SUBSURFACE SEDIMENTOLOGY OF THE MIOCENE-PLIOCENE KINGSHILL LIMESTONE, ST. CROIX, U. S. V. I.

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ABSTRACT

The Kingshill Limestone (Miocene-Pliocene) was laid down in a fault-bounded basin or open seaway during a time of tectonic instability and eustatic fluctuations. Outcrops from within the seaway indicate a range of environments from deep basin to reef. The width of the seaway ranged from 8 to 16 km.

Cores taken from midway between outcrops representing basinal and reefal facies, display skeletal packstones and wackestones with no visible bedding. The allochems in the skeletal packstone facies consist of shallow-water benthic foraminifera, rounded clasts from normal-salinity reef and encrusting communities, and well-preserved globigerinid forams. The moldic coral wackestone facies occurs in 20 to 30 cm thick intervals and is dominated by cm-sized molds of Stylophora coral fragments.

Diagenetic textures follow a consistent pattern downcore. A highly leached interval is followed by a zone of highly cemented packstones with decreased porosity. Intervals of the moldic coral wackestone facies are included at various points throughout this low porosity zone. The low porosity zone directly overlies and grades into a more porous interval of pitted appearance with mm-size vugs. This zone is directly underlain by an abrupt transition into porous, pervasive dolomite.

The sediments were deposited in an outer shelf to slope environment open to ocean circulation. Reef growth was probably recessed several kilometers landward of these cores. Early cementation took place before complete immobilization of the lime mud matrix, since micrite layers commonly overlie early marine cement. Porosity occlusion by blocky calcite is followed by dolomitization and related dissolution.

There is not yet enough information to describe a particular model of dolomitization. This example is petrographically similar to other Caribbean dolomites of inferred mixed-water origin, and there is no evidence of hypersaline conditions. Mixed-water dolomitization is suggested as a hypothesis.

INTRODUCTION

The Kingshill Limestone is a Miocene-Pliocene unit that lies in the central plain of St. Croix, United States Virgin Islands. Geologic studies of St. Croix date back to the beginning of the century; more complete work was done by Cederstrom (1950) and Whetten (1966). Accurate identification of the age and depositional facies of the carbonate units waited until the work of van den Bold (1970), Multer and others (1977), Frost and Bakos (1977), Gerhard and others (1978), and Lidz (1982).

These sources contain outcrop descriptions in more detail than can be presented here, and the reader is referred to them for further information. In general, the outcrop interpretations herein agree with those of the above publications, and the core data is fit into the framework of the outcrop observations. As more core material becomes available, the details of deposition will hopefully become clearer, and modifications to the depositional model will be made.

The cores described here are part of a set of shallow engineering bore holes donated by a drilling contractor. Maximum depth is 34 m (110 ft), with most of the holes penetrating alluvium for the first 18 to 24 m (60 to 80 ft). Because the cores represent a very limited geographic area, core data are compared with outcrop observations before interpretations are made.

Core samples were examined and logged, and thin sections of impregnated samples were analyzed by point-count for porosity and composition. Mineralogy was determined by staining and confirmed by X-ray diffraction. Outcrop measurement and sampling took place in 1983 and 1984. Sample descriptions are given in the sections on diagenesis and depositional facies, with interpretations reserved for the discussion section.

GEOLOGICAL SETTING

St. Croix is located at the northwestern edge of the Lesser Antilles arc (Fig. 1). The island lies 176 km (95 mi) southeast of Puerto Rico and 2600 km (1400 mi) southeast of New York. At its widest points, the island is 39 km (21 mi) long, 9 km (6 mi) wide and covers an area of 207 square kilometers (84 square miles; Cederstrom, 1950).

Well-lithified Cretaceous siliciclastics form the mountainous eastern and western ends of the island. These rocks are composed of tuffaceous and eroded volcanoclastic material, deposited in deep water (Whetten, 1966). Early Tertiary diorite and gabbro intrusives crosscut the Cretaceous sedimentary material on both ends of the island.

The central part of the island is underlain by the Miocene Kingshill Limestone and the Oligocene Jealousy Formation. These formations were penetrated by test wells in 1939, which revealed a maximum thickness for the Kingshill of approximately 183 m (600 feet). The test wells did not completely pierce the Jeaslousy Formation and the maximum thickness of the unit is thought to exceed 427 m (1400 ft).

Depositionally, the Kingshill has been placed within the framework of an elongate, fault-bounded seaway (Multer and others, 1977; Gerhard and others, 1978). Facies within the Kingshill consist of interbedded basinal pelagic and hemipelagic sequences, shallowing upward into reefal debris deposits and in-situ reefs. The latest foraminiferal stratigraphy is that of Lidz (1982), who placed the Kingshill deposition between Late Miocene and Early Pliocene. This is somewhat later than previously published biostratigraphic work, which dated the Kingshill from Early to Middle Miocene (van den Bold, 1970; Multer and others, 1977).

The cores referred to in this paper were taken from the southern end of the central limestone plain. This location is downdip and to the south of the type-section outcrop at Villa La Reine. To the east and west are outcrops representing reefal and basinal deposits, respectively

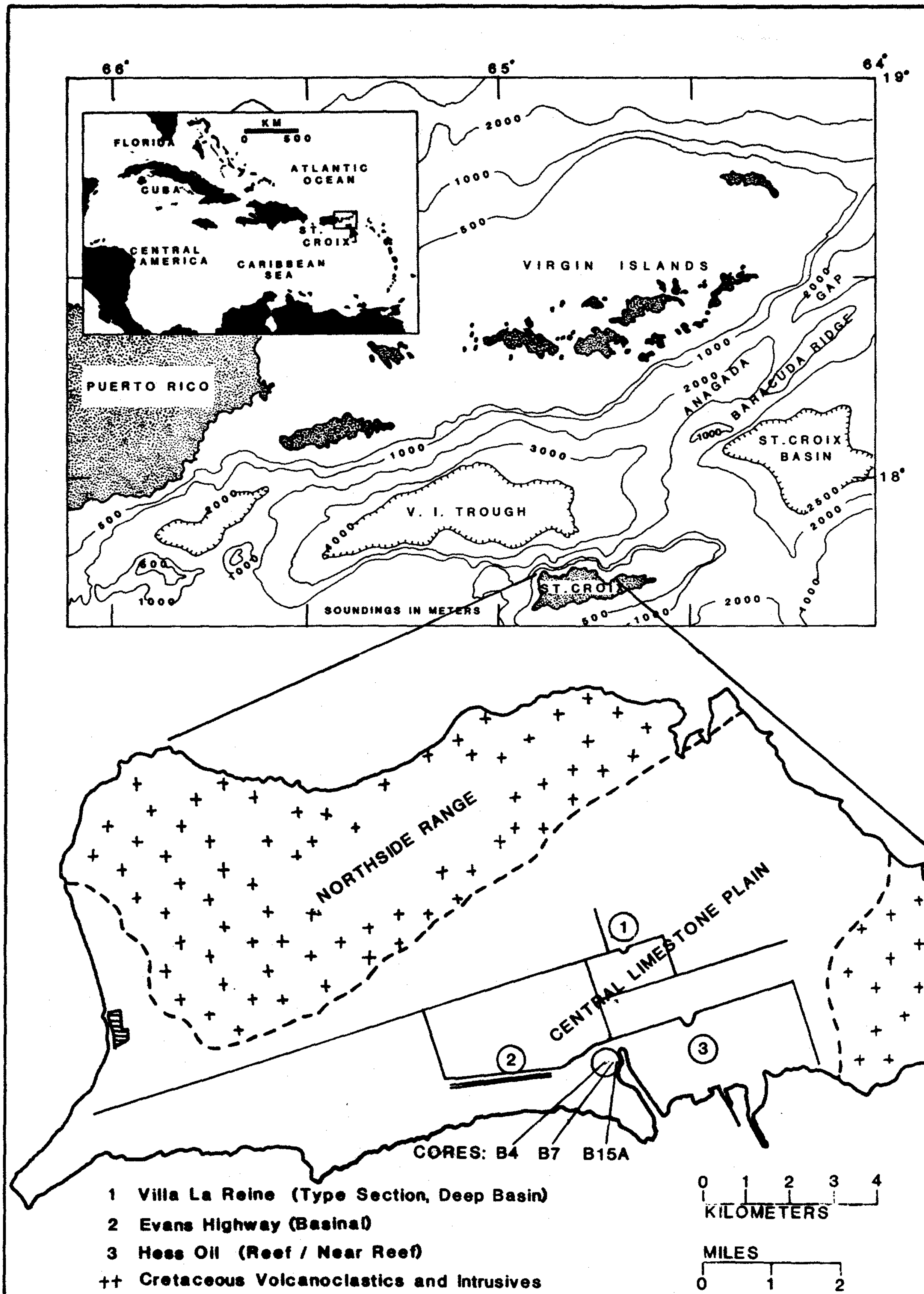


Figure 1. Location map showing geographic setting of St. Croix and simpilified geologic relationships. Core locations and the location of important outcrops are labeled.

(Fig. 1). The type-section of the Kingshill consists of rhythmically interbedded pelagic and hemipelagic sequences. Pelagic material in this outcrop consists primarily of planktonic foraminiferal and nannofossil ooze. The hemipelagic deposits appear to be shallow-derived sediment gravity flows containing sand-sized reefal and terrigenous debris. Other flows contain cobble-to boulder-sized clasts of head corals and terrigenous material. This type of deposition typifies the bulk of the exposed Kingshill and is interpreted as deep basin-margin sedimentation.

The Evans Highway Cut, to the west, shows some similarity to the type-section in its rhythmic bedding. At outcrop base, pelagic material alternates with graded, shallow-derived sand layers. This bedding becomes less regular and more nodular up the outcrop, and is truncated by a channel-like layer that Lidz (1982) interprets as an unconformity. The top of this outcrop contains large quantities of benthic forams similar to those encountered in the cores described in this paper. This outcrop is interpreted as mid-basinal deposits of the shoaling Kingshill basin.

The Hess Oil Refinery outcrop, to the east, contains coral molds, altered debris, and several presumed exposure and hardground surfaces (Fig. 1). The interpretation here is one of in-place or near in-place reef deposits. Gerhard and others (1978) suggest that these deposits unconformably overlie the Kingshill-proper and are somewhat younger in age. Lidz (1982) places the time of deposition of this unit during the Early Pliocene which is roughly coincident with deposition at the Evans Highway cut. Lidz (1982) makes no mention of an unconformity surface between these reefal deposits and the basinal sediments.

DEPOSITIONAL FACIES

The bulk of sediment in these cores conforms to either a skeletal, reef-derived packstone facies or to a coral-mold wackestone facies. There is considerable variety in the dominance of allochem type present in both facies, but major bioclast varieties are those to be expected in

Tertiary reef and near-reef debris. Most allochems are rounded, sand-sized skeletal debris, with a large percentage of both benthic and planktonic foraminiferans. Encrusting forms, such as crustose coralline algae and Homotrema sp. are also well represented. Recognition of specific skeletal types depends on the amount of post-depositional alteration within a core interval. Since the effects of micritization, dissolution, and recrystallation vary widely within short core intervals, point count results reflect diagenetic as well as depositional trends. Throughout the cores, bedding was either well hidden or absent. Core descriptions are shown in Figures 2 through 5.

Skeletal Packstone Facies

Dominant grain types within this facies were benthic and planktonic forams, coralline algae, and bioclasts obscured by alteration (Figs. 2-5). This latter category includes rounded debris with micritized or recrystallized interiors. Minor constituents include echinoid fragments, bryozoans, ostracodes, molluscan fragments (as molds) and rock fragments. Originally aragonitic debris have been altered with no retention of skeletal structure. Rounded coral and green algal clasts, while presumably contributors to this sediment, are seldom recognizable.

The matrix of these rocks ranges from micrite to blocky microspar. In areas where micrite is absent as matrix, it is often still present in geopetal fill. Where well preserved, micrite matrix material is often pelleted. Matrix content (relative to allochems) in this facies varies from around 20 to 80 percent, averaging about 35.

Other than lithic fragments and minor clay, inorganic grains are not present in this facies. Coated grains are restricted to red algal encrustations, either around other grains such as benthic forams, or around grain aggregates. Grain size alternates between sand-sized skeletal debris and coarser granule to pebble sized rhodolites and molluscan shell fragments (Fig. 6C and D). Sorting is generally poor.

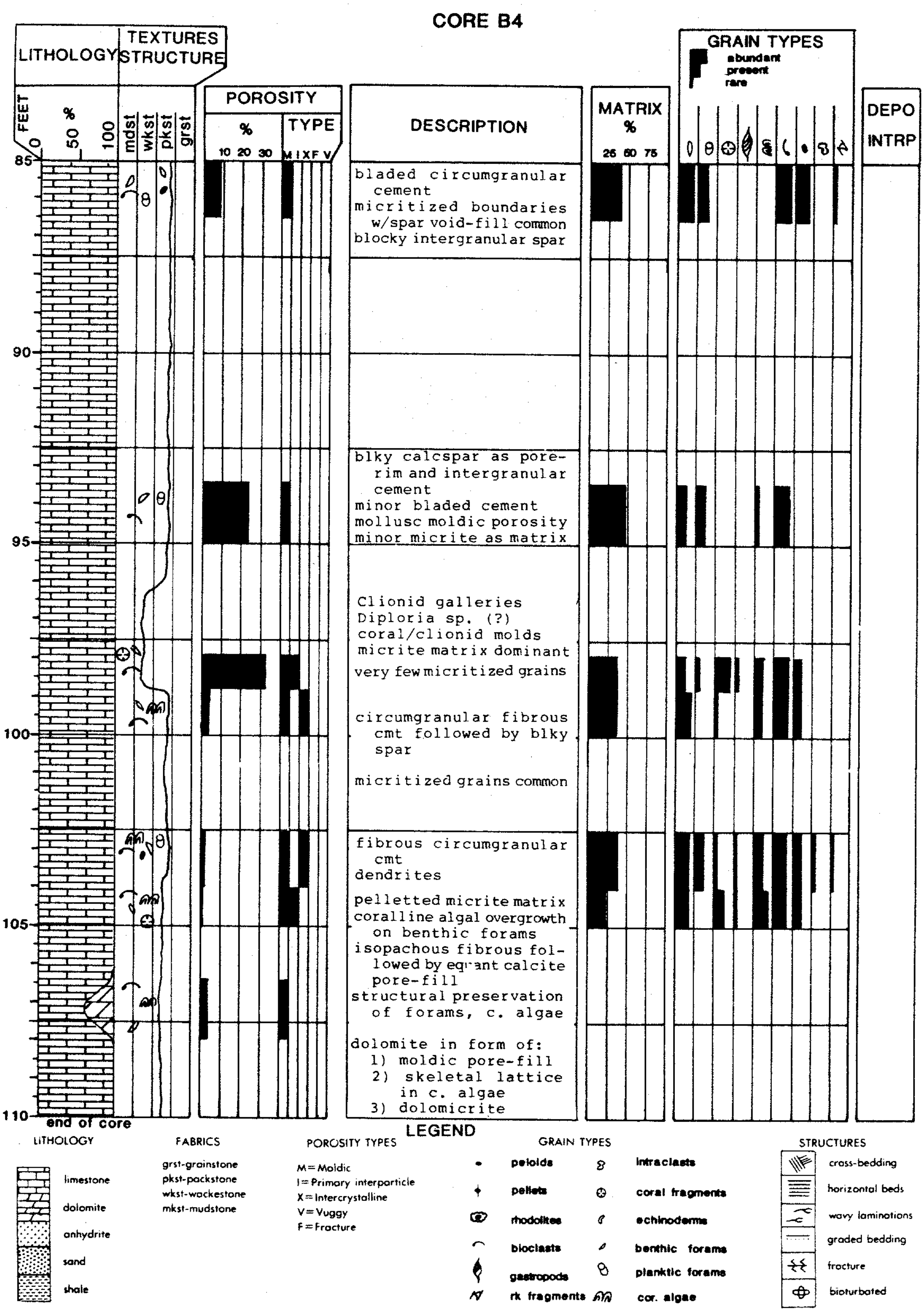


Figure 2. Core log for Core B4. Information from thin-sections is included.

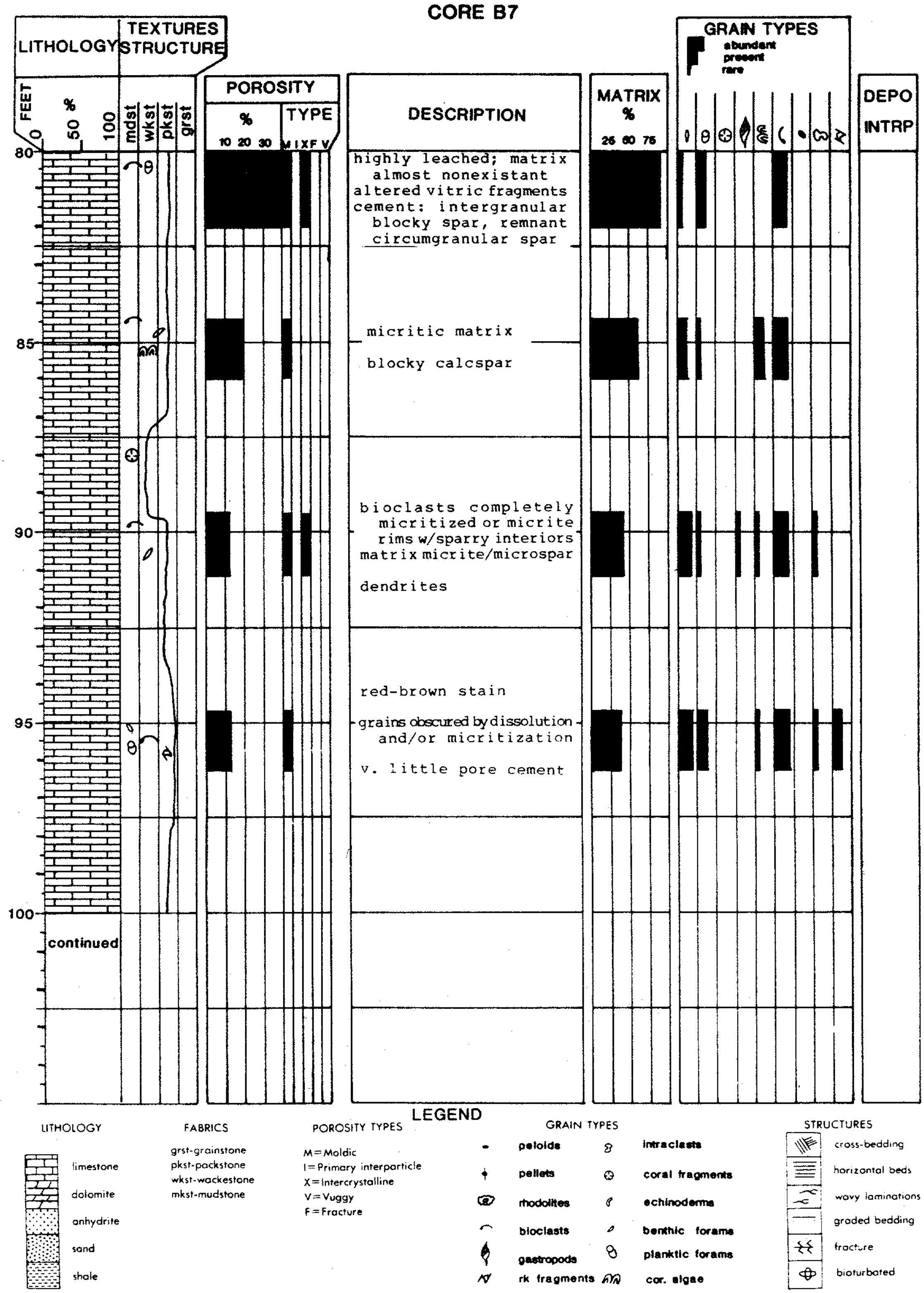


Figure 3. Core log for Core B7. Thin-section information is included.

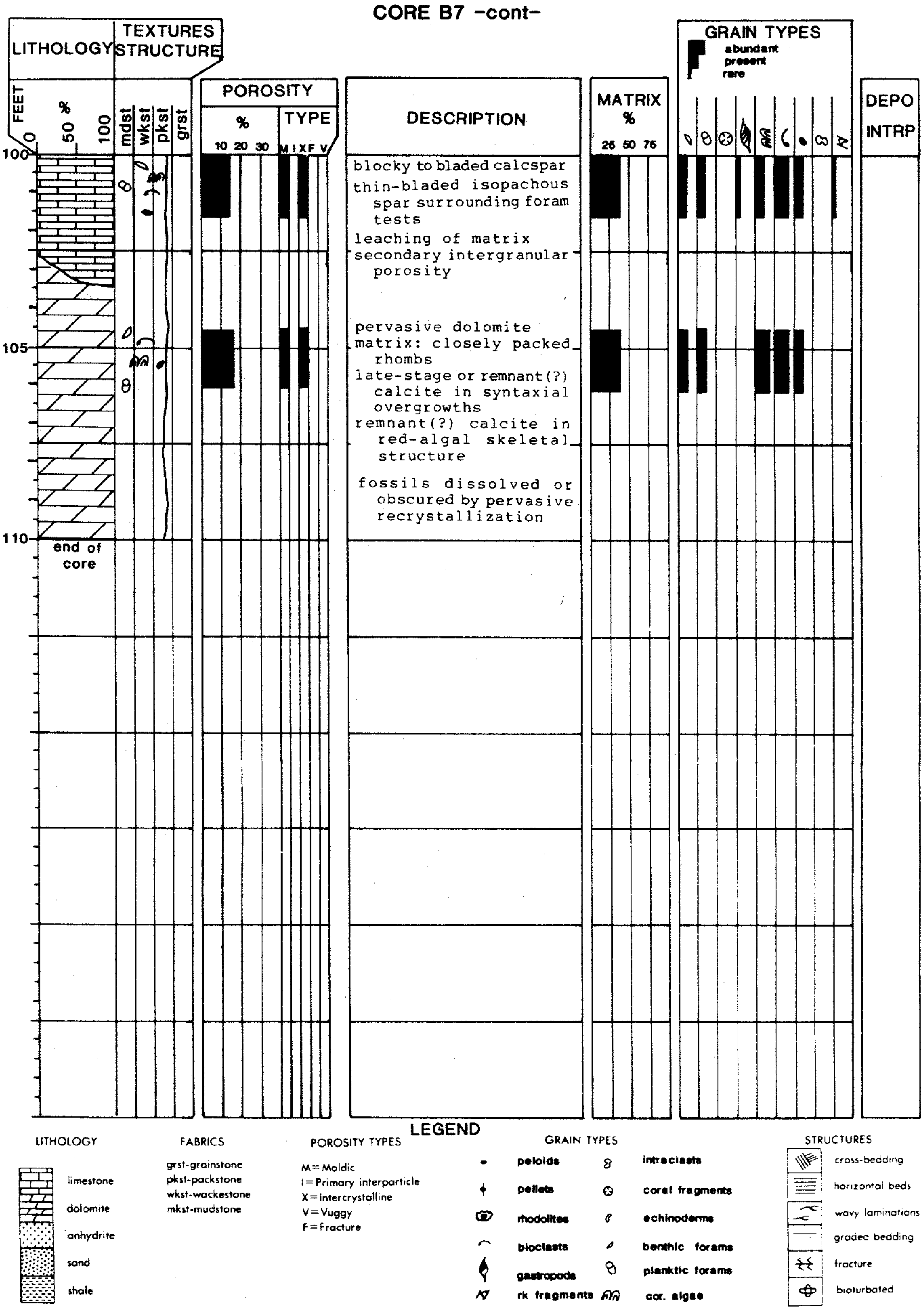


Figure 4. Core log for Core B7, continued.

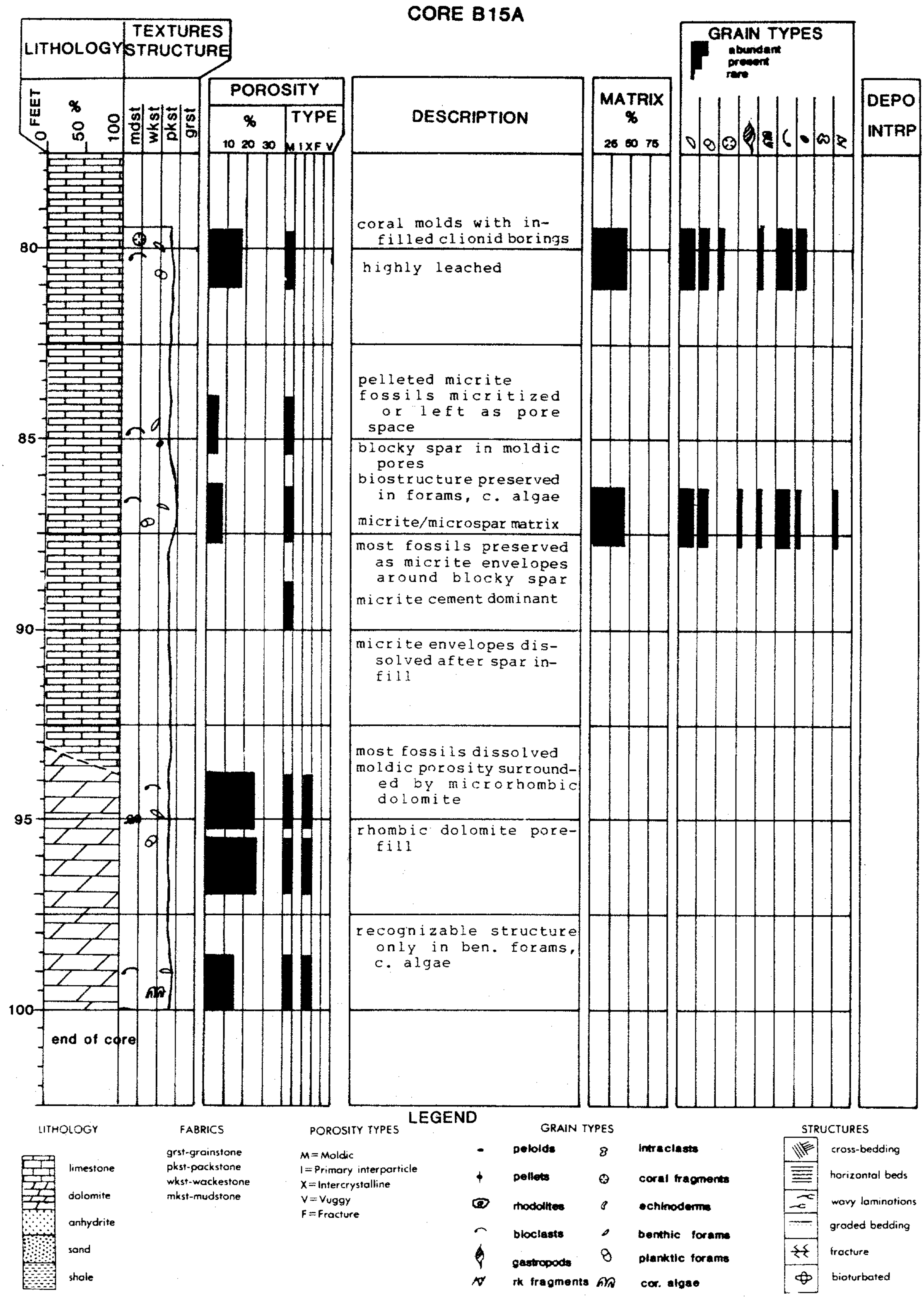


Figure 5. Core log for Core B15A. Thin-section data included.

In general, the constituents of this facies represent a normal reef and shallow water assemblage, with the inevitable exception being the planktonic forams. These are of the globogerinid type, and are generally very well preserved, showing no signs of abrasion or fracturing. Planktonic forams make up between 2 and 10 percent of the allochems present.

Coral Wackestone Facies

This facies is not present in every core. When present, it appears as a muddy interval between 30 and 50 cm (12 - 20 in) thick, dominated by coarse moldic porosity (Figs. 6A and B; 7A, B and C). The molds represent branching coral fragments up to several centimeters long, in which detailed calyx structure is well preserved. Internal borings of endolithic sponges are preserved as fine lobes and fibers of mud left after dissolution of the aragonitic skeleton (Figs. 6B and 7C). Grain preservation is generally good in these intervals, with fewer micritized clasts. Other skeletal components correspond to the same assemblage as those in the skeletal packstone facies.

The major coral species represented here appears to be Stylophora sp., a branching coral very similar in appearance and habitat to Acropora cervicornis. The fragments appear to be disarticulated and deposited with the mud matrix. A single example of a head coral fragment with calyx structure similar to Diploria also appears in this facies. In general, the moldic coral wackestone facies is enclosed within the packstone facies.

DIAGENETIC FACIES

Cement in these sediments is of three major types: (1) bladed isopachous calcite, (2) blocky pore-fill calcite, and (3) rhombic dolomite. The first two are common to the bulk of the cored interval, but are absent in the dolomitic zones. The transition to dolomite is

Figure 6. Scale divisions in centimeters.

A. Core B4: piece 1/3, 26.2 m (86 ft). Moldic wackestone facies.

B. Core B4: piece 3/13, 30.2 m (99 ft). Moldic coral wackestone facies. Moldic pores penetrate through the core piece; internal molds of clionid borings and external calyx molds are visible within the pores.

C. Core B4: piece 5/2, 32.3 m (106 ft). Skeletal packstone facies.

D. Core B4: piece 5/4, 32.6 m (107 ft). Skeletal packstone facies. Note coarse grains, often with coralline algal encrustations. Isolated patch of partial dolomitization is at the bottom of this cece (not visible).

Figure 7. Scale divisions in centimeters.

A. Core B7: piece 1/4, 26 m (84 ft). Moldic wackestone.

B. Core B7: piece 2/13, 27 m (88 ft). Moldic coral wackestone.

C. Macrophotograph of B (above). Note internal molds of clionid borings.

D. Core B7: piece 3/4, 28 m (93 ft). Skeletal packstone, low porosity zone.

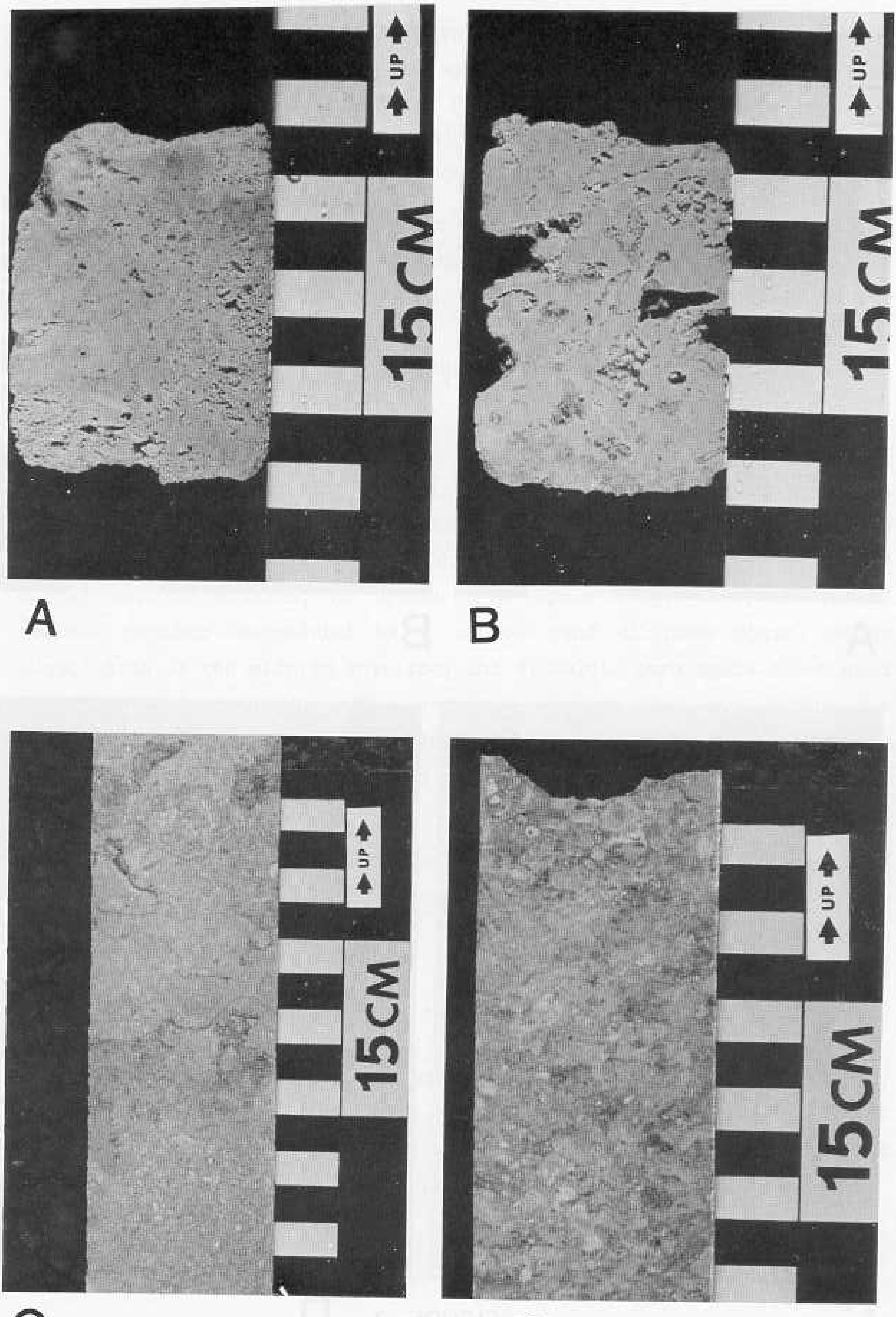
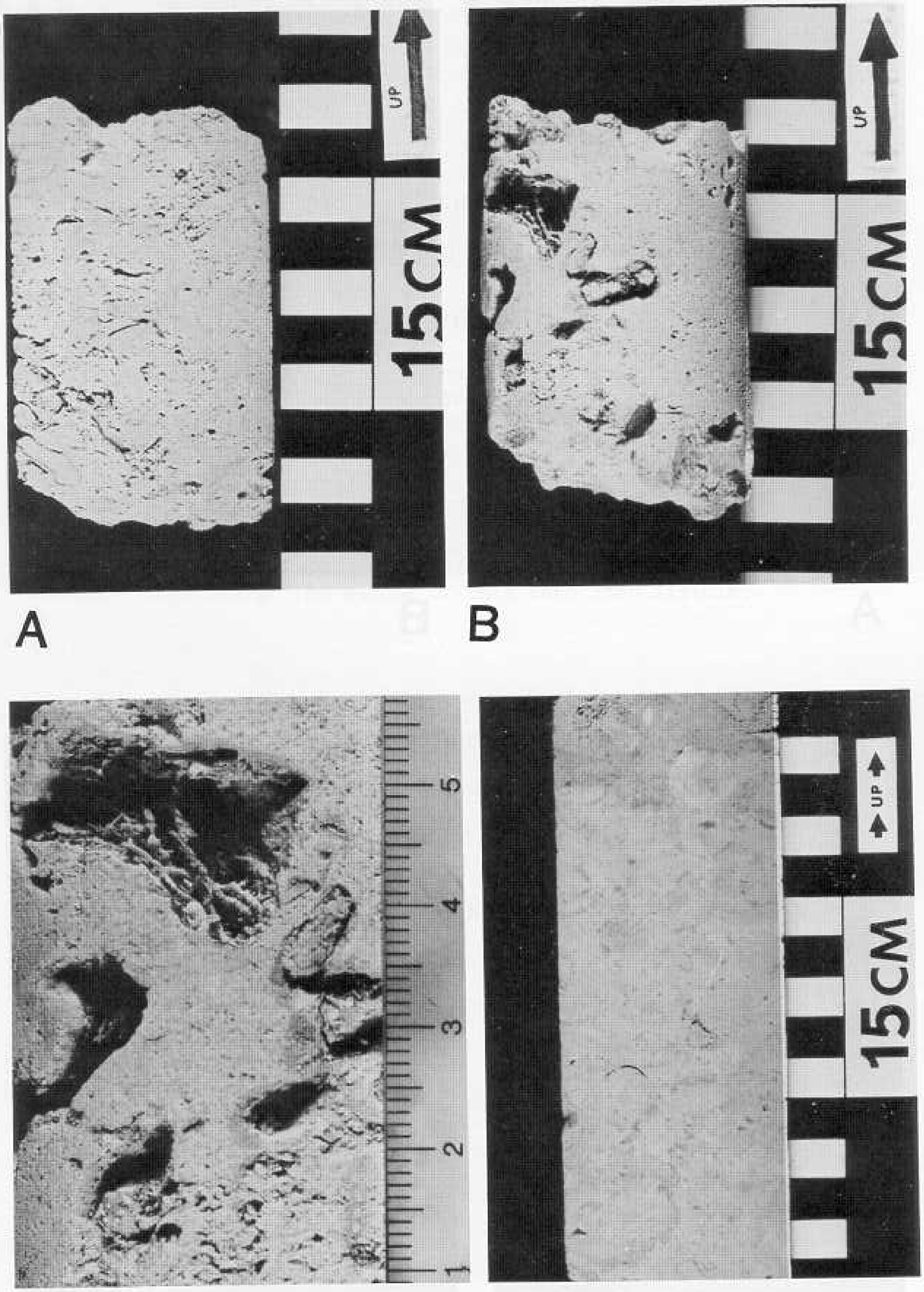


FIGURE 6



A B C D

FIGURE 7

both abrupt and complete. Petrographically, the isopachous cement is formed first, and contains an early generation of inclusion-rich crystals that give way to clear, inclusion-free cement. This bladed cement is followed by a layer of pelleted geopetal micrite, and the void is filled by blocky calcite (Fig. 10C).

Relict biological structure is found most often in coralline algae and foraminifera. This is true within the dolomitic intervals as well, where fine detail in these skeletal types is sometimes preserved despite dolomitization (Fig. 11C and D). However, the majority of bioclasts have been altered by micritization, recrystallization or dissolution, with total loss of skeletal detail. All types of grain alteration can be found throughout the cored interval.

Micritized grains appear to be affected by dissolution in a consistent order. Downhole, micritized fossils appear as: 1) completely micritized grains (peloids, Fig. 10D); 2) micrite envelopes around blocky calcite mosaics, or around pore space (Fig. 11A); 3) blocky calcite mosaics surrounded by a narrow band of pore space, after dissolution of the micrite envelope; and 4) moldic pore space surrounded by microrhombic dolomite. This sequence suggests that with depth, the sediment is subjected to increasingly corrosive fluids, or that deeper sediments have been subjected to corrosive pore fluids for a longer period of time.

The Kingshill Limestone appears to follow a consistent pattern of dissolution and alteration. A generalized downhole sequence of changes consists of the following zones.

Highly Leached Zone

The top of some cores consists of a leached zone with porosity exceeding 45 percent by point count. Bioclasts have been almost completely removed by dissolution, leaving only remnant rims of cemented crusts. Recovered core material is in the form of cobble-sized rubble.

Figure 8. Scale divisions in centimeters.

A. Core B7: piece 4/1, 29 m (95 ft). Skeletal packstone, low porosity diagenetic zone.

B. Core B7: piece 5/3, 31 m (101 ft). Skeletal packstone, vuggy porosity zone. Porosity here is both vuggy and moldic, with an increase in secondary intergranular porosity.

C. Core B7: piece 5/10, 32 m (104 ft). Dolomitic zone, sediment is completely dolomitized.

D. Macrophotograph of C (above). Note banding of slightly more densely-packed dolomitic layers.

Figure 9. Scale divisions in centimeters.

A. Core B15A: pieces 1/3,4, 24.7 m (18 ft). Moldic coral wackstone.

B. Core B15A: piece 4/6, 26.8 m (88 ft). Skeletal packstone, low porosity zone. Note moldic porosity.

C. Core B15A: piece 5/5, 29.7 m (94 ft). Vuggy porosity zone in skeletal packstone.

D. Core B15A: piece 6/7, 30.2 m (99 ft). Dolomitic zone.

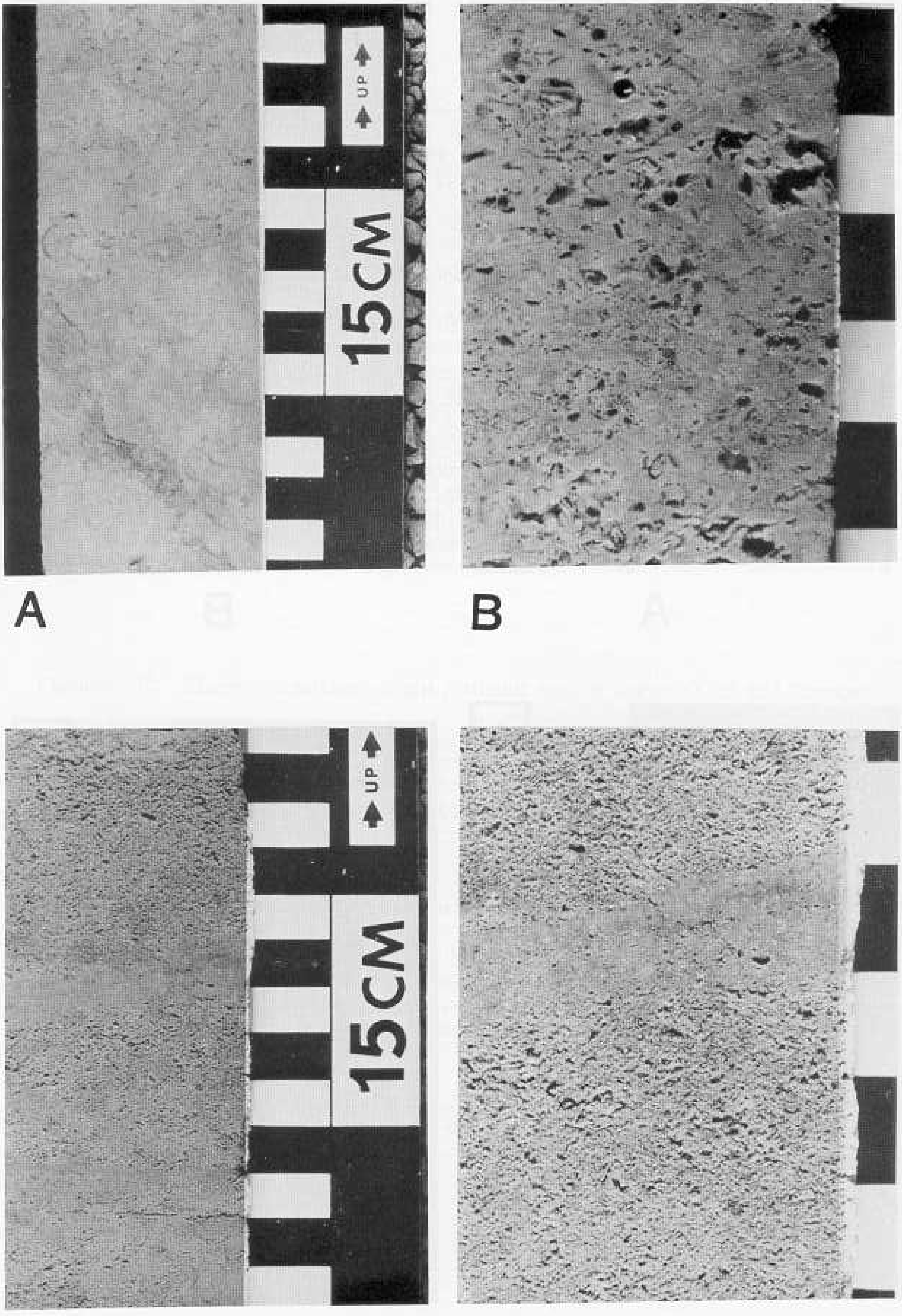
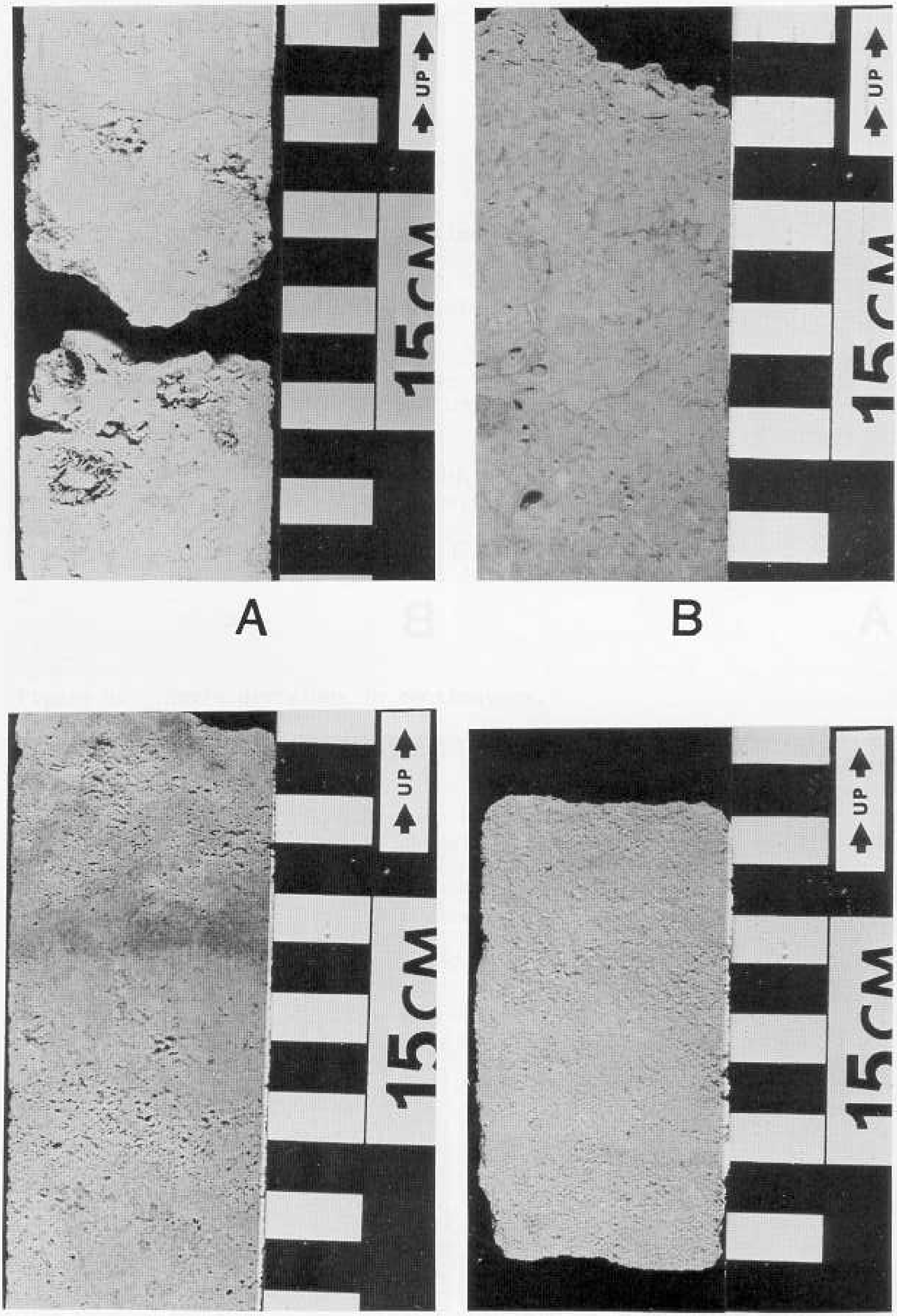


FIGURE 8



A

B

C

D

FIGURE 9

Figure 10. Plane polarized light; black scale bar = 0.25 millimeter.

A. Core B4: pieces 1/1, 25.9 m (85 ft). Skeletal packstone. Micritized grains and grain boundaries, microspar matrix.

B. Core B4: piece 4/8, 31.7 m (104 ft). Skeletal packstone, low porosity zone.

C. Core B4: piece 4/9, 32 m (105 ft). Skeletal packstone, low porosity zone. Pore filled with: 1) inclusion-rich bladed to fibrous calcite, 2) inclusion-free bladed to fibrous calcite, 3) micrite, and 4) blocky spar

D. Core B4: piece 5/4, 32.6 m (107 ft). Isolated dolomitic zone. Micrite matrix, moldic porosity. Slightly dark, subhedral pore-rimming crystals are dolomite; these are interspersed with blocky calcite pore-fill. Dolomite also as: 1) dolomicrite and 2) the skeletal lattice of coralline algal fragments.

Figure 11. Plane polarized light; black scale bar = 0.25 millimeter.

A. Core B4: pieces 2/15, 28.7 m (94 ft). Skeletal packstone, in transition between the highly leached zone and the low porosity zone. Micritized grains and micrite rims with blocky calcite centers; microspar matrix.

B. Core B15A: piece 5/6, 29 m (95 ft). Dolomitic zone. Benthic foram test with circumgranular rim of rhombic dolomite.

C. Core B15A: piece 6/1, 29.2 m (96 ft). Skeletal packstone, extensively dissolved and dolomitized. Light areas are pore space. Remnant coralline structure still visible.

D. Same as C (above), 100X. Skeletal fragments rimmed with patchy, euhedral dolomite rhombs. Light area is pore space.

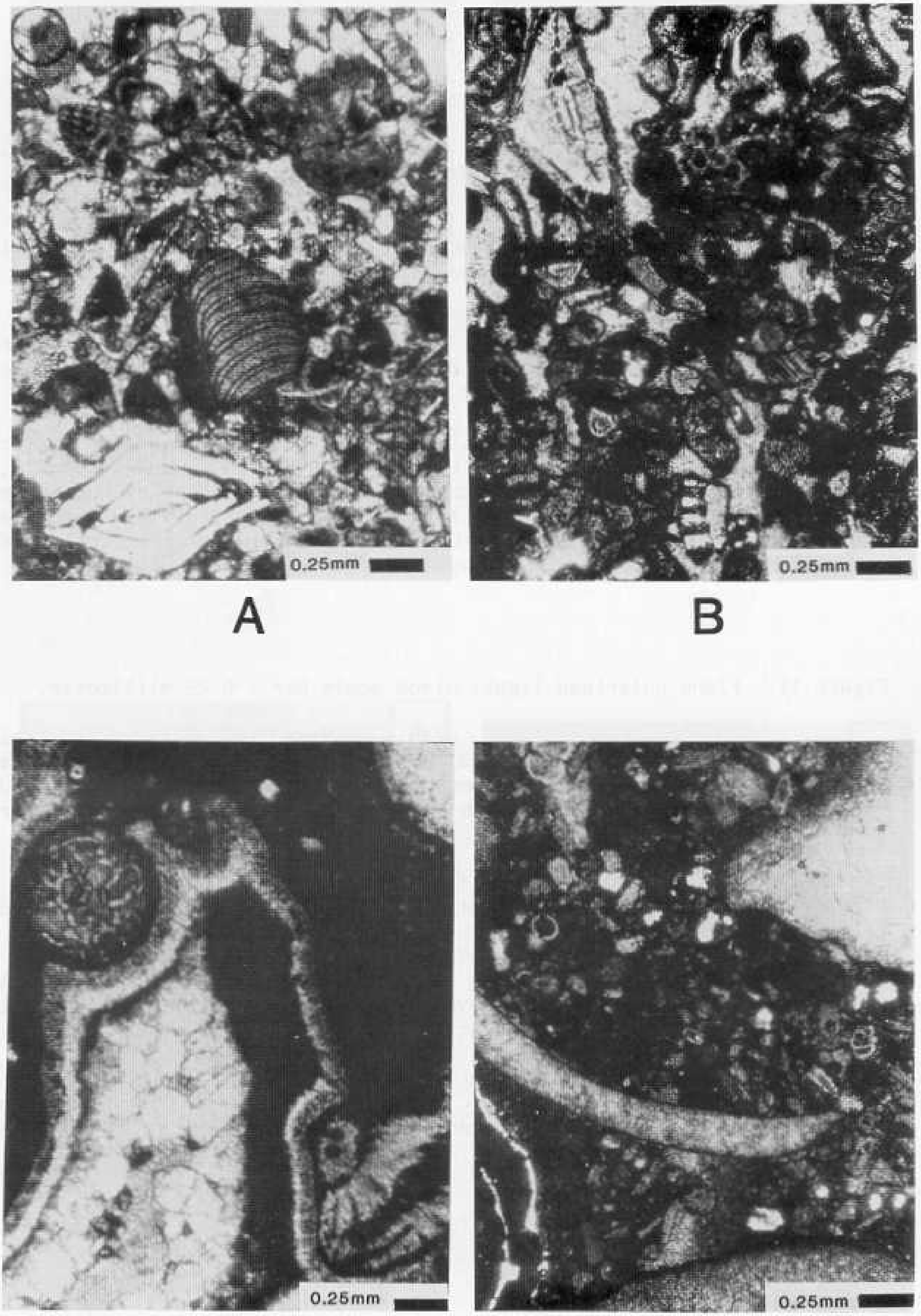


FIGURE 10

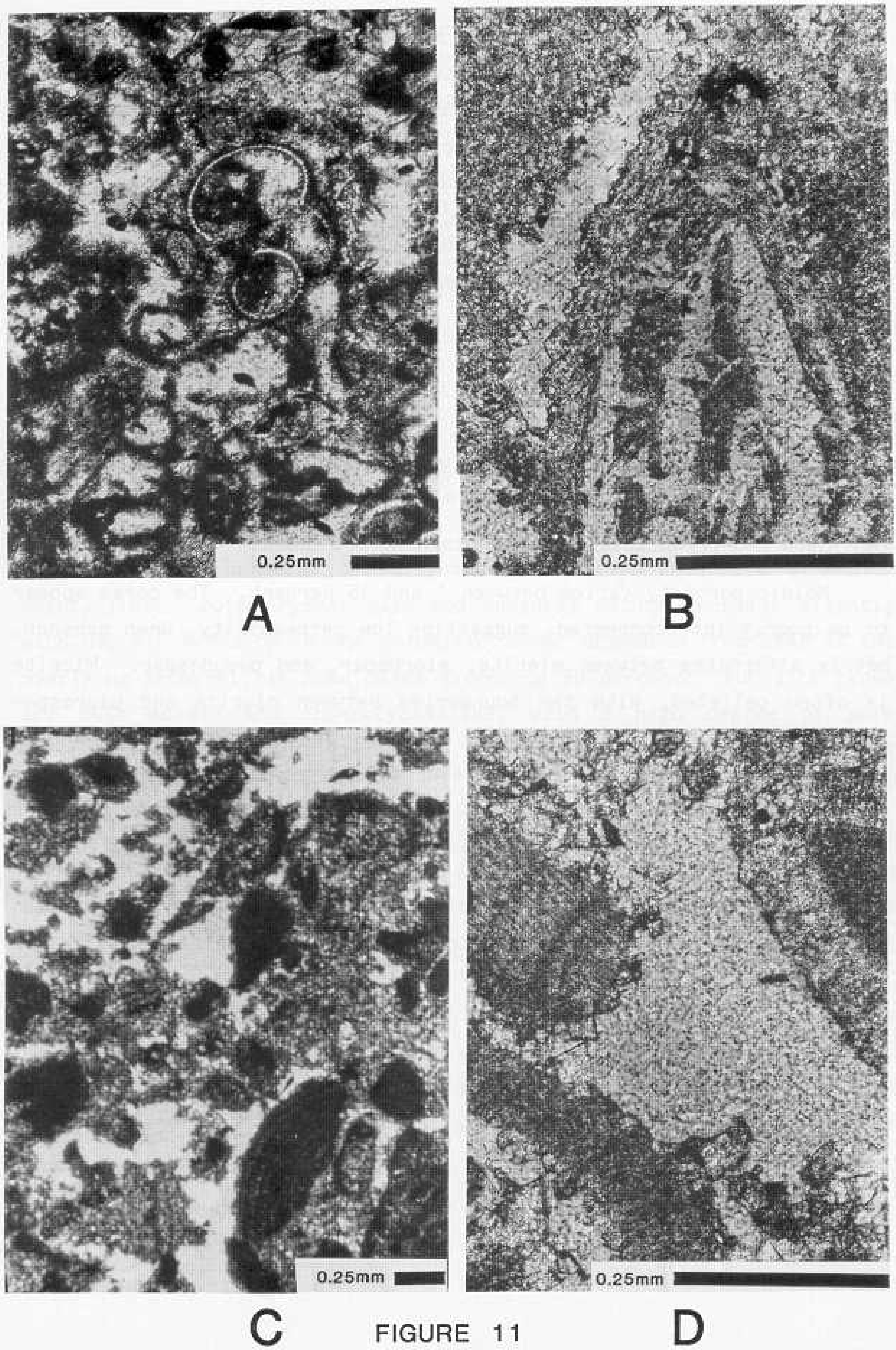


FIGURE 11

On the microscopic level, this zone appears highly leached. Grains and matrix have been dissolved, leaving rims of sparse circumgranular calcite and dispersed intergranular spar. Porosity here is both moldic and intercrystalline, and rare vitric grains appear to be undergoing alteration to clay. This zone occurs as rubble at the tops of cores. Maximum thickness is probably about 0.3 m (1 ft).

Low Porosity Zone

This zone makes up the bulk of the material in the cores and consists of packed bioclasts in the sand to pebble size range (Fig. 6C and D). This material is massive and well cemented. Cement types include both bladed isopachous and equant spar. Core recovery here is high, yielding long and continuous core intervals. Dendritic growths (Mn?) and red-brown intergranular staining are common.

Moldic porosity varies between 1 and 15 percent. The pores appear to be poorly interconnected, suggesting low permeability. When present, matrix alternates between micrite, microspar, and pseudospar. Micrite is often pelleted, with the boundaries between micrite and microspar abrupt rather than transitional. In areas of extensive intergranular spar, micrite is often still preserved as geopetal fill. Fossil preservation is good only for coralline algae and foraminifera. In most cases, bioclasts are highly micritized or are preserved as micrite rims with mosaic calcite centers.

Moldic Coral Zone

Several cores contain short (30 to 50 cm) intervals characterized by centimeter-sized moldic porosity (Fig. 7A, B and C). These intervals correspond to the coral wackestone facies and are contained within the low porosity zone. Porosity here exceeds 30 percent as a direct function of the original content of coral. Other than the obvious dissolution of finger-shaped coral fragments, grain preservation within the micrite matrix is good.

Vuggy Porosity Zone

This zone lies directly above the dolomite zone. The core takes on a pitted appearance caused by the dissolution of intergranular cement and some skeletal material (Fig. 8B). Vug size is on the order of several millimeters. Porosity is 10 to 15 percent, increasing from the less than 5 percent porosity of the Low Porosity Zone. Mineralogy is still calcite. Cementation in this zone consists of bladed isopachous and blocky intergranular spar.

Dolomite Zone

At the bottom of several cores, the vuggy, pitted interval is underlain by an abrupt transition into pervasive dolomite between 27 and 32 m (90 to 105 ft; Figs. 8C and D, 9C and D). Dolomite is in the form of subhedral to euhedral turbid rhombs that range from fine to medium crystalline. Both crystal size and euhedral nature increase slightly with depth. Porosity in the dolomitic zones increases from that of the overlying interval, in some cases exceeding 30 percent. Porosity types are both moldic and intercrystalline, with a high degree of pore interconnection. Due to incomplete penetration, the total thickness of the dolomitic zones is not known.

Relict biological structure is recognizable only in coralline algae and benthic foraminifera (Fig. 11C and D). Other skeletal grains have been dissolved away, leaving moldic pores surrounded by microrhombic dolomite. With increasing depth, both dolomite crystal size and packing density increase, forming bands of denser dolomitic material (Fig. 8C and D). Fine skeletal structures within coralline algal clasts are partially calcitic, presumably a remnant after dolomitization. Similarly, several syntaxial echinoid overgrowths and their nuclei appear to be calcitic. Whether this is a late-stage calcite or remnant material is not known.

An anomolous 2 to 3 cm thick zone of isolated dolomite occurs in core B4 at 33 meters (107 ft, Fig. 2). Other than this occurrence, dolomite is absent in this core, and the dolomite here is less porous and petrographically distinct from that of the other cores. Within this narrow interval, dolomite: 1) forms the crystalline fill of moldic pores; 2) forms the skeletal lattice in coralline algae, either by replacement or fine-scale dissolution and reprecipitation; and 3) acts as matrix in the form of dolomicrite. The dolomite pore-fill is followed by a later stage of blocky calcite, a relationship not seen in other dolomitic intervals (Fig. 10D).

DISCUSSION

Sedimentology

The skeletal allochems that make up the sediments of these cores are typical reef and shallow bank-derived clasts. This observation holds for both the skeletal packstone and coral wackestone facies. Many allochems show significant rounding, with the exceptions being the benthic and planktonic forams, and perhaps the finger-shaped coral fragments preserved as molds. Neither benthic nor planktonic forams show obvious signs of agitation; most tests are whole, with no signs of fracturing or rounding. However, the presence of encrusting forms such as Homotrema and abundant coralline algae imply the presence of reefs, hardgrounds or other stabilized substrates. Coralline algal encrustation around benthic forams establishes a photic-zone origin for several of these species.

The matrix material in these cores is composed of both micrite (sometimes pelleted) and calcite pseudospar. In examples where the pseudospar dominates, micrite can be found in geopetal structures that show unaltered orientation. In cases of bladed void-fill cement, micrite is present as a covering over early cement generations (Fig. 10C). The blocky calcite that often comprises the final porefilling stage is generally inclusion-rich. Our interpretation is that these sediments were deposited in a mud-rich environment, and that early cementation took place penecontemporaneously with lime mud infiltration and redistribution. We also suggest, with inconclusive evidence, that the intergranular calcite in these sediments is replacive rather than a primary precipitate, and is not a reliable indicator of depositional environment.

The cores are too closely grouped to provide geographic trends, and too shallow to indicate broad facies relationships. However, these samples are located midway between outcrops representing basinal and reefal deposits, a location that agrees well with the sedimentological evidence. A deep-shelf to upper slope environment of deposition is suggested on a sloping bank similar to that shown in Figure 12. Reef deposits and shelf patch-reefs provide both the skeletal sediments, and the cemented substrate necessary for the population represented in the cores. A broad bank is indicated by the rich population of nummulitid forams.

The presence of globigerinids argues for a bank margin open to the sea with no reef restriction. The preservation of fragile foram tests argues against their being significantly transported or agitated in shallow water. These forams reside in the ocean surface layers, and can be incorporated into outer shelf and slope sediments. The lack of pelagic chalk accumulations, such as those seen in the type-section outcrop, indicates a shallower environment than deep basinal Kingshill.

The lack of the Coral Wackestone facies in several cores is evidence of patchy distribution of these sediments. This type of distribution could arise from: 1) channelization of muddy sediment-flow deposits; 2) ponding of the sediments in topographic lows; 3) in-situ or locally reworked accumulations of coral debris; or 4) inhomogeneous distribution of the mud and coral debris within the larger mass of skeletal material. Any of these suggestions is possible, and could contribute to the observed distribution.

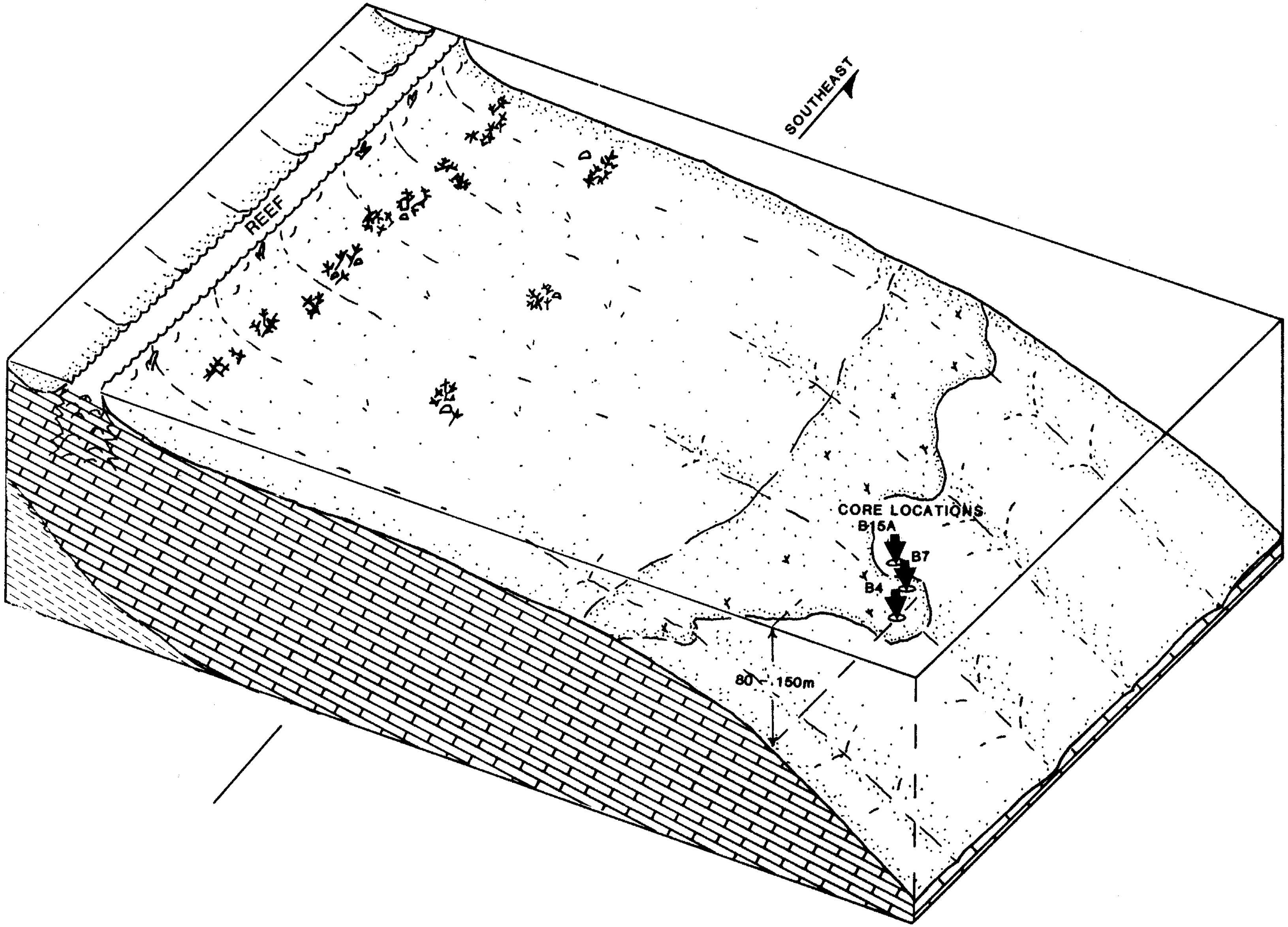


Figure 12. Schematic block diagram of the depositional environment of the Kingshill Limestone. Core locations are marked. Reef buildup is recessed to landward of the outer shelf, with scattered patchreef and forereef growths of Stylophora and headcorals. The diagram shows weak channelization of a coral/lime mud debris layer (coral wackestone facies). Other explanations are: 1) topographic control of sediment flows by ponding and 2) patchy distribution of in-situ or little-transported accumulations.

The lack of boulder-sized coral debris in these deposits is curious, since head-coral conglomerates are commonplace in basinal outcrops to the north of the coral area. Either extensive reef development does not exist in this region, or coarse reef debris are bypassing or are not reaching the area of the cores. Since active reef growth is implied by the sediment constituents, it is plausible that the reef does exist, but is far enough away from the shelf margin to prevent the direct transport of coral boulders into the basin.

Stylophora and Diploria, both present in the wackestone facies, could be derived from fore-reef and bank habitats closer to the slope than the reef proper. Alternatively, relative sea level may have dropped to the point that exposed the extensive reef buildup and moved the strandline out along the shelf. This would effectively remove the reef proper from contributing sediments to the shelf, and restrict basinal sedimentation to reworked shelf material.

To summarize, these cores are located in a slope region of the shoaling Kingshill basin. Reef and bank deposits are transported downslope and deposited with mud. Bedding is either obliterated by bioturbation or precluded by the transport mechanism. Globigerinid foraminifera are mixed into the sediments and imply open-shelf conditions. Active reef growth is set back and isolated from the area of slope deposition, leaving an open sloping bank with scattered patchreefs and hardgrounds. There is no evidence to either prove or disprove the existence of a shelf-margin slope break. Water depth at the core location was probably between 80 to 150 m (260 - 500 ft).

Diagenesis

Sequence of Events

The order of downhole diagenetic changes suggests a consistent pattern of dissolution and cementation. Initial cementation produced the turbid to clear isopachous bladed cements that line cavities and surround grains. This cementation occurred during or prior to immobilization of the micrite matrix, allowing the settling of micrite layers on top of the bladed cement. This relationship can be seen in several geopetal and void-fill structures.

Following the micrite layer, the void space was filled with equant calcite mosaic, and much of the micrite matrix converted to microspar and pseudospar. The micritic interiors of peloids are dissolved and left as void space, or alternatively replaced by equant calcite mosaic. These steps appear to be concurrent with the removal of aragonitic material and the presumed stabilization of the rest of the mineral suite.

Replacement and cementation by blocky spar is followed by dissolution. Three styles of dissolution are interpreted to have occurred simultaneously in different parts of the core but generally are seen with increasing intensity in a downhole direction: 1) Micritized rims are dissolved around equant calcite, leaving halos of void space around crystalline interiors. 2) This is underlain by preferential dissolution of matrix calcite resulting in high intergranular porosity. 3) Finally, dolomitization results in extensive removal of both skeletal and inorganic calcite.

The dolomitic material in these cores closely resembles the petrographic descriptions of dolomite from Bonaire (Sibley, 1980) and Jamaica (Land, 1973) both of which are interpreted as mixing-zone dolomites. However, the petrography of dolomites is poorly understood, and petrographic information alone is certainly insufficient to assign an origin for this example. Unfortunately, there is not yet enough geochemical or regional geological information to constrain the various possibilities further. In the hypothetical scenario below, mixed-water dolomitization is called upon as a best first guess.

Hypothetical Scenario

Initial cementation takes place in the marine environment shortly after deposition. Bladed isopachous cement formed in cavities and around grains, and is covered with interstitial micrite. At this stage, many of the grains have been micritized. Island uplift continues, and allows cementation in the meteroic phreatic zone, producing equant calcite pore-fill and transformation of micrite to microspar in the matrix. Stabilization of the mineral suite and production of pore space from aragonitic allochems occurred at this time. Updip carbonate strata continue to be dissolved, producing saturated pore fluids and net cementation downdip.

Eustatic rise of sea level then places these strata in a mixing zone. Pore fluids become undersaturated with respect to calcite, producing dissolution of calcite grains and matrix. Dolomite forms in the subsurface, producing a rock of high intergranular porosity.

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