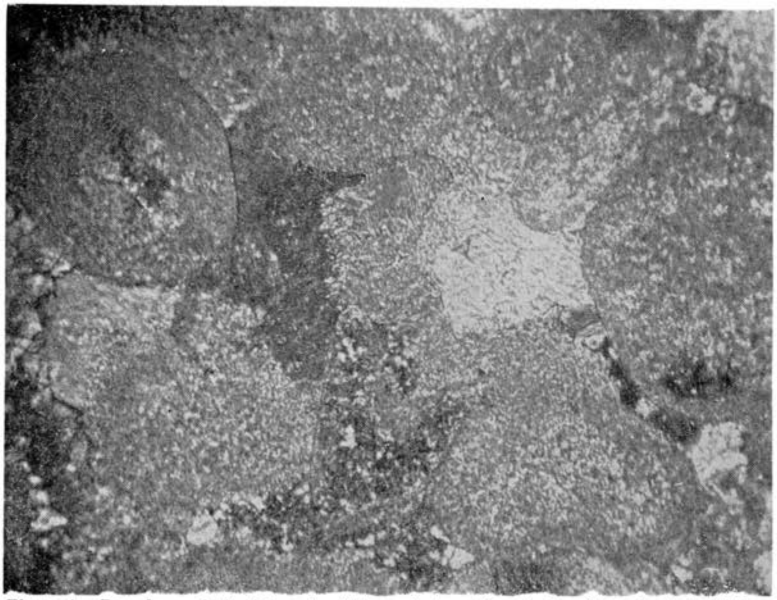

Figure 4. Boundary relationships of pellets against matrix calcite. Crossed nicols, 155x.

and smaller sizes exist, but are distinctly less common than those measured.

A conspicuous feature of the pellets is the fact that, commonly, the coarse calcite contained in them is optically parallel with that of the surrounding matrix. Figure 5 shows such a pellet at the left. A portion of a large pellet is outlined by two semi-parallel lines of fine-grained calcite, separated by a large area of calcite at extinction. The same large crystal encloses the large pellet in the right hand portion of the photograph.

The matrix calcite is composed of much larger crystals than the pellets. The most impressive feature of the matrix calcite is the poikilitic enclosure of pellets, as shown in Figure 5, and partial absorption of the fine-grained calcite, as shown in Figure 6.

Crystals of matrix calcite are, almost without exception, anhedral masses that project into masses of pellet materal with curving contacts like those shown in Figure 4. This growth habit of the matrix calcite seems to be responsible for the pellet texture. Partially recrystallized pellets mark the matrix crystals in most, if not all, instances.

In the more nearly lithographic rocks at the top of the section, there are few large calcite crystals and few pellets. As the rock grades downward into the pseudo-oolitic or pelletiferous textures below, the total amount of matrix calcite increases. An estimate of

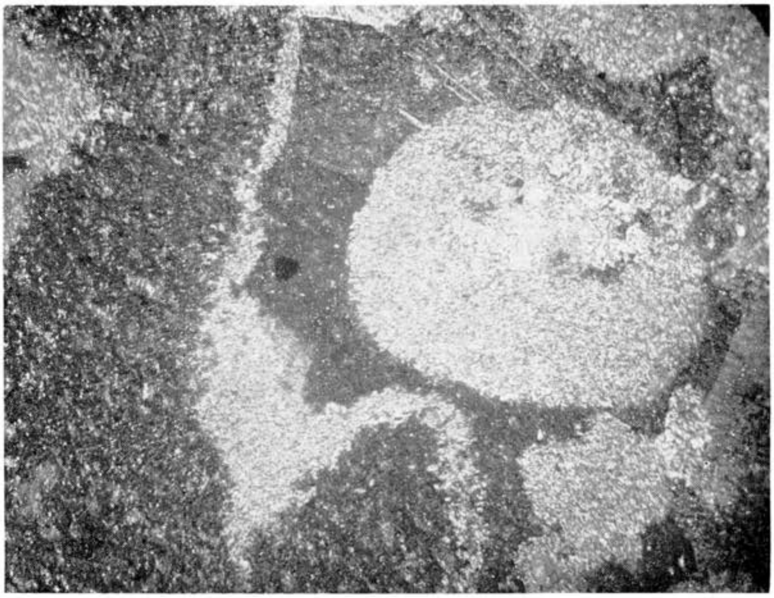

Figure 5. Single crystal of matrix poikilitically enclosing a pellet and partially replacing another. Crossed nicols. 155x.

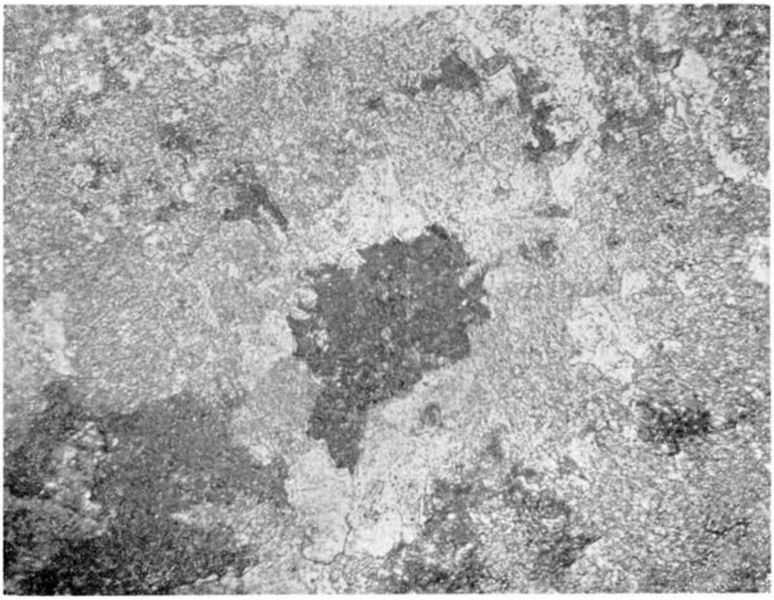

Figure 6. Partially re-crystallized pellet fragments in a crystal of matrix calcite. Crossed nicols, 155x.

the change in percentage of matrix versus pellet calcite, based on random traverses with the integrating stages is given in Table 1.

Table I

Sample	% Pellet	% Matrix
1	81	19
2	55	45
3	51	40
4	50	50
5	51	49
7	68	32
8	65	35
9	54	46
10	53	47
11	66	34
12	55	45
13	53	47

Table 1. Percent pellets versus matrix, as determined by random traverses with the integrating stage.

Discussion

Evidence of detrital origin for the pellets (Illing, 1954) is lacking. There is little fossil debris present; the pellets are not rolled masses about detrital cores, for though they commonly contain coarse calcite, it is not of a detrital outline, and the pellets are not centered about it as are oolites having detrital cores. No radial or concentric structure is present in the pellets, and their outlines are not smooth as would be expected of rolled particles. Moreover, the lithographic rocks in the upper part of the section have the same mineral content and the same texture as the pellets.

This increase of pellets at the expense of the lithographic texture, the irregular shape of the pellets, their lack of internal structure, and their replacement by the matrix calcite suggest that the pellets originated, or were extensively modified, during diagenesis. The irregular masses of coarse calcite included in the pellets, particularly those in optical continuity with crystals of the matrix, and the poikilitic enclosure of several pellets by a single calcite crystal are further evidence that the present texture does not represent a depositional environment.

A more diagnostic criterion than pellet texture then is needed before carbonate rocks can be assigned with great confidence to a particular origin. It might be argued that rocks in general should be regarded not as finished products but as processes that are interrupted at some state, and the impressions gained by the investigator are in some part colored by the status of the process at the moment of interruption.

References

Illing, L. V. 1954. Bahaman calcareous sands, Bull. Am. Assoc. Petroleum Geol., vol. 38, pp. 1-95.

Pettijohn, F. J. 1957. Sedimentary rocks, Harper and Brothers, New York, N. Y.

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