PETROLOGY OF THE BASAL HIGH-PURITY BED OF THE BURLINGTON LIMESTONE*

DONALD L. GRAF
State Geological Survey, Urbana

A high-purity, virtually chert-free limestone occurring near the base of the Burlington limestone in western Illinois is being mined or quarried at Quincy, Gladstone, and Pearl. This article presents the results of an initial study of the petrology of this 10 to 25-foot unit. Twenty thin sections, perpendicular to the bedding, were prepared from specimens collected at the localities mentioned, especially the Quincy area.

The specimens are mixtures, in varying proportions, of five principal components: (1) large fragments of crinoid plates and stem segments, which are inclusion-rich, unit-extinguishing sheets of calcite; (2) secondary white calcite, deposited in optical continuity upon the detrital fragments; (3) moderate to fine-grained fossil detritus, including fragments of bryozoa, pelecypods, brachiopods, and smaller bits of crinoid plates and stem segments; (4) very fine-grained dark gray interstitial calcite; and (5) small unit-extinguishing rhombs of dolomite. Coarsely crystalline specimens of the limestone consist chiefly of the secondarily enlarged pieces of crinoidal calcite. Finely crystalline varieties show pronounced banding in thin section, with different bands varying both in components and in particle size. The banding, in general, parallels the bedding planes of the rock, but in detail it may be contorted or lenticular at some places. Dolomite rhombs occur mostly in the fine-grained interstitial carbonate component, and are thus commonest in fine-grained varieties of the rock.

* Published by permission of the Chief, Illinois State Geological Survey.

History of Events

The history suggested by the thin-section study is indicated in table I. In the first stage crinoid fragments were deposited with a mud containing abundant fossil fragments. The interstitial material between the crinoid fragments contains far too much debris and is too fine grained to have crystallized

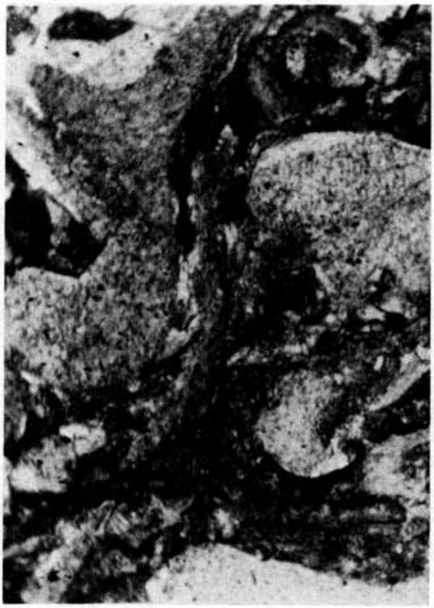

FIG. 1.—Subparallel alignment of smaller detrital fragments. Parallel nicols, 20 X.

from circulating water. A streakiness in the fine-grained portion of the interstitial material arises in part from the presence of elongate, laminated pieces of pelecypod shells, and, almost certainly, in part from the original deposition of elongate pieces of fossil detritus in planes essentially parallel with the ocean floor. However, a "streamline" effect seen in some places (fig. 1), in which sub-parallel particles diverge to go around larger particles, suggests local flowage during compaction which accentuated the other two features.

Secondary white calcite, free of inclusions, was deposited in optical

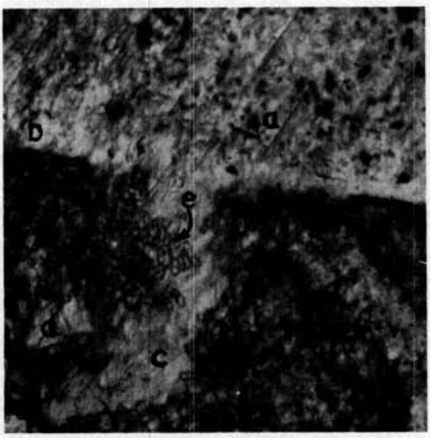

FIG. 2.—Portion of crinoid stem segment (a), secondary calcite rim (b), vein-like extension of rim (c), "island" (d), and fine-grained aggregate interpreted as result of late partial destruction of vein-like extension (e). Parallel nicols, 135 X.

continuity upon the large, inclusion-rich, unit-extinguishing sheets of calcite in crinoid plates. Less commonly (fig. 2) it forms vein-like extensions into fine-grained interstitial calcite. Secondary calcite from two or more nearby fragments commonly meets along a curving contact, giving rise to local areas in the rock that are coarsely crystalline aggregates (fig. 3). The deposition of secondary white calcite has been so extensive in some places as to cut across and isolate areas of streaked interstitial material. In these areas rearrangement of particles by flowage would have been unlikely without some disruption of the secondary calcite, which has not been seen;

FIG. 3.—Secondary calcite rims on adjacent grains grown together to form a coarse-grained rock, with small remnant areas of dark fine-grained interstitial calcite. Parallel nicols, 20 X.

hence deposition of secondary calcite is placed after compaction and flowage.

The margins of many of the secondarily enlarged calcite sheets in contact with interstitial carbonate are ragged, and the question arises as to which calcite is replacing the other. The fact that there are outlying islands of secondary white calcite in optical continuity with larger areas (fig. 2) suggests that the fine-grained interstitial calcite is the active replacing agent, but the "islands" may actually be continuous in the third dimension with the main mass. Further evidence is furnished by a few fine-grained aggregates of

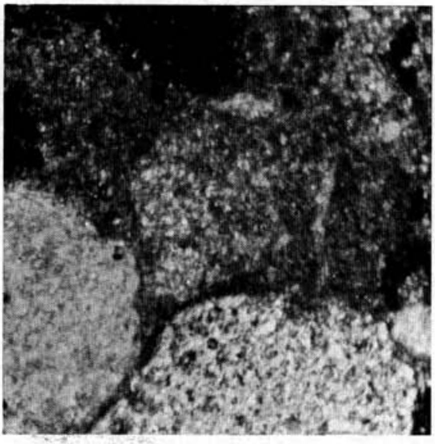

FIG. 4.—"Ghost" composed of small grains in center of picture; two unit-extinguishing sheets of inclusion-rich crinoid calcite below. Crossed nicols, 65 X.

clear white calcite adjoining the secondary calcite projections, which are best explained as partially resorbed marginal portions of the projections.

"Ghosts" in the interstitial calcite show outlines of larger calcite particles that are now represented by an aggregate of small grains (fig. 4). Although the "ghosts" were not necessarily formed at the same time as the partial solution of the secondary carbonate rims, their presence does indicate that coarsely crystalline calcite has at one time during the history of the rock undergone alteration to a fine-grained aggregate. Both these solution effects can be placed, with considerable assurance, later than deposition of secondary calcite because cores of organic calcite lying within the secondary calcite rims are smooth and uncorroded.

The dolomite rhombs have been identified by Debye powder X-ray diagrams; in the absence of evidence to the contrary, they are assumed to be of a single age and of essentially constant composition. They are later than the postulated compaction, for they cut across "streamline" textures. They are earlier than at least part of the period of replacement of coarsely crystalline calcite, for many thin sections contain rhombs that have been partially dissolved (fig. 5). The prominence of this solution varies considerably within limited stratigraphic thicknesses. The age of the rhombs with regard to the deposition of secondary calcite is uncertain. A few rhombs project into the secondary calcite, but it is not yet known whether the rhombs have replaced the coarsely crystalline material, or the latter has replaced the material around the rhombs but left them untouched.

Minor Components

Uncommon small irregular areas of low birefringence, moderate index, and non-uniform extinction are found within large unit-extinguishing crinoid plates (fig. 6). They are not potash feldspar, since a sodium cobaltinitrite staining test gave neg-

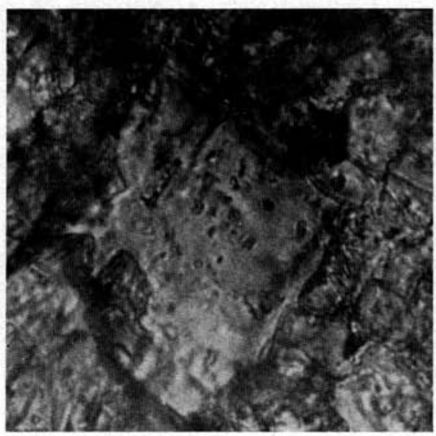

FIG. 5.—Dolomite rhomb partially dissolved along left-hand margin. Parallel nicols, 280 X.

Table I. History of Events

1. Deposition of detritus from crinoids; interstices between larger crinoid fragments filled with mixture of lime mud, glauconite granules, and fossil detritus.

2. Compaction locally accentuates parallelism of elongate particles in interstitial material.

3. Deposition of secondary calcite in optical continuity upon crinoid fragments

Formation of dolomite rhombs.

Some crinoid fragments in interstices reduced to fine-grained aggregates.

4. Secondary calcite partially replaced by fine-grained aggregate, perhaps contemporaneously with solution of dolomite rhombs and with replacement of small detrital fragments.

Partial solution of dolomite rhombs.

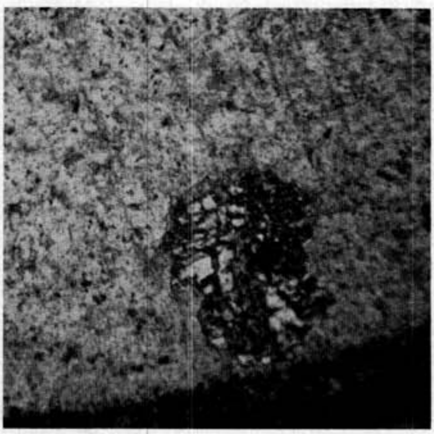

FIG. 6.—Aggregate of grains which may be secondary silica, lower center near margin of crinoid stem segment. Crossed nicols, 65 X.

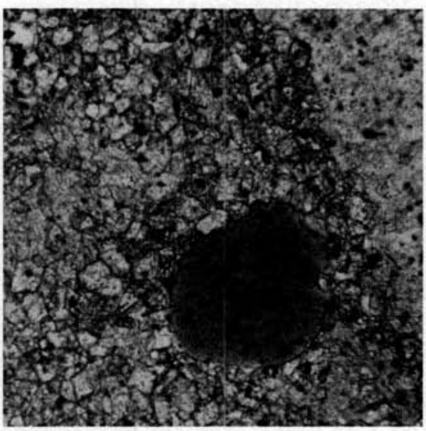

FIG. 7.—Glauconite grain in dolomite-rich Burlington limestone. Parallel nicols, 65 X.

ative results, but they may be secondary silica.

Rounded areas of a greenish material (fig. 7) give an X-ray pattern and a differential thermal curve which correspond in general with those expectable for glauconite, but this identification will not be meaningful until glauconite and related layer-lattice minerals have undergone much more study as mineral types. A basal spacing of 10 Ångström units was noted, but other critical X-ray reflections were obscured by lines of quartz, which occurred even in the 1-micron fraction of the "glauconite." These rounded greenish areas do not cut across other structures, and are most likely detrital in origin. Many dolomite crystals end abruptly against the "glauconite," without completing the rhomb shape. In some cases they penetrate into cracks, but no actual replacement of "glauconite" by either calcite or dolomite has been noted.