20. PELAGIC LIMESTONES OF THE CENTRAL CARIBBEAN, LEG 15

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INTRODUCTION

Pelagic and hemipelagic sediments rich in calcareous planktonic organisms comprise the bulk of the recovered rocks in the central Caribbean. The continuous coring and good recovery provided the shipboard party with an excellent record of those sediments. Recovered sections contain a vertical diagenetic succession ranging from calcareous muds to completely cemented limestones. The limestones contain varying amounts of planktonic foraminifera and radiolarians and thus can be characterized as pelagic limestones.

Pelagic limestones of Jurassic and Cretaceous age have been described from the Alps, Carpathians, Appenines, Pyrenes, Anatolia, the Balkans, and Cyprus. Similar strata have been described in the Himalayas and Indonesia, and pelagic "Aptychus limestones" have been reported in Cuba and the Cape Verde Islands (Garrison and Fisher, 1969). Lithified Upper Cretaceous chalks have been studied in Israel (Schneidermann, 1970), England (Hancock and Kennedy, 1967), Ireland (Wolfe, 1968), and in the western interior of the United States (Hattin, 1971).

The studies mentioned above involved rocks exposed on land and with a rather complex diagenetic history. The occurrence of limestones in the deep sea eliminates a number of factors influencing land-exposed rocks, precluding diagenesis by meteoric waters, considerable tectonism, and subaerial weathering. Moreoever, the mainly monomineralic calcareous phase of low magnesium calcite of most of the Upper Cretaceous rocks of Leg 15 confirms the proximity to the compensation depth postulated from other evidence. Metastable aragonite and magnesian (high Mg) calcite, so abundant in shallow-water carbonates, were not present in any appreciable amount.

The purpose of this paper is to summarize the textural variations with depth occurring in the studied cores. Detailed descriptions of thin sections and general lithology are given separately in each site report and will not be repeated here. It is hoped that the results will provide a useful model for cementation of deep-sea calcareous sediments.

METHODS OF STUDY

The soft sediments were studied in longitudinal sections on board the ship following standard procedures. Textural characteristics of the compacted and cemented rocks were best recognized on etched, fresh fractures or polished surfaces by means of acetate peels. In some cases those surfaces were stained by Alizarin-S-red.

Oriented thin sections were prepared from selected samples chosen for shore studies. For scanning electron microscopy both fresh fractured and polished-etched surfaces were used. After mounting on specimen stubs, the samples were vacuum coated on a rotating stage with gold and palladium. A nondispersive x-ray analysis was used in a few cases.

TERMINOLOGY

The modified classification of Olausson (see Chapter 2 this volume) was used to describe the various lithologies. Variations in induration of the sediments were expressed by addition of adjectives: ooze, indurated, highly indurated. This description is arbitrary, due to the lack of a standard terminology and a suitable mechanical device capable of measuring units of compaction.

A review of previous reports of the Deep Sea Drilling Project indicates the rather subjective usage of terms like "hard chalks" and limestones. Undoubtedly, the paucity of limestones in previous legs was the direct cause of using the term "limestone" to describe highly indurated chalks. It is hoped that the terminology defined here will be useful for similar descriptions in future reports.

In this volume, the term limestone is used to describe any calcareous rocks containing more than 30 percent $CaCO_3$ (equivalent of marl and chalk) and having undergone cementation. The textural expression of this process is precipitation of microspar and spar as an infilling of skeletal chambers or other voids. The term is prefixed by "argillaceous" if the $CaCO_3$ content is in the range of marl, or by the most abundant microfossil. This sediment classification differs somewhat from the popular terminology. In most cases in the literature, the term "limestone" applies to a rock containing more than 50 percent by weight of calcite, thus excluding a considerable part of marl.

On board the ship, the following criteria have been used to differentiate between chalks and limestones.

1) The chalks characteristically have fossils with either empty or micrite-infilled chambers (Plate 1, Figure 1). The micrite infilling is comprised mainly of nannofossils, rarely of mosaic grains (Schneidermann, 1970). In each case, the infilling is mainly a result of mechanical processes. The limestone may contain micritic infilling, but usually the chambers are infilled by microspar and spar (Plate 1, Figure 2), often in a drusy pattern.

2) The chalk tends to crumble or fracture easily under a mechanical stress, such as pressure with a spatula.

3) Soaking in water or acetone may cause dissociation or swelling of the chalk, but will not affect the limestone.

The criteria for differentiation described above are in accord with the definition of the term "chalk" in the literature. According to Bissell et al. (1967), chalk is "A porous, fine textured material, light colored, friable to subfriable, largely to wholly calcareous. Commonly finely grained, not crystalline and may be composed largely of foraminiferal tests and/or comminuted remains (notably of coccolithophoridae). It is largely micro-textured (about 0.01 m or smaller)."

Cayeux (1935) distinguishes chalks from limestones by their greater porosity and lack of cohesion. The porosity, microtexture, and friability are regarded as important characteristics of chalks also by Thomas (1962) and Leighton and Pendexter (1962).

Sanders and Friedman (1967) list the following characteristics of chalks: (a) abundance of calcite organic remains, particularly coccoliths; (b) lack of aragonite organic remains; (c) absence of terrigenous admixture; and (d) lack of contemporary lateral gravity displacement. The deep-sea cores indicate clearly that the last three criteria do not apply to most of the chalks recovered.

The purpose of this discussion was to present some of the problems arising from variations in definition. The friability of chalk as a distinguishing characteristic is probably the most important criterion. The presence of microspar and spar infilling of the chambers and of micritic grains in the matrix (ultrastructural detail) are a direct manifestation of cementation. Consequently, they are useful in differentiation of the chalk from the limestone.

Folk's (1965) classification was used to describe the microscopic features. Following Schneidermann (1970), the term "micrite" in the microfacies description was extended to include grains up to 31 microns (compare Leighton and Pendexter, 1962). In the ultrafacies analysis, "micrite" refers to grains smaller than 4 to 6 microns and microspar to the 4 to 31 micron grains (Folk, 1965). Consequently, "micrite" of the optical microscope includes both "micrite" and "microspar" of the ultrastructure (see also Flugel et al., 1968). The term "spar" was used to describe both the cavity infillings and neomorphic crystals (pseudospar of Folk, 1965).

MICROSCOPY

Acetate peels and thin sections indicate the considerable textural variations of the Leg 15 carbonates. The ratios between grains (skeletal particles) and the matrix fluctuate greatly in consecutive samples as well as in the same slide. A whole range from fossiliferous micrites to packed biomicrites is recognized, commonly modified by silicification.

The indurated chalks usually display a grain-supported texture (Plate 1, Figure 1) resulting in a packed fabric. Rarely can the chalk be classified as a sparse biomicrite. Marls usually contain less skeletal grains. The biogenic components, mainly foraminifera (benthonic and planktonic) and Radiolaria, indicate deposition in an open ocean. Pteropods are found only in the Plio-Pleistocene sections and are presumably dissolved in older sediment. Sponge spicules are conspicuous only in the upper parts of the sections. Rare echinoderm spines and various molluscan fragments, often abraded, are also found.

The nonbiogenic components are usually of a volcanic origin, predominantly with glass shards, quartz, and feldspar. Pyrite is dispersed in a few units.

The matrix, as observed in smear slides, is composed mainly of nannofossils and their fragments. The clay contents and volcanic components vary in different samples. Dolomite and nonbiogenic carbonate were also recognized. Bioturbation is common and results in a mottled appearance. Concentrations of skeletal particles or clays in burrows are quite conspicuous.

Micritic grains and rhombs of calcite appear in smear slides in a few indurated chalks. Their abundance increases with induration. The first clearly neomorphic micrite is found around 600 meters depth at Sites 146 and 153 and around 200 meters at Site 152. The abundance of micrite increases rapidly, and about 10 to 20 meters deeper the precipitation of spar as void filling of the microfossil chambers appears.

The limestones are mainly sparse biomicrites, often argillaceous. The relative abundance of the biogenic components varies vertically in each hole and horizontally in isochronous units in different holes. Radiolaria are abundant at Site 146, and planktonic Foraminifera at this site are abundant only in the lowermost samples. Planktonic Foraminifera are very abundant at Sites 152 and 153, and the bulk of the limestone at those sites is a packed biomicrite. Benthonic Foraminifera, echinoderm spines, and abraded molluscan fragments are also found.

The Radiolaria are usually calcified, ranging from well preserved to totally recrystalized. The Foraminifera are well preserved, sometimes fragmented or compressed. Diagenetic silicification often obscures the original texture, and with continuous replacement the limestone is transformed into chert.

Interbedded ash layers, dispersed volcanic components, and clays are particularly conspicuous in the lower parts of the sections. Radiolarian-rich layers with a sandy texture may represent turbidite activity. They contain a sharp, undulose lower boundary, commonly with erosional features. Graded bedding and sorting is also observed. The radiolarian or foraminiferal content, as determined by the paleontologist, often differs from the surrounding faunal assemblages.

In some samples the microfossils, volcanic debris, and clay flakes appear to be aligned, with the longest axis parallel to subparallel to bedding. Microcrosslamination and development of lamination (1 to 5 m thick) is common, accentuated by concentration of micas or other volcanic debris in the bedding planes. The bedding is common in the lowermost samples but is often disrupted due to bioturbation (see Warme et al., this volume).

Color mottling is related to uneven grain size distribution of the biogenic components, of clay minerals, or of grains in the matrix. It is also influenced by selective silicification and variations in volcanic components. The mottling is probably a result of bioturbation. In the thin sections, the traces of biogenic activity are also expressed as disrupted laminations, concentrations of pellets or pyrite lensing, and irregular distribution of biogenic components (Plate 1, Figures 3, 4 and 5).

Compactional features are rare and are best developed in the lowermost samples. Early post-depositional compaction is recognized by flattening of burrows, warping of clay minerals and mica flakes around microfossils, and slight interpenetration of microfossils (Plate 1, Figure 6). Late compaction involves development of microstylolites, recognized as subhorizontal to horizontal sutures with concentrations of pyrite and clays.

Veins, both fractures (tectonic) and replacement (neomorphic), are present in the studied sections. The fractures are lined by calcite, pyrite, and quartz. The walls of fractures are usually straight, parallel and oriented subvertically, but in one case a Y-shaped vein was observed. Replacement veins are confined to the lowermost 50 meters at the Site 146 section and are less conspicuous in the other sections. A typical vein is subhorizontal and meandering, with irregular boundaries and concentrations of insoluble material along those boundaries (Plate 2, Figures 1-4). Sparry calcite with anhedral to subhedral crystals displaying planar to banded cleavage and strong twinning infills in most veins. Undigested fragments of the matrix are often found "floating" in the sparry infilling.

ULTRASTRUCTURE

The matrix of the chalk is mainly composed of various nannofossils and their fragments, rare intact coccospheres, fragments of Foraminifera, clay, and oval bodies, probably fecal pellets. Commonly completely separated elements (units of a nannofossil structure) are indistinguishable from grains of micrite. The amount and diversity of the nannofossils varies between samples, as well as their ratio to the dispersed elements and other fragments. The overall appearance is very similar to the nanno micrites described by Schneidermann (1970).

The foraminiferal chambers are usually empty, but often very fine calcitic grains appear to overgrow the original ultrastructure (Plate 3, Figure 1). Such overgrowths are also observed coating coccoliths (Plate 3, Figures 2 & 3). The foraminiferal walls appear to be well preserved, and no apparent neomorphism was observed.

The amount of separated elements and "micritic" grains is high in the matrix of some turbidite layers (Plate 4, Figures 1-3). Those same layers contain, on the other hand, well-preserved coccospheres (Plate 4, Figures 4 and 5). No indication of grain welding or grain dissolution was found in the highly indurated layers.

"Micrite" was recognized in smear slides in various marls and chalks. The ultrastructural study indicates the similarity between fragmented coccoliths and some grains of calcite. As a result, we must question the validity of optical determinations of micrite as a sole reason for sediment description.

The indications of cementation processes appear gradually with depth, but the transition zone between chalk and limestone (Plate 5, Figures 1-3) is rather sharp. Recognizable neomorphic crystals in the matrix (Plate 6, Figure 1 and 3) and initial infilling of foraminiferal and radiolarian chambers are confined to a relatively thin zone (Plate 6, Figures 4 and 6). The matrix of this transitional zone and a part of the pelagic limestone consists of interlocking grains of calcite with well preserved to almost destroyed coccoliths (Plate 5, Figure 3). This matrix is comparable to the nannomosaic matrix (Schneidermann, 1970) found in other pelagic limestones (Plate 6, Figure 2; Plate 7, Figures 1 and 2) (Fischer et al., 1967; Hancock and Kennedy, 1967; Garrison, 1967; Flugel and Franz, 1967). Contrary to the fabric of many of those limestones, the mosaic grains in our samples are euhedral to subhedral, rhomb-shaped, and have straight intercrystalline boundaries. The grain size ranges from less than 1 micron to the microspar range, with high abundance in the 1.5 to 2.5 micron and 4 to 6 micron range.

At Site 146, Cores 31 and 36 (Plate 7, Figures 3-5), a considerable change in the grain-size distribution is observed. This is caused by porphyroid neomorphism whereby microspar grains dispersed in the matrix "consume" finer grains resulting in a poikilotopic (Friedman, 1965) fabric. The mechanism of this process is unclear.

The lower part of the limestone sequence contains a poorly preserved, monotonous assemblage of nannofossils (Hay, this volume). This may be caused by selective dissolution due to deposition in the proximity of the calcium carbonate compensation depth. The study of the matrix reveals that the coccoliths also undergo neomorphic changes and are partly replaced by mosaic grains (Plate 7, Figure 5). In the vicinity of the basement most of the matrix is composed of micrite and microspar grains, and the amount of recognizable coccoliths is small.

In Sample 146-41R-2 odd shaped grains and crystals were observed. They have a positive relief due to their resistance to etching during preparation of the sample. This resistant material is commonly found poikilotopically inside spary infilling of foraminiferal chambers or as an intercrystalline material (Plate 8). The origin and composition of this material is still unknown, but it may be metamorphic and influenced by the doleritic sill (see core description) and basement near where it was sampled.

DISCUSSION

The pelagic limestones of the Caribbean recovered during Leg 15 can be characterized by the following:

1) They are confined to Upper Cretaceous sediments only.

2) They directly overlie intrusives and at Site 146 contain a doleritic sill.

3) The limestones of Sites 146 and 153 have a considerable overburden, while Site 152 limestones have only a rather thin cover.

4) Replacement veins and microstylolites are found in the vicinity of the basement.

5) Petrographically, the bulk of the limestone is a sparse to packed biomicrite with Radiolaria (often calcified) and planktonic foraminifera. The chambers of the skeletal components are infilled by microspar and spar, often in a drusy pattern. Microspar and spar are also found in the matrix.

6) The matrix is composed of nannofossils and euhedral to subhedral mosaic grains in the micrite and microspar range. The amount and average size of the mosaic grains increases with depth. Neomorphic processes are common, particularly in the lower part.

The observed gradient of cementation with depth may be a result of various processes:

1) Submarine cementation on the sea floor of the slowly accumulating marls and chalks. To account for the sudden disappearance of limestone at the end of the Cretaceous, we must assume cessation of the process at that time, probably due to changes in the sedimentation rate and the water properties.

2) Cementation at depth as a result of compaction with burial. Dissolution of small grains and pressure welding supply the cement, which is secondarily redistributed in the matrix and as an infilling of cavities.

3) Cementation induced by or connected with the emplacement of the intrusives. The observed gradient represents in this case textural features decreasing away from the intrusion.

Submarine cementation has been studied extensively in various areas of the world (Gevirtz and Friedman, 1966; Fischer and Garrison, 1967; Thompson et al., 1968; Bricker, 1971; and many others). The sediments undergoing cementation are characterized by a high-Mg calcite or aragonitic cement and by stable isotope compositions indicating cementation in equilibrium with the ambient waters (Milliman, 1971). They are distributed as crusts and are comparable to hardgrounds found in the European chalks (see Bathurst, 1972, for discussion). Cores in areas of submarine cementation (Bartlett and Greggs, 1969) consist of alternately lithified and unlithified interbedded layers. In many cases the lithified layers contain evidence of nondeposition, such as stylolitic undulating contacts, sharp upper boundaries, ferro-manganese encrustations, age difference between the lithified and unlithified couples, etc.

Excluding the crusts found at the Cretaceous-Tertiary boundary, the pelagic limestones of Leg 15 do not contain evidence of interrupted deposition, development of crusts, or other indication of submarine cementation.

Remobilization of $CaCO_3$ with depth due to compaction has been postulated by Wolfe (1968) and Scholle (1971) to explain the cementation of chalks (see also Bathurst, 1972). Anhedral crystals with serrate boundaries, evidence of compaction, and pressure-welding features indicate the internal source of the cement. Solution welding of coccoliths and other grains has also been reported from various localities by Fischer et al. (1967).

Lancelot et al. (1972) have postulated a similar origin for the Late Jurassic and Early Cretaceous limestones recovered in the western North Atlantic on Leg 11 of the Deep Sea Drilling Project. The dissolution of foraminiferal tests and coccolith shields is believed by Lancelot et al. (1972, p. 992) to be the source of the cement. However, the studies by Berger (1968), McIntyre and McIntyre (1970), and Schneidermann (1972) indicate that dissolution of foraminiferal tests and coccolith remains can occur during their descent and on the bottom of the ocean. The presence of such dissolved tests does not have to indicate a diagenetic process, and may well be a primary depositional feature.

Compactional features are scarce in the Leg 15 limestones. Microstylolites are rare and do not indicate considerable compaction. Warping of clays around microfossils and interpenetration of foraminifera (pressure solution) is also observed in a few samples. We can assume that the volume of potential cement generated by pressure solution in the studied samples cannot account for the total cement observed.

Lithified or highly indurated pelagic sediments overlying igneous rocks were found on previous legs of the DSDP, but never in quantities recovered during Leg 15. Due to the lack of comparable data, no clear petrographic evidence for cementation under the influence of the intrusive dolerite is available. The geochemical data, on the other hand, indicate cementation and neomorphism under high temperatures or in contact with O^{18} depleted solutions (Anderson and Schneidermann). Such conditions could be initiated during the emplacement of the dolerite in the form of hydrothermal fluids, increase in the temperature of the connate waters, etc. The high heat flow, possibly associated with the intrusion (Donnelly, this volume) can influence the solubility of $CaCO_3$ in the pore waters and cause precipitation of cement (Anderson and Schneidermann, this volume).

The textural evidence obtained in this study precludes submarine lithification as the sole cause of cementation of pelagic limestones. The possibility of cementation as a result of compaction and remobilization of $CaCO_3$ cannot be ruled out completely but is not compatible with the geochemical evidence.

The cementation in equilibrium with high-temperature solutions as indicated by the stable isotope data must be influenced by the emplacement of the basement and the resulting high heat flow. During this process, heated pore waters were probably released from the sediment as a result of compaction caused by the intrusion and subsequently mobilized by the thermal gradient. Partial pressure solution and dissolution of smaller particles as a result of compaction might have supplied a part of the dissolved carbonate.

The postulated model for cementation of pelagic sediments must be tested in other areas. The scarcity of pelagic limestones at other sites may be a result of the deposition of the sediments upon a spreading extrusive basement contrary to a hot intrusive basement in the Caribbean.

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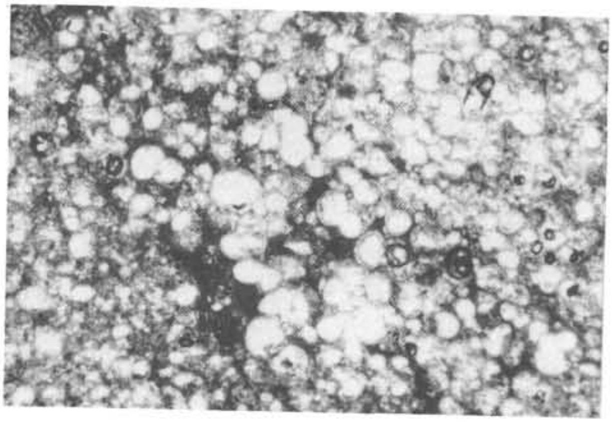
PLATE 1

Figure 1	Typical chalk-packed biomicrite with planktonic foraminifera. The chambers are empty. Sample 15-146-5-1 (54-56). ×30.
Figure 2	Fossiliferous micrite with a spar infilled, calcified radiolarian. Sample 15-146-31-3 (16-19). ×66.
Figure 3	Concentration of large fecal pellets. Sample 15-153-16(CC). ×40.
Figure 4	Concentration of pyrite. Sample 15-146-38R-1 (113-116). ×30.
Figure 5	Biogenic activity. Traces enhanced by differential silicification of the flattened burrows. Sample 15-146-27-2 (137-141). ×20.
Figure 6	Compaction resulting in reorientation of the microfossils, warping of clays around them and slight pressure welding. Sample 15-153-16-1 (79-81). ×40.

PLATE 1



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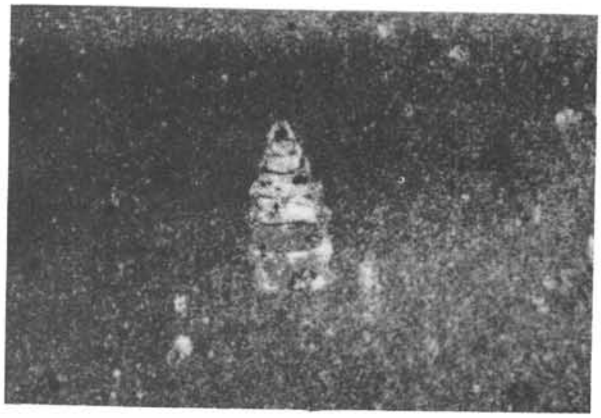

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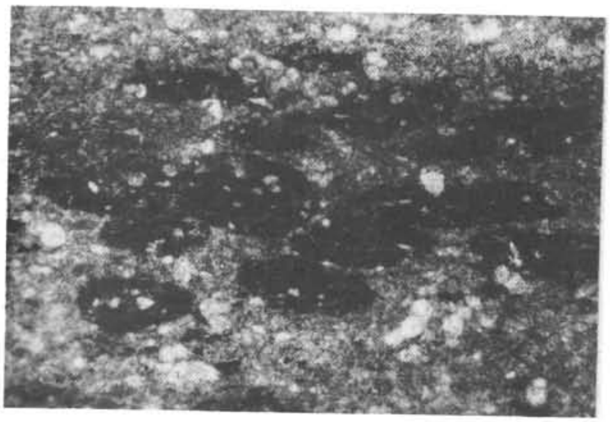

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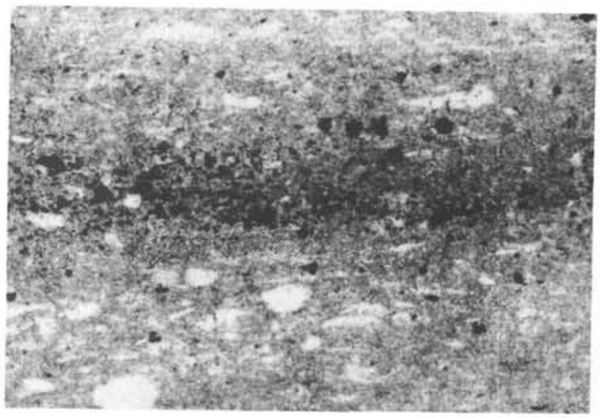

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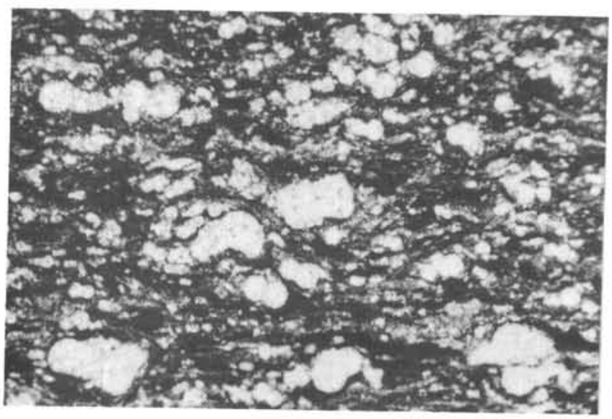

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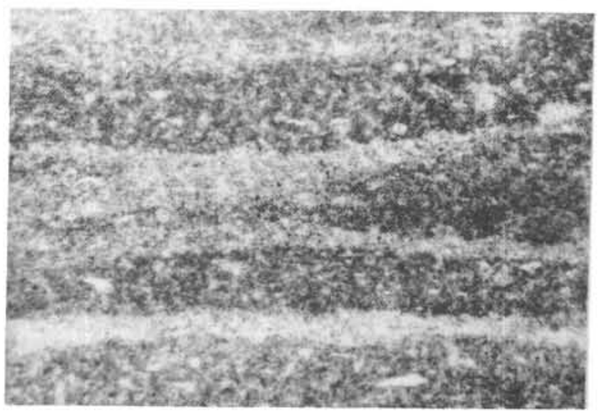

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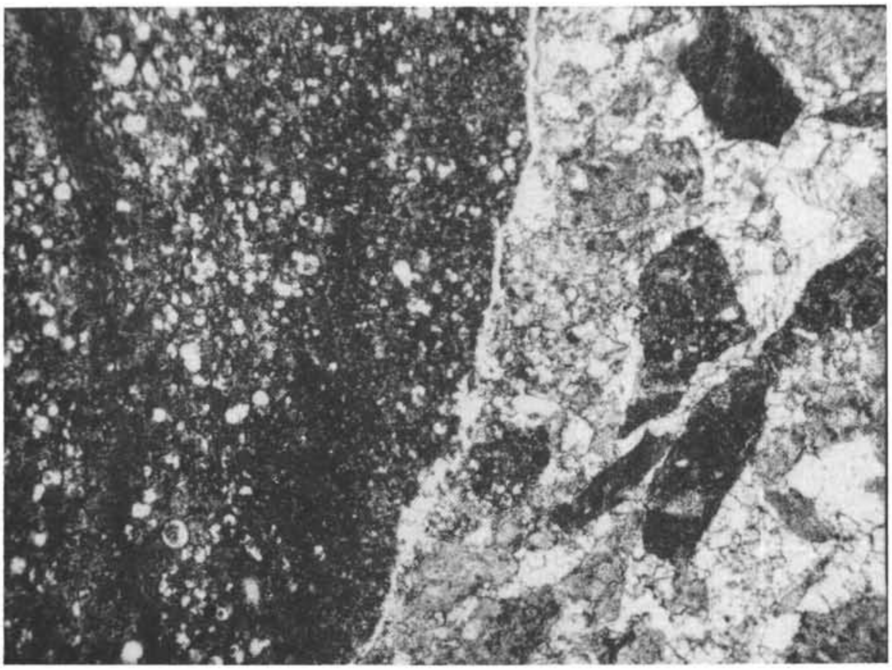
PLATE 2

Figure 1	The Cretaceous-Tertiary boundary. Parts of a sparite infilled fracture containing unsorted, angular intro-clasts and lithoclasts. Sample 15-153-12-1 (100-103).
Figure 2	Details of a cruved, subhorizontal replacement vein containing undigested remnants of the matrix. Sample 15-146-38R-1 (130-132). ×27.
Figure 3	Chlorite and quartz infilled druse with a spar infilled fracture (white streak). Slightly metamorphosed limestone, Sample 15-152-23(CC). ×40.
Figure 4	Concentration of insoluble residue along the boundary of a replacement vein (lower part). Sample 15-146-39R2 (40-42). ×960.

PLATE 2



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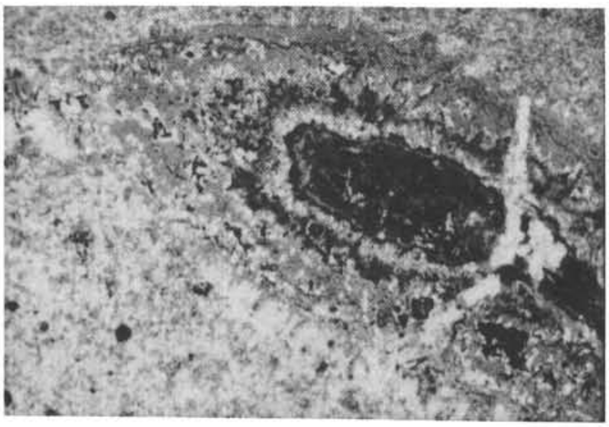

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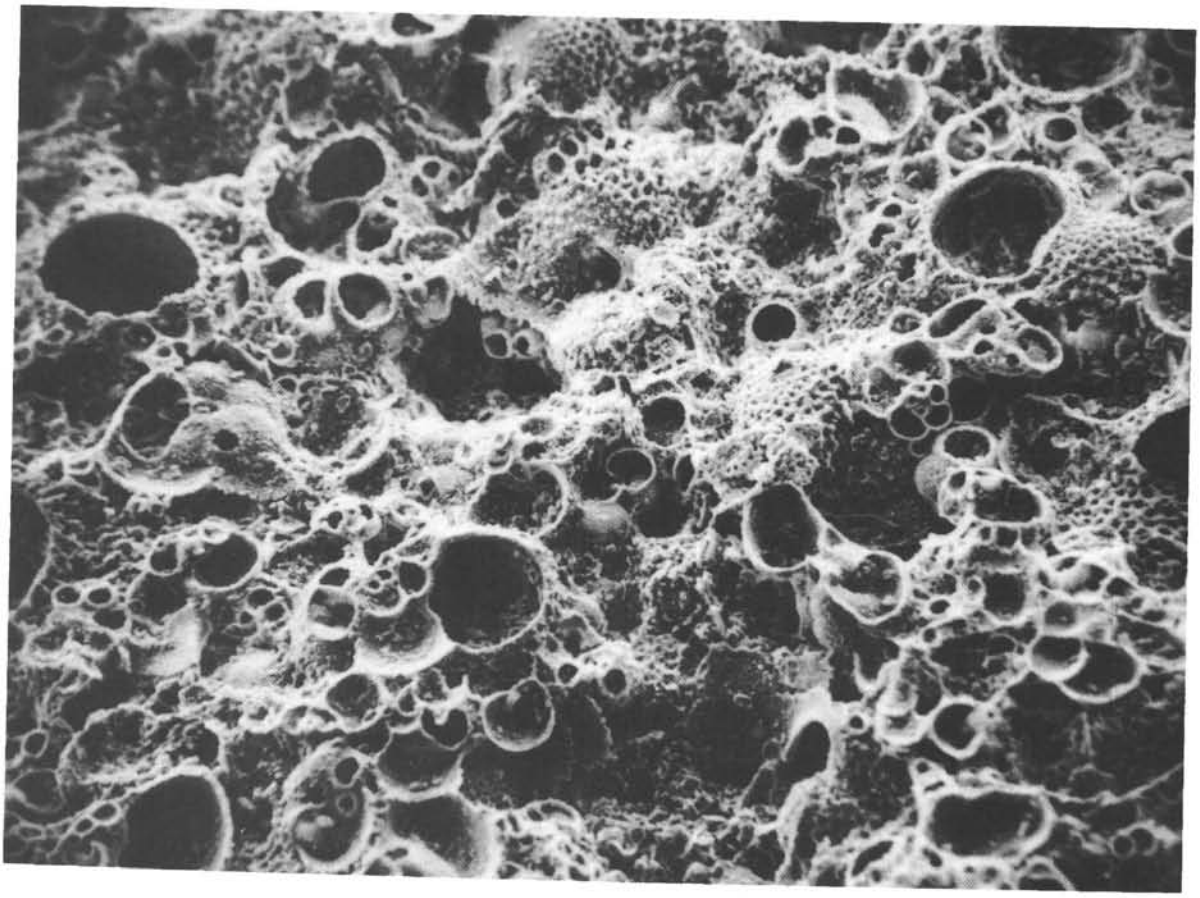
PLATE 3

Figure 1	Chalk-packed foraminiferal biomicrite. Foraminiferal chambers are empty. Sample 15-151-10-1 (135-139). ×110.
Figure 2	Nannomicrite. The matrix of the chalk is composed of nannofossils and their fragments. Note the intact coccosphere (indicated by C). Sample 15-152-19-1 (63-66). ×1980.
Figure 3.	As above. Note the pelleted texture.

PLATE 3



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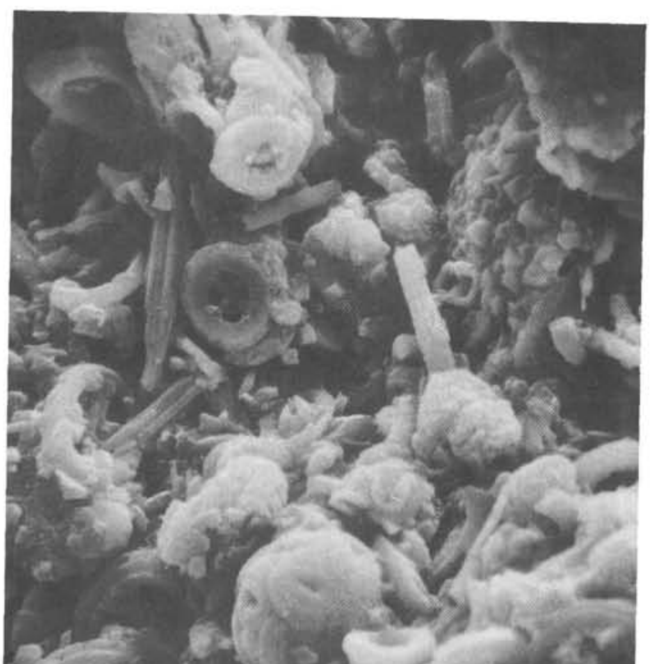

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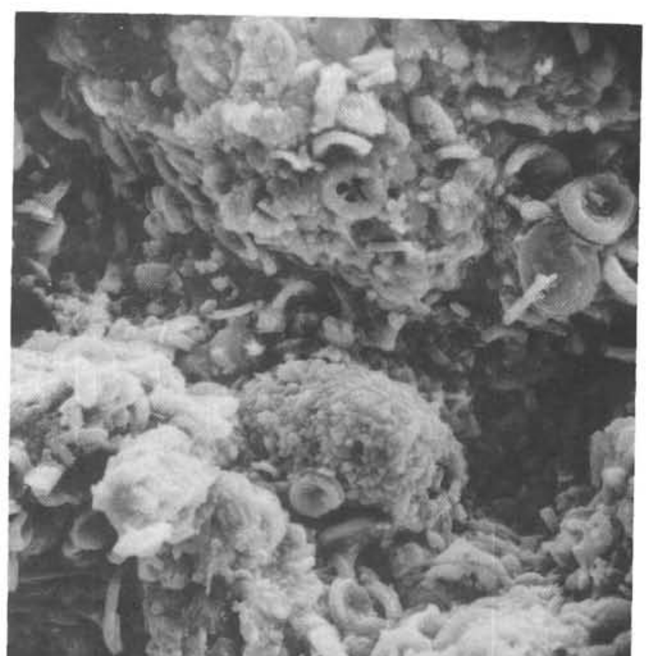

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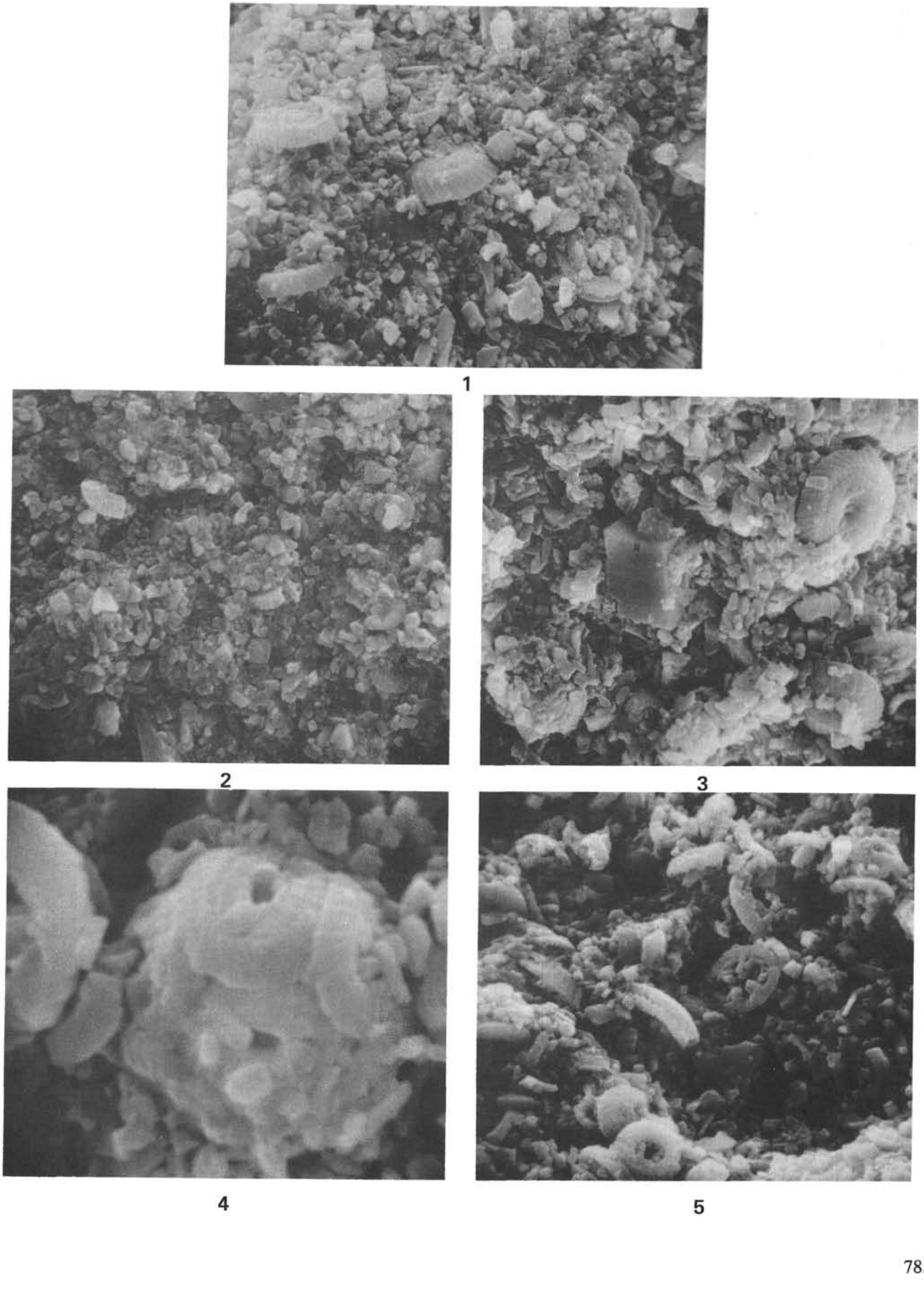
PLATE 4

Figures 1-3	Matrix of a turbidite layer composed of nannofossils and their separated elements. Note the gradation in the coccolith's shield disintegration. An authigenic crystal (dolomite?) is shown in the center of Figure 3. Sample 15-152-21(CC). X2678.
Figure 4.	A well-preserved coccosphere in a trubidite layer. Sample 15-146-20-2 (55-56). X5525.
Figure 5.	Matrix of a turbidite with abundant nannofossils. Sample 15-146-20-2 (55-56). X2295.

PLATE 4

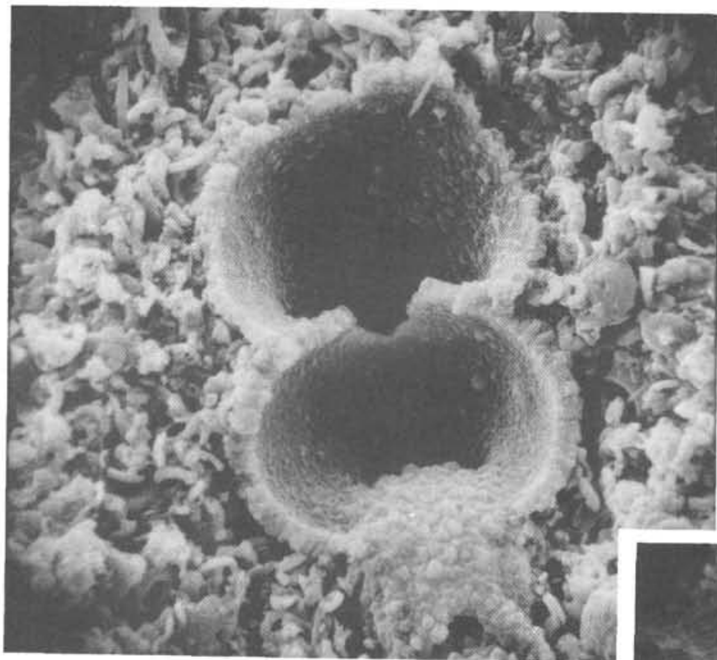


1 2 3 4 5

PLATE 5

Figure 1	Ultrafacies of the chalk: an empty planktonic foraminifer with nannomicrite. Sample 15-152-18-1 (49-53). ×1200.
Figure 2	Initial precipitation of sparite into a foraminiferal chamber. Sample 15-152-19-2 (63-66). ×790.
Figure 3	Ultrafacies of the limestone: a sparite infilled planktonic foraminifer with a mosaic micrite. Sample 15-146-39R-2 (22-24). ×604.

PLATE 5



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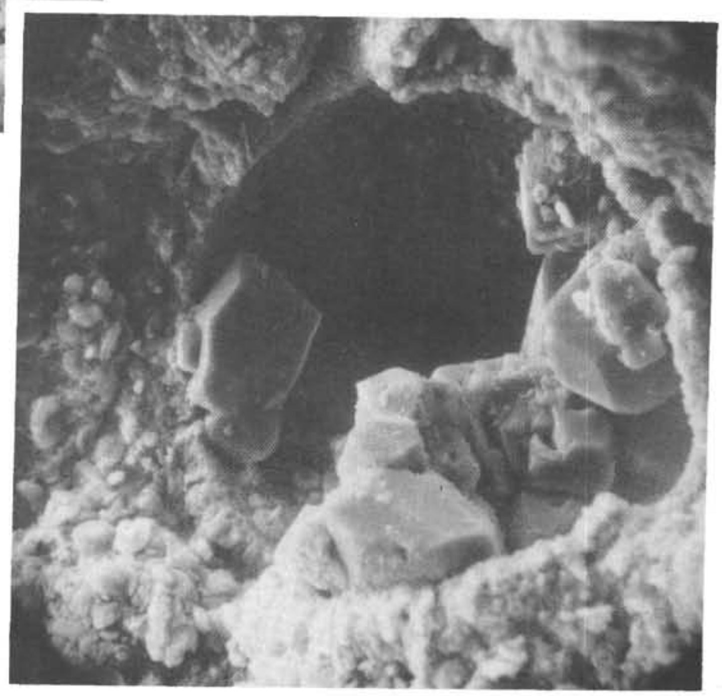

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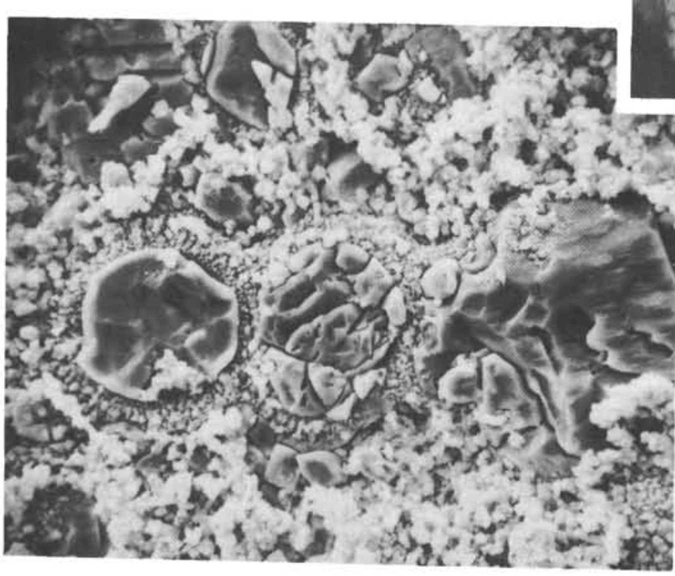

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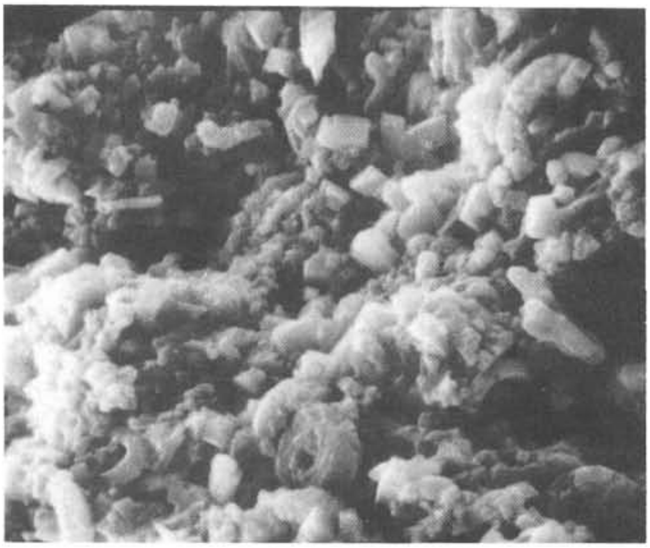
PLATE 6

Figure 1	Nanno-mosaic matrix of the pelagic limestone. Sample 15-153-14-1 (134-138). ×2085.
Figure 2	Nanno-mosaic matrix (coccolith indicated by C). Upper Jurassic pelagic limestone, Austrian Alps. Sample U-300 courtesy R. E. Garrison. ×1110.
Figure 3	Mosaic matrix composed of interlocked fine rhombs. Sample 15-146-31-3 (14-16). ×1020.
Figure 4.	Foraminiferal chambers infilled by single crystals. Sample 15-146-39R-2 (26-28). ×2150.
Figure 5	Foraminiferal chamber infilled by drusy sparite. Sample 15-153-16(CC). ×2085.
Figure 6	Calcite-replaced Radiolarian. Sample 15-146-30-1 (105-110). ×1110.

PLATE 6



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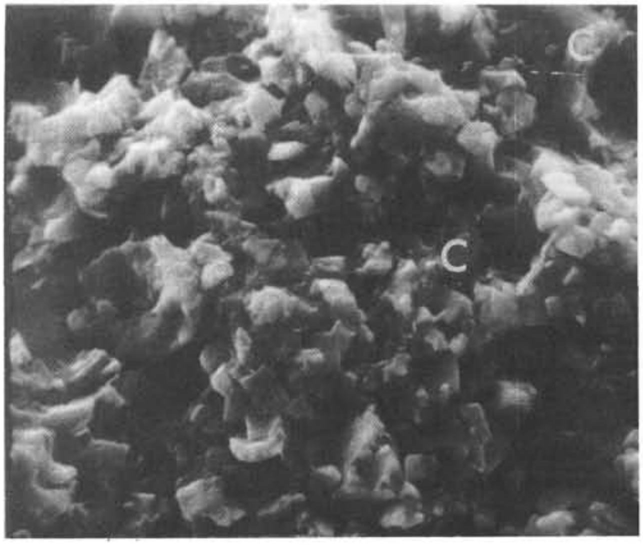

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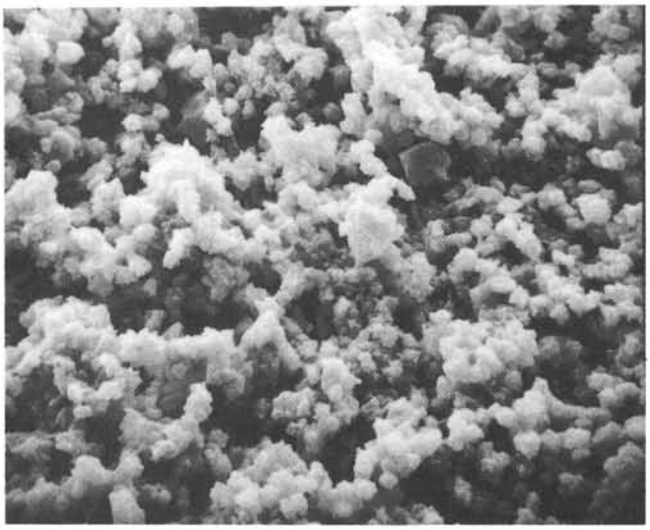

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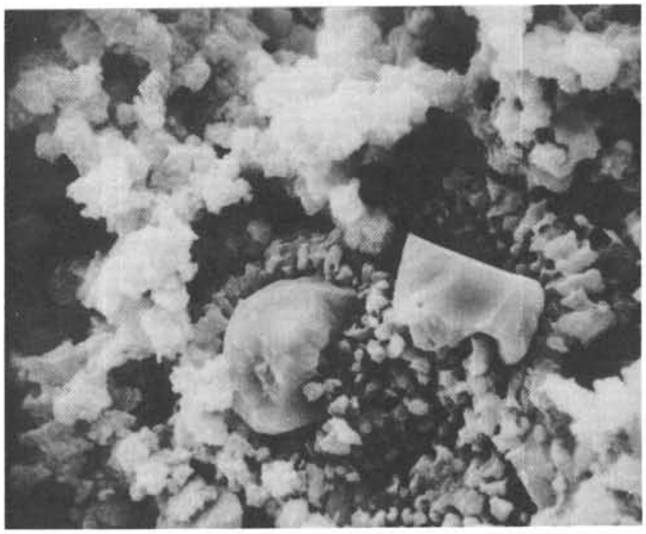

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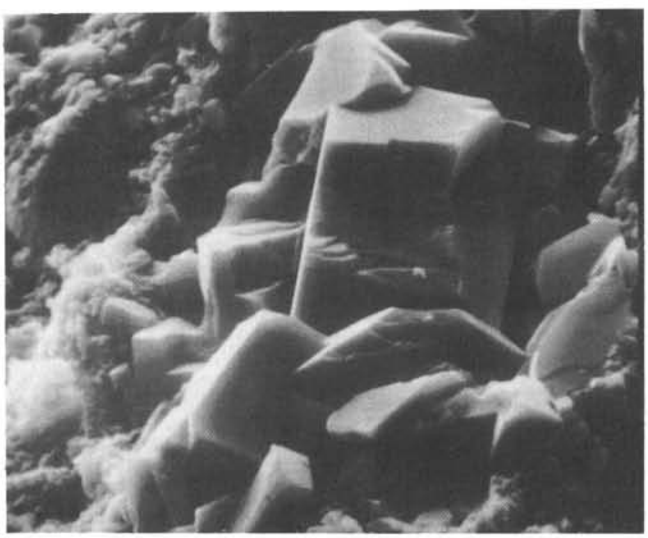

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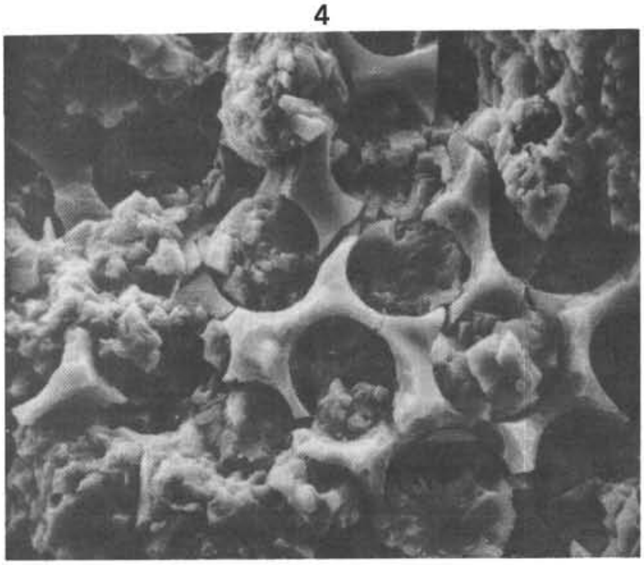

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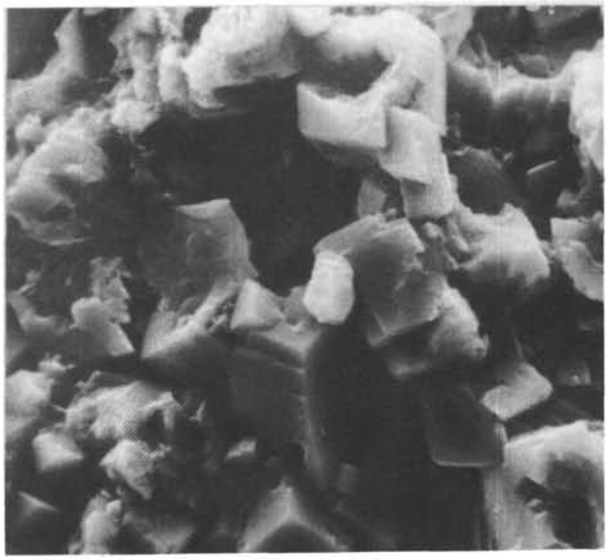
PLATE 7

Figures 1, 2	Neomorphic microspar and spar in a recrystallized pelagic limestone. Note remains of a coccolith in the center of Figure 1. Sample J. S. 3145, Barbados, courtesy J. B. Saunders. ×2255.
Figure 3	Neomorphic micrite and microspar. Note the variations in grain size. Sample 15-146-31-3 (16-19). ×2450.
Figure 4	Details of above. Incomplete growth of neomorphic microspar. ×6120.
Figure 5	Completely recrystallized coccolith by degrading neomorphism. Sample 15-146-31-3 (16-19). ×7425.

PLATE 7

1



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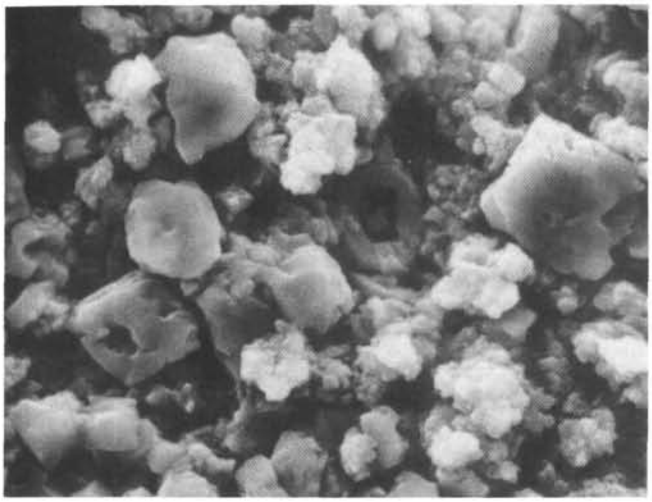

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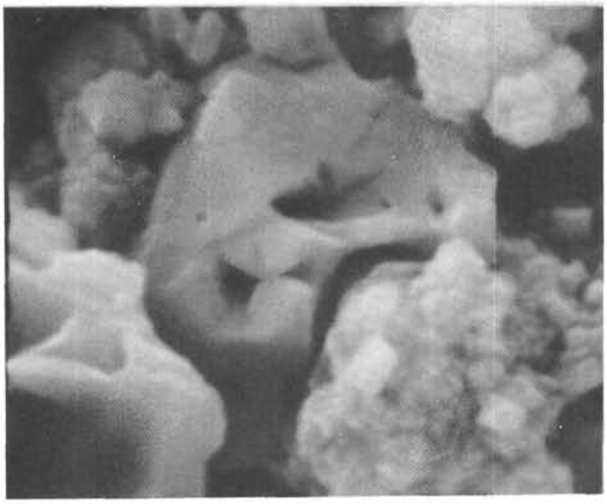

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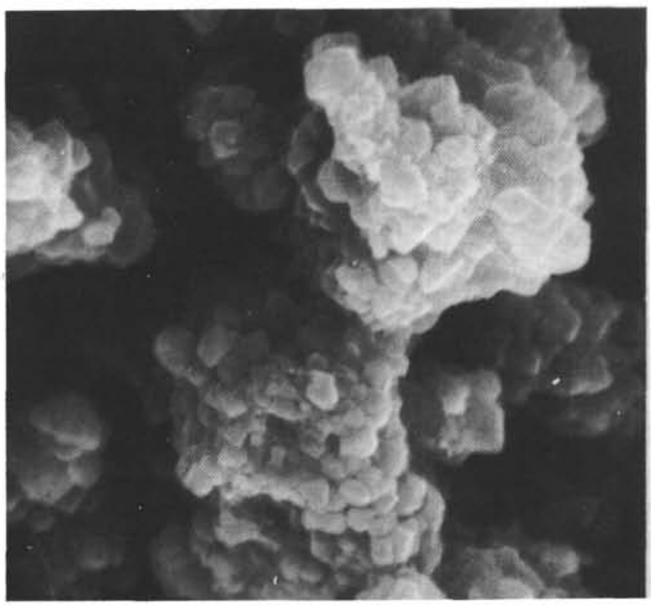

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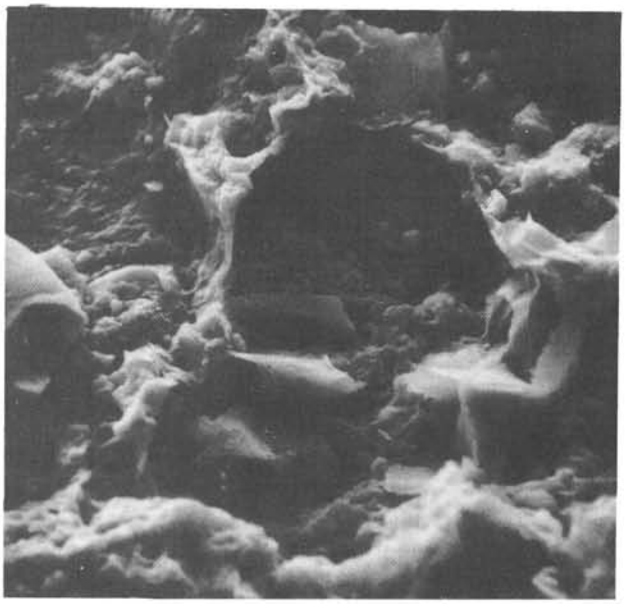
PLATE 8

Figures 1, 3	Amorphic and platy minerals, probably metamorphic, concentrated along foraminiferal boundaries. Sample 15-146-41R-2 (142-145). ×1400.
Figure 2	Replacement of spary infilling by platy, metamorphic minerals. Sample 15-146-41R2 (142-145). ×1300.

PLATE 8



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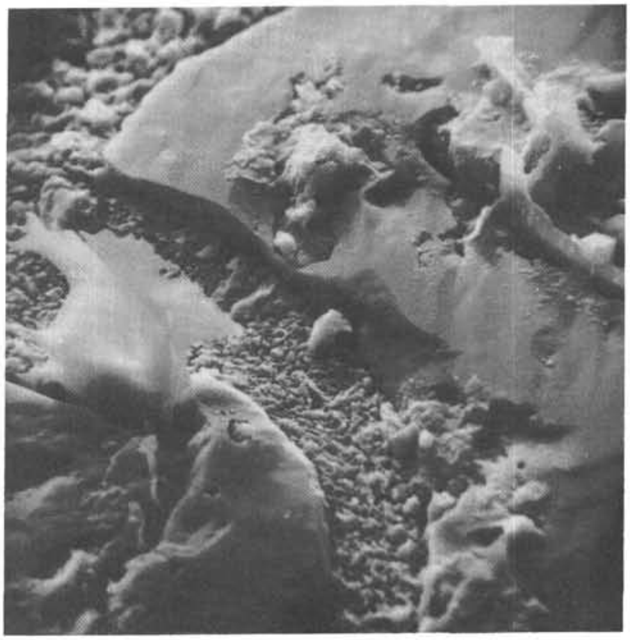

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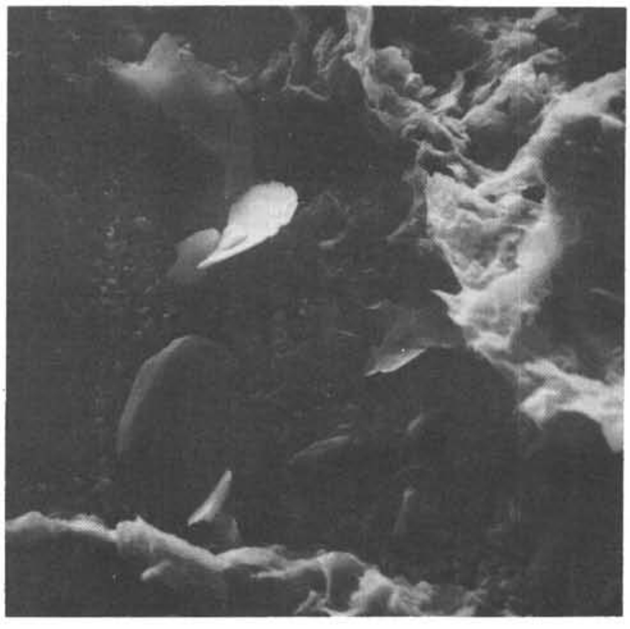

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