

41.2. LOWER CRETACEOUS LIMESTONES FROM THE HELLENIC TROUGH, IONIAN BASIN (SITE 127)

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INTRODUCTION

Three holes (127, 127A, 127B; latitude 35° 43.95'N, longitude 22° 29.67'E) were drilled west of Crete in the Hellenic Trough during Leg 13 of the Deep Sea Drilling Project. These holes were placed near the north-eastern inner wall (arc side) of a partially filled oceanic trench which rims the Hellenic Island Arc in the eastern Mediterranean (Figure 1). All three holes in the Hellenic Trough bottomed in Lower Cretaceous limestones. The mode of emplacement of the Lower Cretaceous limestones—which apparently occur as blocks—in the trench setting is not clear, and interpretations have been controversial. Two hypotheses have been presented (see Chapter 9 of this volume): a) they represent a tectonic “melange” resulting from recent underthrusting of the Ionian Basin beneath the Hellenic Arc; b) they are exotic blocks (olistostrome) on a continental talus slope. The writer tends to accept the second alternative because a layer of Pliocene nannofossil ooze, 70 cm thick, was found to be intercalated between two hard rock sections (427 to 435.3 m and 436 to 437 m) in Hole 127. This ooze interbed also carries fragments of dolomite and limestone. Middle Pliocene foraminiferal nannofossil ooze (*Discoaster surculus* Zone) was again recovered in Core 19 taken at the bottom of Hole 127; that is, below the lowermost Lower Cretaceous blocks drilled here. Moreover, some of the Lower Cretaceous limestone fragments recovered in Core 1 of Hole 127B are embedded in an indurated matrix of greenish-gray pelagic *Orbulina-Globigerina* marl of probable Pliocene age.



Figure 1. Location of Site 127 in the Hellenic Trench west of Crete.

LITHOLOGY AND FAUNAL CONTENT OF THE LOWER CRETACEOUS LIMESTONES

Hole 127

The hard rock section below the Pleistocene trench fill, composed of Lower Cretaceous dolomite and limestone, was first encountered in Core 16 (428.7 to 429 m below bottom). Two pieces of barren dark gray to brownish fractured dolomite, coarsely recrystallized, were recovered (Plate 1, Figure 1).

Core 17 (434.3 to 435 m below the sea floor) yielded nine pieces of hard rock. Piece 1 (0 to 68 cm) is a partly brecciated, mylonitized limestone with strongly recrystallized portions and stylolitic sutures. Except for one questionable specimen of *Ammobaculites*, no fossils were observed.

Piece 2 is a micritic limestone, parts of which are completely dolomitized and/or recrystallized, and which contains calcite veins (Plate 1, Figure 2) and some obscure indeterminate fragments of foraminifera.

Piece 3 is a mylonitic-brecciated, in part dolomitic micrite with stylolitic sutures and calcite veins; some random sections of *Orbitolina*¹ (Plate 1, Figure 3) were observed. *Orbitolina* and *Chrysalidina* were recognized in piece 8 (Plate 1, Figures 4-6).

Core 18 (434.9 to 436 m) yielded four fragments of partly dolomitized limestone, next to olive-gray, plastic nannofossil ooze with *Sphaeroidinellopsis seminulina* (Schwager), *S. subdehiscens* (Blow), *Globorotalia acostaensis* Blow, etc. (det. M. B. Cita) of Middle Pliocene age. This ooze also contains small scattered fragments of dolomite and limestone.

Piece 1, a micritic limestone (partly dolomitized) with calcite veins, contains specimens of *Orbitolina*, *Chrysalidina*, *Haplophragmoides*?, indeterminate sections of foraminifera, and *Hensonella cylindrica* Elliot.

Piece 4 (41 to 64 cm), a dark-gray to brownish, partly brecciated micrite, contains *Orbitolina*, *Chrysalidina*, *Haplophragmoides*?, *Sabaudia minuta* (Hofker), *Cuneolina* cf. *laurentii* Sart. and Cres., *Valvulamina* aff. *picardi* Henson Ophthalmitidae, Miliolidae, and algae such as *Hensonella cylindrica* Elliot and *Bacinnella irregularis* Radoičić (Plate 2, Figures 1-6; Plate 3, Figures 1-4).

¹In our shipboard report, we referred all the random sections to *Orbitolina* gr. *discoidea-conoidea* Gras (= *O. lenticularia* (Blumenbach) fide Hofker, =subgenotype of *Palorbitolina* Schroeder, 1963), known from the Barremian-Aptian-Albian. A closer determination is not ventured as none of the thin-sections prepared on board the *Glomar Challenger* cut the embryonic apparatus. This opinion is shared by Prof. R. Schroeder, Frankfurt, an expert in orbitolinids, to whom some thin-sections were submitted. He also pointed out (*in litt.*) the primitive evolutionary stage as well as the thin marginal zone of the concerned specimens which are suggestive of Urgonian (Barremian-Aptian) age.

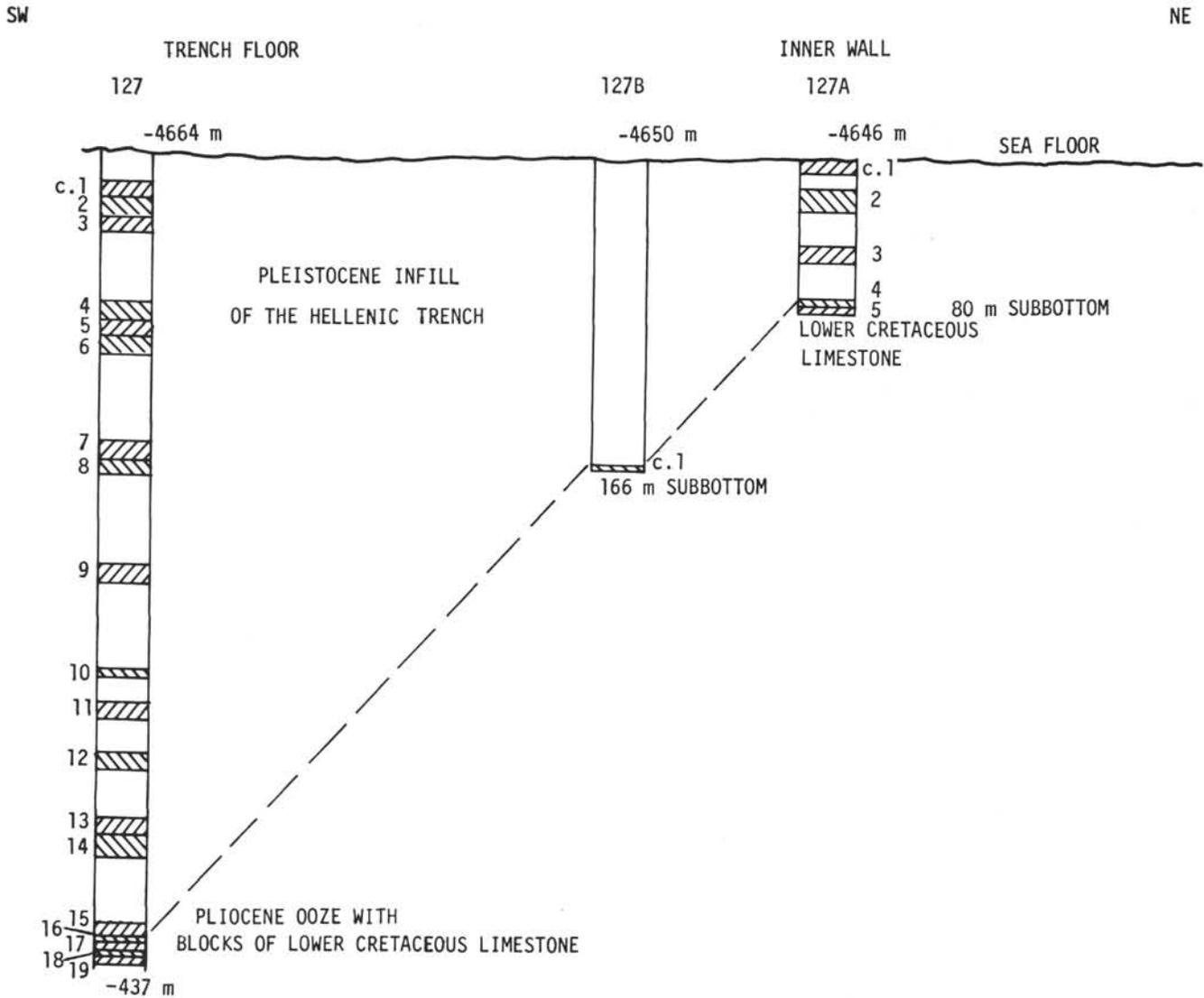


Figure 2. Position of cores taken in the three holes at Site 127, SW of Kythera Island, Hellenic Trench.

Core 19 (436.4 to 437 m below bottom) consists of 0.6 m of marl ooze and eight fragments of dolomite and fractured, recrystallized limestone.

Hole 127A

Hole 127A was drilled on the inner wall of the Hellenic Trough. This hole penetrated Quaternary marl ooze, rich in planktonic foraminifera, pteropods and coccoliths, down to a depth of 79 meters below the sea floor where it encountered the first block of light gray, micritic limestone (Core 4, at 79 m). This limestone bears *Orbitolina*, *Chrysalidina*, *Nezzazata* gr. *simplex* Omara, *Sabaudia minuta* (Hofker), *Cuneolina* cf. *laurentii* Sart. & Cresc., *Valvulammina* aff. *picardi* Henson, *Haplophragmoides*?, Miliolidae, Ophtalmidiidae, Textulariidae, *Hensonella cylindrica* Elliot, *Bacinnella irregularis* Radoičić, and a Codiacean alga (*Boueina*?; Plate 4, Figure 1) (Plate 4, Figures 1-4; Plate 5, Figure 1).

Core 5 (120 to 150 cm), from 79.7 to 80 m, yielded five fragments of a light gray to brownish fractured biomicrite

which contains *Orbitolina*, *Chrysalidina*, *Sabaudia minuta* (Hofker), *Nezzazata* gr. *simplex* Omara, *Valvulammina* aff. *picardi* Henson, *Haplophragmoides*?, *Cuneolina* cf. *laurentii* Sart. & Cresc., Miliolidae, Ophtalmidiidae, etc. (Plate 5, Figures 2-5; Plate 6, Figures 1-6).

Hole 127B

The last hole of Site 127 was located between Holes 127 and 127A; one core was taken at a subbottom depth of 166 meters.

Core 1 (110 to 150 cm) is represented by seven pieces of limestone and breccia (angular limestone fragments embedded in a foraminiferal marl matrix). Piece 1, a pebble of brecciated biomicrite in a greenish-gray *Orbulina-Globigerina* marl, contains *Valvulammina* aff. *picardi* Henson (Plate 7, Figure 2) and some indeterminable smaller foraminifera.

The strongly brecciated micrite with dolomitized parts (piece 2) contains rare discoid specimens of *Orbitolina* and

rare algal debris of *Pianella turgida* Radoičić. Piece 3 reveals angular components of dolomitic, partly brecciated limestone of different lithology with indeterminate sections of smaller foraminifera (Plate 8, Figure 4). Piece 5, a dark gray to brown limestone of the same lithology as piece 1, contains *Cuneolina* cf. *laurentii* Sart. & Cresc., *Valvulamina*, *Nezzazata*?, Miliolidae, etc. Piece 6, a gray-brown fractured limestone with stylolitic sutures, embedded in *Orbulina-Globigerina* ooze, is nonfossiliferous. Some rare Ophthalmiidae were observed in the fractured, partly dolomitized limestone of piece 7.

REMARKS ON THE AGE OF THE LOWER CRETACEOUS BLOCKS

The available material from the Lower Cretaceous cores recovered at Site 127 is not sufficient for the preparation of a large number of thin-sections. For this reason, unambiguous determinations of the represented microfossils, and hence a more precise age assignment, cannot be made.

The presence of *Hensonella cylindrica* in Holes 127 (Core 18) and 127A (Core 4) strongly suggests, however, a Barremian-Aptian age which is also favored by *Orbitolina* (*Palorbitolina*).

Orbitolina

(Plate 1, Figures 3, 5-6; Plate 4, Figure 2; Plate 5, Figures 1-3; Plate 6, Figures 3-6; Plate 8, Figures 1-3)

It was pointed out that all the specimens of *Orbitolina* encountered in the thin-sectioned limestone blocks, comparable to *O. discoidea-conoidea* Gras = *Orbitolina lenticularis* (Blumenbach), are suggestive of a Barremian-Aptian to Lower Albian age.

Some authors consider the *Orbitolina lenticularis* Zone as basal Middle Cretaceous (central Italy). It falls between the *Cuneolina camposaurii* Zone and the *Cuneolina pavonia parva* Zone (Albian-Cenomanian) (Crescenti, Crostella, Donzelli & Raffi, 1969).

According to Crescenti (1969), the *Cuneolina camposaurii* Zone with *Sabaudia minuta*, *Cuneolina laurentii*, *Cuneolina scarsellai*, *Nezzazata simplex*, *Bačinnella irregularis*, etc., is Valanginian-Aptian in age, the *Orbitolina lenticularis* Zone marks the Aptian-Albian boundary, and the *Cuneolina pavonia parva* Zone with *Cuneolina laurentii*, *Cuneolina scarsellai*, *Nezzazata simplex*, *Ovalveolina*, *Bačinnella irregularis*, *Pianella turgida*, etc. is Albian-Cenomanian.

In addition to *Orbitolina*, the thin-sections prepared on board the *Glomar Challenger* contain:

Chrysalidina

Cuneolina cf. *laurentii* Sartoni and Crescenti

Sabaudia minuta (Hofker)

Nezzazata gr. *simplex* Omara

Valvulamina aff. *picardi* Henson

Haplophragmoides?

The algae are represented by:

Hensonella cylindrica Elliot

Bačinnella irregularis Radoičić

Pianella turgida Radoičić

and *Boueina*?

Chrysalidina

(Plate 1, Figure 4; Plate 3, Figures 1-3; Plate 4, Figures 1, 3; Plate 5, Figure 1)

The specific identification is questionable. As no labyrinthic axial column is revealed in our thin-sections, an attribution to *Pseudochrysalidina* (= *Dukhanina* Henson) is not justified.

Our forms correspond to those figured as Verneuilinidae (*Eggerellina*?) from the Barremian-Aptian of Yugoslavia (Radoičić, 1960).

Similar forms already occur in the Jurassic. No stratigraphic significance can hence be given to the specimens encountered in the thin-sections from Holes 127 and 127A.

Cuneolina cf. *laurentii* Sartoni & Crescenti

(Plate 2, Figures 1-2; Plate 5, Figures 2-3)

The small tests of *Cuneolina* found in some of the thin-sections seem to belong to *Cuneolina laurentii*, rather than to *Cuneolina scarsellai* De Castro.²

Cuneolina laurentii is a species recorded from the *Cuneolina camposaurii* Zone (Valanginian-Aptian) of Southern Italy (Sartoni & Crescenti, 1962; Sinni, 1966a, 1966b), which, however, was also found in the lower part (Albian) of the next higher biozone of *Cuneolina pavonia parva* (Sartoni & Colalongo, 1964; De Castro, 1964).

In the central part of the Apennines (Pescara-Gran Sasso), the Lower Cretaceous *Cuneolina camposaurii* Zone is defined as the stratigraphic interval between the Upper Jurassic (Malm) and the *Orbitolina* level (=base of the Albian-Cenomanian *Cuneolina pavonia parva* Zone) (Crescenti, Crostella, Donzelli & Raffi, 1969; Crescenti, 1969).

The range of *Cuneolina laurentii* is given as Barremian to Lower Albian (Chiocchini & Di Napoli, 1966).

Sabaudia minuta (Hofker)

(Plate 2, Figures 1, 3?, 4; Plate 5, Figure 5)

This small species originally assigned to the genus *Textulariella* is based on material from the Aptian-Albian *Orbitolina* beds of north and northeast Spain (Hofker, 1965) where it is associated with *Orbitolina lenticularis*, *Simplorbitolina manasi*, *Mayncella greigi*, *Daxia cenomana*, and others.

Sabaudia minuta is also recorded from the Upper Aptian of the southern Apennines in association with *Orbitolina*, *Cuneolina scarsellai*, *Cuneolina laurentii*, *Bačinnella irregularis*, etc. (Chiocchini & Di Napoli, 1966).

Sabaudia minuta, which also occurs in France, Switzerland, etc., may be taken as an index species of the Barremian-Lower Albian (Hostettler, 1968).

²Dr. Piero De Castro, Naples, the author of *Cuneolina scarsellai*, kindly gave me his opinion concerning the specific determination of some of the *Cuneolinae* from Site 127.

Nezzazata gr. simplex Omara
(Plate 4, Figure 1; Plate 6, Figure 1)

The genus *Nezzazata* was created for the peculiar, asymmetric-trochospiral, later planispiral tests assigned to the Barkerinidae which occur in Cenomanian strata of Egypt (Omara, 1956). The genus *Begia* Smout is a junior synonym.

Nezzazata simplex Omara is a widespread and characteristic microfaunal element of Cenomanian beds (Egypt, Lebanon, Israel, Iran, Iraq, Yugoslavia, Greece, Italy) which was subsequently also encountered in strata of the Lower Turtonian (Israel, Iraq) as well as in Labian and Aptian sediments (Israel, Italy). Its stratigraphic range was recently extended to the Hauterivian and Senonian (Hamamoui & Saint-Marc, 1970); consequently, *Nezzazata* cannot play an important role in an age assignment.

Valvulammina aff. *picardi* Henson
(Plate 3, Figures 1, 4; Plate 5, Figure 4;
Plate 6, Figure 2; Plate 7, Figure 2)

Valvulammina of the *picardi* type widely occurs in the Upper Cretaceous. The type species *Valvulammina picardi* was established for specimens derived from Santonian beds of Egypt (Henson, 1948).

Forms comparable to *Valvulammina picardi* were later described and figured from the Cenomanian and Albian of Israel, Lebanon, Iran, Yugoslavia and Italy (Reiss, 1961; Bozorgnia, 1964; Radoičić, 1965; Hamamoui, 1966; Hamamoui & Saint-Marc, 1970).

A form most similar to the one from Site 127 was also illustrated from the *Cuneolina camposaurii* Zone (Valanginian-Aptian) of southern Italy (Sartoni & Crescenti, 1962).

Haplophragmoides? sp.
(Plate 2, Figure 1)

Some of the available thin-sections are tentatively interpreted as a small multi-chambered *Haplophragmoides*. An attribution to *Nautilocolina* might also be considered.

Identical tests have been figured as *Haplophragmoides* sp. from the *Cuneolina camposaurii* Zone (Valanginian-Aptian) as well as from the Upper Aptian-Lower Albian of southern Italy (Sartoni & Crescenti, 1962; Sinni, 1966a).

Algae

Hensonella cylindrica Elliot
(Plate 2, Figures 5, 6; Plate 4, Figure 4)

The dasycladacean alga *Hensonella cylindrica* was based on material from Barremian-Aptian sediments of Iraq and Iran (Elliot, 1960).

Hensonella cylindrica subsequently proved to be a very useful stratigraphical index of the Barremian-Aptian, as it has not been found so far in post-Aptian beds. It occurs, for example, in the Aptian of Israel and in the Barremian-Aptian of Iran (Reiss, 1961; Bozorgnia, 1964; James & Wynd, 1965).

The author observed *Hensonella cylindrica* in the Lower Cretaceous blocks drilled in Holes 127 and 127A, but this characteristic form is not represented in the Cretaceous limestones encountered in Hole 127B.

Bačínella irregularis Radoičić
(Plate 4, Figure 1)

This nodular incrustated form of alga incerta sedis formed by irregular cells of different shape and size was described from Barremian-Aptian limestones of Yugoslavia, where it occurs in association with other algae and *Orbitolina* (Radoičić, 1959).

Further occurrences in the Yugoslavian Dinarids and in the Apennines of Italy were subsequently discovered (Radoičić, 1960; Sartoni & Crescenti, 1962; Farinacci & Radoičić, 1964; 1966; Sinni, 1966; Crescenti, 1969); *Bačínella irregularis* was found in the zone with *Orbitolina conoideadiscoidea/lenticularis* (Barremian-Albian) and in the zone of *Cuneolina camposaurii* (Valanginian-Aptian) to Lower Albian).

Bačínella irregularis also occurs in the Urgonian limestone facies (Upper Barremian-Lower Aptian) of Sicily, where it is associated with *Orbitolina lenticularis*, *Dictyoconus*, *Iraqia*, *Cuneolina camposaurii*, etc., (Montanari, 1964).

In the Abruzzi Mountains, central Italy, *Bačínella irregularis* is present in the *Orbitolina lenticularis* Zone of largely Albian age (Crescenti, Crostella, Donzelli & Raffi, 1969; Crescenti, 1969).

The main stratigraphic range of *Bačínella irregularis* in southern Italy is Upper Aptian to Lower Albian (Chiocchini & Di Napoli, 1966).

Bačínella irregularis is also reported from Aptian and post-Neocomian breccias of the Carnian Alps of northern Italy, in association with *Orbitolina texana parva* Douglass (Cousin, Durand Delga & Sigal, 1966) as well as from a Valanginian algal limestone of Ibiza, Balearic Islands (Colom, 1969).

Pianella turgida Radoičić

This dasycladacean alga, characterized by its large thallus from which branches extend in alternating rows, was first described and figured from the Cenomanian of Yugoslavia (Radoičić, 1965).

Pianella turgida was later reported from Albian-Cenomanian beds of Italy (Sinni, 1966; Crescenti, 1969).

One tangential section of *Pianella turgida* was recognized in Core 1 of Hole 127B.

ON THE OCCURRENCE OF ORBITOLINA-BEARING BEDS IN GREECE

The regional structural framework of the western and central Hellenides (according to published sources) and the location of Site 127 are shown in Figure 3.

Orbitolina limestones have a wide distribution in Greece, (Ionian zone, Gavrovo-Tripolitza zone, Olonos-Pindos nappe, Parnassos-Trapeziona nappe, Vardar zone, etc.), but no details or modern determinations are available³.

The major part of the numerous localities from which *Orbitolina* is recorded is assigned to the Cenomanian. This

³Professor Jean Aubouin, Paris, and Professor George Marinou, University of Athens, very kindly answered my inquiring letters pertinent to the geology of Greece for which I wish to express my sincere thanks.

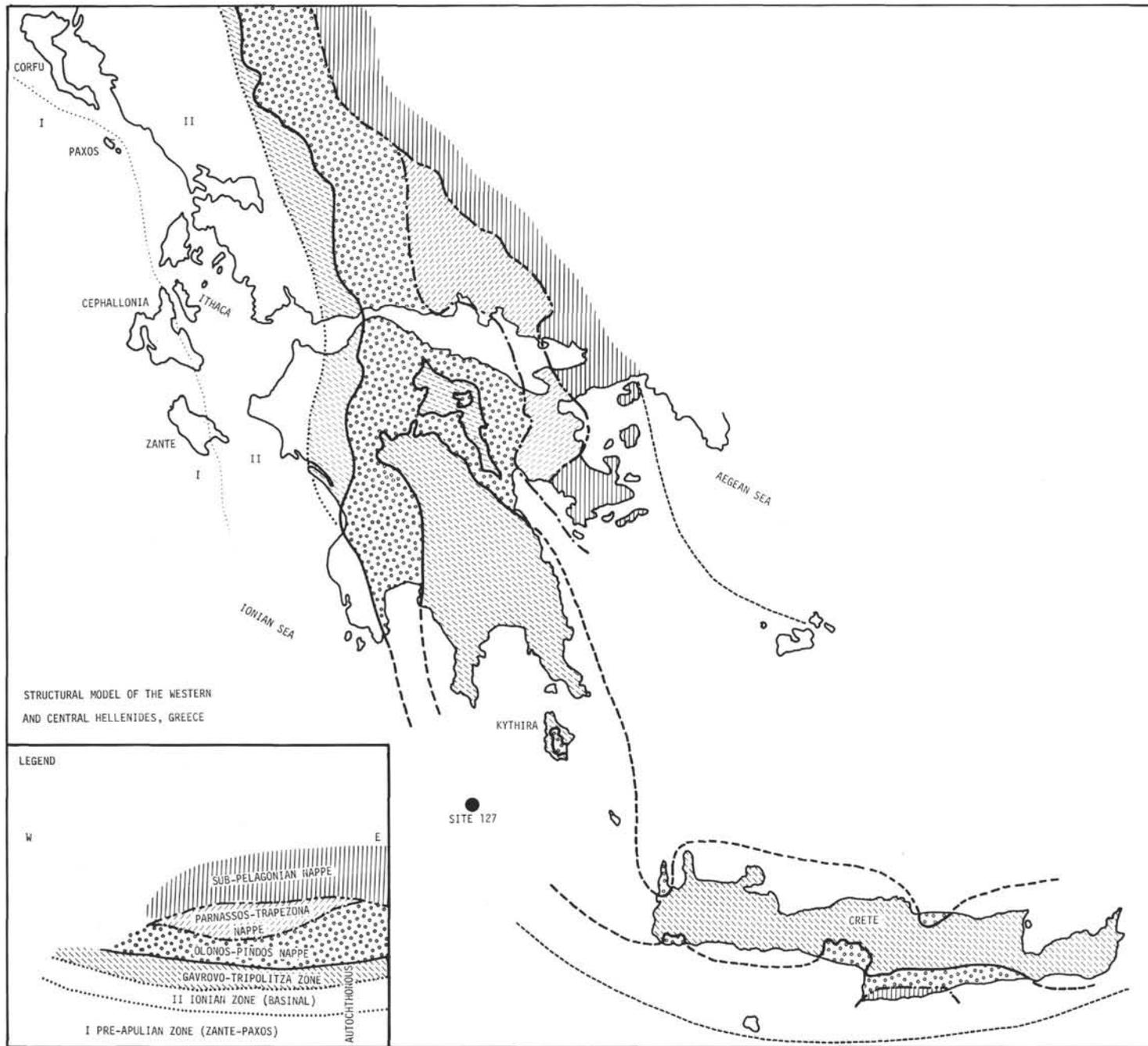


Figure 3. Structural Model of the western and central Hellenides, Greece.

interval is characterized by *Orbitolina concava* (Lam.) and *Orbitolina conica* (D'Arch.), typically Cenomanian species (the former sets in with the Albian). Locally, for example, in the Viglaes Limestone of the Ionian zone, the intermediate *Orbitolina* interval also contains *Rotalipora appenninica* (Renz), another Cenomanian index species.

In addition to *Orbitolina concava* and *Orbitolina conica* of Cenomanian age, several other species are listed in the relevant literature, for example, *Orbitolina lenticularis* (Blumenbach), *Orbitolina conoidea-discoidea* Gras, *Orbitolina bulgarica* (Boué), and others.⁴ These forms largely occur in a lower *Orbitolina* level and are suggestive of an Urgonian (Upper Barremian-Aptian) age.

The presence of a lower, pre-Cenomanian *Orbitolina* level (Barremian-Albian) was stressed in several papers by Carl Renz.

From the Viglaes Limestone of the Ionian zone, a pelagic chert-bearing thin-bedded limestone of about 450 meters thickness (Jurassic to Senonian), Urgonian *Orbitolina* and *Trocholina alpina* (Leupold) are recorded from the section below the Cenomanian (Renz & Reichel, 1946).

The Tripolitza Limestone of the Gavrovo-Tripolitza zone, a complex of dark limestones up to 1000 meters in thickness of Upper Triassic age at the base and with a Middle Eocene *Alveolina-Nummulites* fauna at the top, shows above the *Cladocoropsis-Clypeina* limestone (Upper Jurassic) dark gray to black neritic limestones, more or less dolomitic, which carry *Orbitolina*, *Trocholina*, etc. With regard to their lithology, these limestones closely correspond to those drilled at Site 127 in the Hellenic Trough.

The Cenomanian *Orbitolina* level is widely represented in the Mesozoic series of the Olonos-Pindos nappe, which is thrust on the Gavrovo-Tripolitza Flysch (see Figure 3) and can be traced from Albania southward across the Pindos Range, Peloponnesos, Kythera Island to Crete (see Figure 3). The bioclastic limestones which yield *Orbitolina* are usually gray-reddish, well-bedded, and contain shale breaks and chert. The presence of *Orbitolina conoidea*, *O. bulgarica*, and *O. paronai* suggests that pre-Cenomanian strata are also developed.

In the Tsoumerka Mountains of the Pindos Range, a complex of radiolarites, 250 to 300 meters in thickness, and brecciated *Trocholina* limestone (upper Jurassic to basal Cretaceous) is overlain by 50 meters of flysch-like beds; that is, an alternation of sandstones, marls, limestones, radiolarites, from which *Orbitolina lenticularis*, *Orbitolina trochus* (Fritsch), *Orbitolina bulgarica*, and *Dictyoconus arabicus* Henson of Barremian-Aptian age are reported (Aubouin, et al, 1960).

Brecciated limestones with *Orbitolina conoidea* and rudistids are mentioned from Kythera Island where they overlie the shale-radiolarite group of the Pindos nappe.

⁴ According to J. Hofker (1963), the genus *Orbitolina* is monotypic and all the described species belong to *Orbitolina lenticularis* of which the form-groups I-V are differentiated by means of certain features of the megalospheric embryonic apparatus. The classification by R. Schroeder (1963, etc.) places i.a. *Orbitolina bulgarica*, *O. conoidea-discoidea*, in synonymy with *Orbitolina lenticularis* for which the subgenus *Palorbitolina* was created. This group embraces the earliest known representatives of the genus *Orbitolina* (Upper Barremian to base of the Upper Aptian).

Dark, thick-bedded, partly dolomitic limestones with chert in the region of Ethia, southern Crete, contain *Orbitolina conoidea* and *Orbitolina paronai* which point to a pre-Cenomanian *Orbitolina* level.

Overthrust on the Pindos Flysch (Danian-Paleocene) or immediately on the Gavrovo-Tripolitza series is the Parnassos-Trapezona nappe of eastern Greece (see Figure 3). Here, pink-gray limestones with *Orbitolina concava* and *Orbitolina conica* occur widely. The *Orbitolina* limestones are developed here as compact, nonbrecciated limestones—as in the Ionian zone and the Olonos-Pindos nappe—and are attributed to the Cenomanian. However, they seem locally, for example, in the Oeta Mountains, to be of Urgonian age as they are reported to carry *Orbitolina conoidea* (Renz, 1955). A limestone breccia with *Orbitolina*, *Iraqia*, *Dictyoconus*, *Cuneolina*, etc., (Urgonian) was found to succeed Lower Cretaceous limestones containing *Bacinella irregularis* Rad., *Pseudocyclammina*, *Trocholina* in the southernmost Parnassos-Trapezona zone, eastern Peloponnesos (Dercourt, 1962). Transgressive limestones in the same area (Akros) which have yielded *Orbitolina concava*, *Orbitolina discoidea*, *Trocholina arabica* Henson, *Nezzazata simplex* Omara, *Pseudolituonella reicheli* Marie, etc. are assigned to the Cenomanian.

Orbitolina conoidea, *O. paronai* and *O. bulgarica* also occur in Lower Cretaceous oolitic limestones with corals of the Parnassos area.

Detrital black limestones with *Orbitolina lenticularis*, *O. trochus*, *O. discoidea*, etc. of Urgonian age have also been described from the Vardar zone of eastern Greece where they transgress on folded Upper Jurassic strata. The Cenomanian level with *Orbitolina concava* was found higher up in the section (Mercier, 1960).

Similar Urgonian *Orbitolina*-bearing limestones are known from the sub-Pelagonian nappe (Aubouin et al., 1960).

REFERENCES

- Aubouin, J. et al., 1960. Le Cretace superieur on Grèce. *Bull. Soc. Geol. France*. 7e ser., Vol. II, No. 4.
 ———, 1963. Esquisse de la Géologie de la Grèce. *Mem. Soc. Géol. France, Livre mém. Prof. Paul Fallot*. Vol. II.
 Aubouin, J. and Dercourt, J., 1965. Sur la géologie de l'Egée: regard sur la Crète (Grèce). *Bull. Soc. Géol. France*. 7e sér., Vol. VII.
 Aubouin, J. et al., 1965. Un élément externe de la zone du Pinde: la série d'Ethia (Crète, Grèce). *Bull. Soc. Géol. France*. 7e sér., Vol. VII.
 ———, 1970. Dinarides. *Encyclopaedia Universalis*. p. 642.
 Bozorgnia, F., 1964. Microfacies and microorganisms of Paleozoic through Tertiary sediments of some parts of Iran. *Nat. Iranian Oil Co., Tehran*.
 Brunn, J. H., 1960. Les zones helléniques internes et leur extension. Réflexions sur l'orogénèse alpine. *Bull. Soc. Géol. France*. 7e sér., Vol. II, No. 4.
 Castro, De P., 1963. Nuove osservazioni sul livello ad *Orbitolina* in Campania. *Boll. Soc. dei Naturalisti in Napoli*. Vol. LXXI-1962.
 ———, 1964. *Cuneolina scarsellai* n. sp. nel Cretacico dell'Appennino meridionale. *Boll. Soc. dei Naturalisti in Napoli*. Vol. LXXII-1963.

- , 1966. Contributo alla conoscenza delle alveoline albiano-cenomaniane della Campania. *Boll. Soc. dei Naturalisti in Napoli*. Vol. LXXV-1966.
- Chiocchini M. and Di Napoli Alliata, E., 1966. Sulla presenza de "Textulariella minuta" Hofker e "Textulariella auruncensis" n. sp. (Foraminiferida) nel Cretacico inferiore dei Monti Aurunci (Lazio meridionale). *Boll. Serv. Geol. d'Italia*. Vol. LXXXVII-1966.
- Colom, G. D., 1969. Litomicrofacies de los terrenos secundarios de España *Mem. Real. Acad. Ciencias y Artes Barcelona*. Vol. XXXIX, No. 11.
- Cousin, M., Durand Delga, M. and Sigal, J., 1966. Données nouvelles sur le Crétacé de la haute et moyenne vallée du Tagliamento (Alpes méridionales, Frioul, Italie). *Bull. Soc. Géol. France*. 7e sér., Vol. VIII.
- Crescenti, U., 1969. Biostratigrafia delle facies Mesozoiche dell'Appennino centrale: Correlazioni. *Geol. Romana*. Vol. VIII.
- Crescenti, U., Crostella, A., Donzelli, G. and Raffi, G., 1969. Stratigrafia della serie calcarea dal Lias al Miocene nella regione Marchigiano-Abruzzese. *Mem. Soc. Geol. Ital.* Vol. VIII.
- Dercourt, J., 1960. Esquisse géologique du Nord du Pélouponèse. *Bull. Soc. Géol. France*. 7e sér., Vol. II.
- , 1962. Contribution à l'étude géologique du Pélouponèse. Terminaison paléogéographique du haut-fond du Parnasse. *Bull. Soc. Géol. France*. Vol. IV, No. 3.
- Elliot, G. F., 1960. Fossil calcareous algal floras of the Middle East with a note on a Cretaceous Problematicum *Hensonella cylindrica* gen. et sp. nov. *Quart. J. Geol. Soc., London*. Vol. CXV.
- Farinacci, A. and Radoičić, R., 1964. Correlazione fra serie giuresi et cretacee dell'Appennino centrale e delle Dinaridi esterne. *Consiglio Naz. delle Ricerche, Rendiconti A*. Vol. 7, No. 2. ser. 2.
- Grader, P. and Reiss, Z., 1958. On the Lower Cretaceous of the Heletz area. *Geol. Survey, Bull. No. 16, Oil Div. Paper No. 3*.
- Hamamoui, M., 1966. Microfossils from Cenomanian sections in the Negev. *Israel Geol. Survey Rept.* No. Pal/3/66.
- Hamamoui, M. and Saint-Marc, P., 1970. Microfaunes et microfaciès du Cénomanien du Proche-Orient. *Bull. Centre Rech. Pau-SNPA*. Vol. 4, No. 2.
- Henson, F. R. S., 1948. New Trochamminidae and Verneulinidae from the Middle East. *Ann. and Magaz. of Nat. Hist. ser. II*, Vol. XIV (1947).
- Hofker, J., Jr., 1965. Some foraminifera from the Aptian-Albian passage of northern Spain. *Leidse Geol. Mededel.* pt. 33.
- Hostettler, M., 1968. Étude sur des *Sabaudia minuta* (Hofker) (Foraminifères) du nord de l'Espagne et du sud de la France. *Diplome Études Supérieures*. No. 64, Université de Dijon, Laboratoire de Géologie.
- James, G. A. and Wynd, J. G., 1965. Stratigraphic nomenclature of Iranian Oil Consortium agreement area. *Bull. Am. Assoc. Petrol. Geol.* Vol. 49, No. 12.
- Mercier, J., 1959. Remarques sur la bordure occidentale de la zone du Vardar en Macédoine. *C. R. somm. Soc. Géol. France*. No. 8.
- , 1960. Zone pélagonienne et zone du Vardar en Macédoine grècque. *Bull. Soc. Géol. France*. 7e sér., Vol. II.
- Montanari, L., 1964. Geologia del Monte Pellegrino (Palermo). *Rivista Mineraria Siciliana*. Anno XV, No. 88-90.
- Omara, S., 1956. New foraminifera from the Cenomanian of Sinai, Egypt. *J. of Paleontol.* Vol. 30, No. 4.
- Papastamatiou, J., 1960. La géologie de la région montagneuse du Parnasse-Kiona-Oeta. *Bull. Soc. Géol. France*. 7e sér., Vol. II, No. 4.
- Radoičić, R., 1959. Some problematic microfossils from the Dinarian Cretaceous. *Bull. Serv. Geol. and Geophys. Serbie*. Vol. XVII.
- , 1960. Microfaciès du Crétacé et du Paléogène des Dinarides externes de Yougoslavie. *Inst. Recherches Géol. R. P. Crna Gora, Pal. Din. Yougosl. ser. A: Micropal.*, Vol. IV, No. I.
- , 1965. *Pianella turgida* n. sp. from the Cenomanian of the Outer Dinarids, *Geol. Vjesnik Inst. Geol. Istrazivanja Zagreb*. Svezak 18, broj 1.
- , 1968. Biostratigrafija povlatne serije bijelog boksita u bijelim rudinama (Zapadna Crna Gora). *First Coll. on Geol. of Dinaric Alps, Ljubljana*.
- Reiss, Z., 1957. Occurrence of *Nezzazata* in Israel. *Micro-paleontol.* Vol. 3, No. 3.
- , 1961. Lower Cretaceous microfacies and microfossils from Galilee. *Bull. Research Council Israel*, sect. G, No. 16, Oil Div., Paper No. 3.
- Renz, C., 1928. Die Verbreitung kretazischer Foraminiferen in der westgriechischen Olonos-Pindoszone. *Prakt. Acad. d'Athènes*. Vol. 3.
- , 1930a. Geologische Reisen im griechischen Pindosgebirge (1929). *Eclog. Geol. Helv.* Vol. 23, No. 1.
- , 1930b. Geologische Voruntersuchungen auf Kreta. *Prakt. Acad. d'Athènes*. Vol. 5.
- , 1936. Neue Beiträge zur Geologie der Insel Leukas und ihrer Umgebung (Westgriechenland). *Eclog. Geol. Helv.* Vol. 29, No. 2.
- , 1947. Progress of the geological exploration of Greece. *Am. J. Sci.* Vol. 245.
- , 1955. Die vorneogene Stratigraphie der normal-sedimentären Formationen Griechenlands. *Inst. f. Geol. and Subsurface Research, Athens*.
- Renz, C., and Mistardis, G., 1939. Der Nachweis von Orbitolinenkalk in Aegaleos. *Prakt. Acad. d'Athènes*. Vol. 14.
- Renz, C. and Riechel, M., 1946. Beiträge zur Stratigraphie und Paläontologie des ostmediterranen Jungpaläozoikums und dessen Einordnung im griechischen Gebirgssystem. *Eclog. Geol. Helv.* Vol. 38, No. 2.
- , 1949a. Kreideforaminiferen aus dem Kalkhügel von Eleusis (Attika). *Eclog. Geol. Helv.* Vol. 41, No. 2.
- , 1946b. Neue Foraminiferenfunde im boeotischen Seengebiet (mittelgriechenland). *Eclog. Geol. Helv.* Vol. 41, No. 2.
- , 1950. Neue Fossilfunde in Griechenland und Vorderasien. *Eclog. Geol. Helv.* Vol. 42, No. 2.
- Sartoni, S. and Crescenti, U., 1962. Ricerche biostratigrafiche nel Mesozoico dell' Appennino meridionale. *Giornale di Geol., Ann. Museo Geol. Bologna*. ser. 2, Vol. XXIX (1960-1961).
- Sartoni, S. and Colalongo, M. L., 1964. Sul Cretaceo dei dintorni de Caiazzo (Caserta). *Mem. Soc. Geol. Ital.* Vol. IV.
- Schroeder, R., 1963. *Palorbitolina*, ein neues Subgenus der Gattung *Orbitolina* (Foram.). *Neuses Jahrb. Geol., Pal. Abhandl.* Vol. 117 (Festband Lotze).
- , 1964. Orbitoliniden-Biostratigraphie des Urgons nordöstlich von Teruel (Spanien). *Neuses Jahrb. Geol. Pal. Abhandl., Monatshefte*, No. 8.

Sinni Luperto, E., 1966a. Microfaune mesozoiche del M. Raparo. *Boll. Soc. dei Naturalisti in Napoli*. Vol. LXXV-1966.

_____, 1966b. Microfaune del Cretaceo delle Murge Baresi. *Geol. Romana*. Vol. V.

Smout, A. H., 1956. Three new Cretaceous genera of foraminifera related to the Ceratobuliminidae. *Micropaleontol.* Vol. 2, No. 4.

PLATE 1

(Scale bars represent 1 millimeter.)

- | | |
|-------------|--|
| Figure 1 | Fractured dolomite, barren. Hole 127, Core 16, piece 1. |
| Figure 2 | Fractured dolomitic limestone. Hole 127, Core 17, piece 2. |
| Figure 3 | Dolomitized limestone with <i>Orbitolina</i> . Hole 127, Core 17, piece 3. |
| Figure 4 | Fractured dolomitized limestone with <i>Chrysalidina</i> . Hole 127, Core 17, piece 8. |
| Figures 5-6 | Fractured dolomitized limestone with <i>Orbitolina</i> . Hole 127, Core 17, piece 8. |

PLATE 1

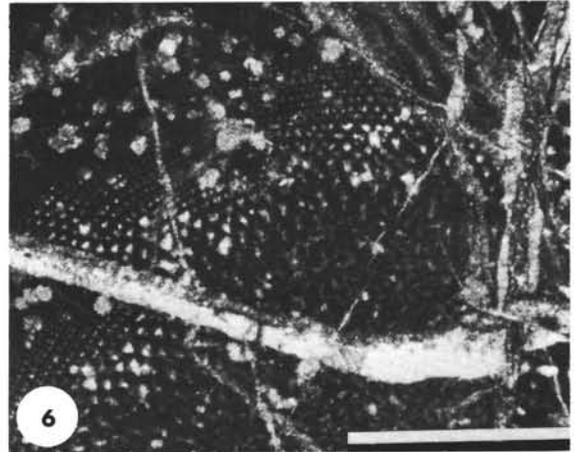
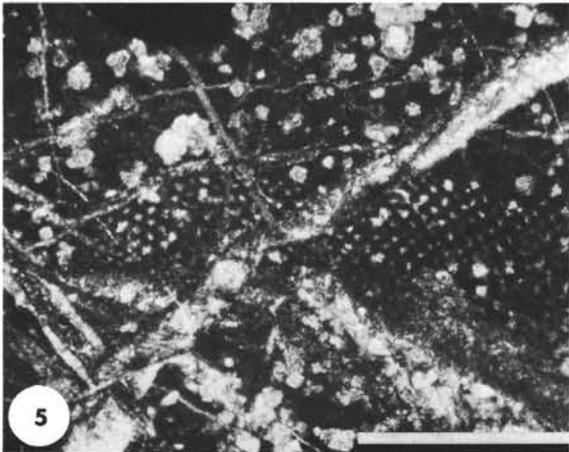
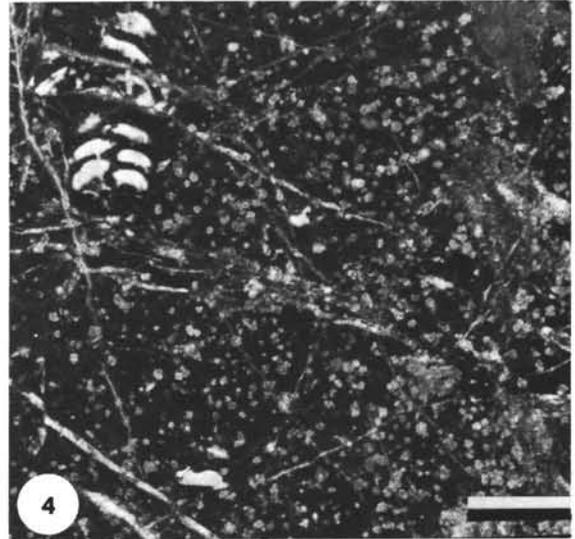
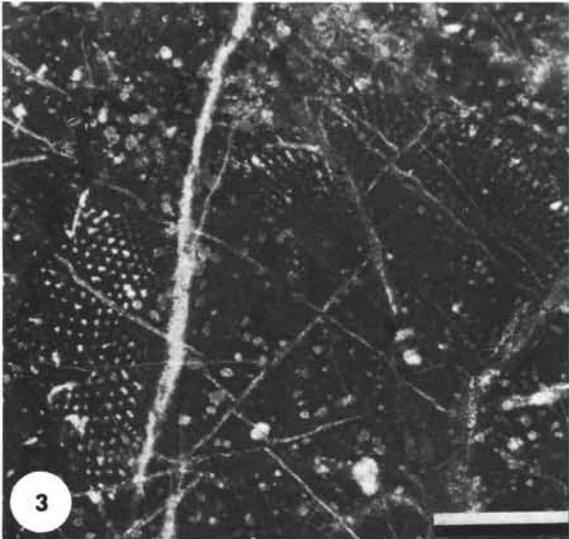
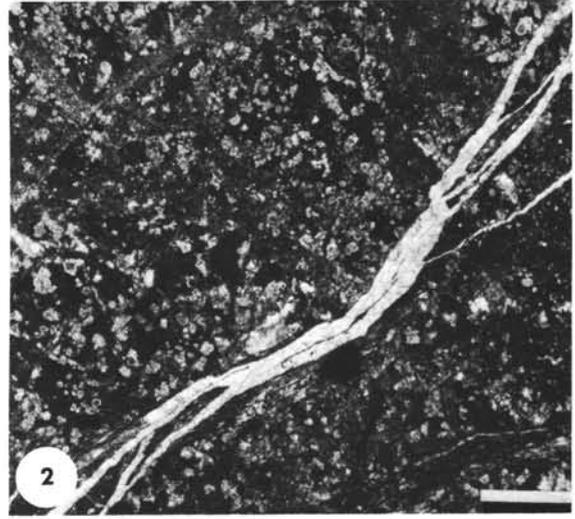
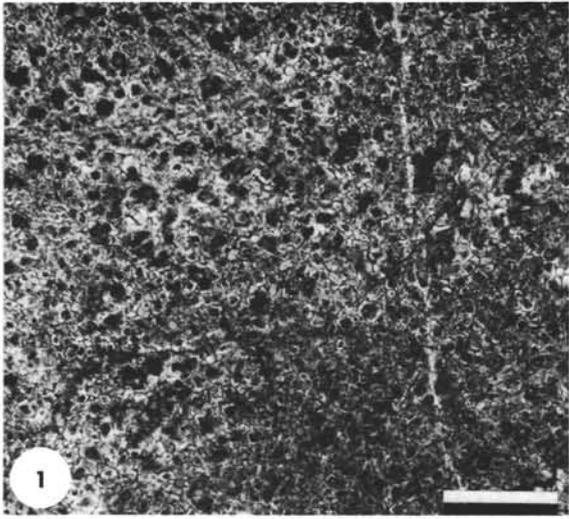
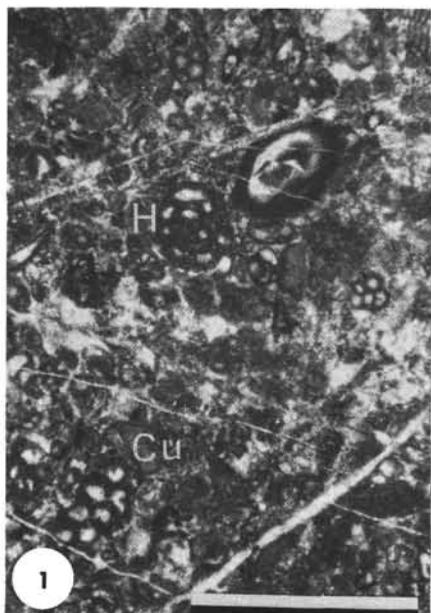


PLATE 2

(Scale bars represent 1 millimeter except for Figure 4, where it represents 0.1 millimeter.)

- Figures 1, 2 Micritic limestone with *Cuneolina* cf. *laurentii* Sart. & Cresc., (Cu) *Sabaudia minuta* (Hofker) (S) *Haplophragmoides?* sp. (H). Hole 127, Core 18, piece 4.
- Figure 3 Fractured limestone as above with *Sabaudia minuta* (Hofker) or *Cuneolina* and Ophtalmidiidae. Hole 127, Core 18, piece 4.
- Figure 4 Limestone as above, with *Sabaudia minuta* (Hofker), transverse section. Hole 127, Core 18, piece 4.
- Figures 5, 6 Limestone as above, with *Hensonella cylindrica* Elliot. Hole 127, Core 18, piece 4.

PLATE 2



S

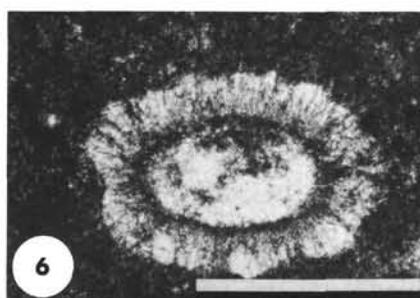
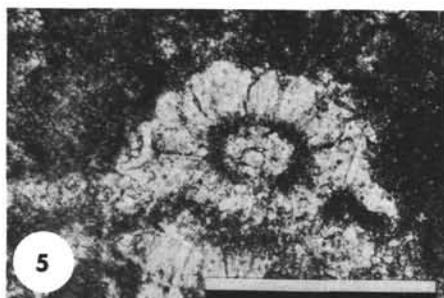
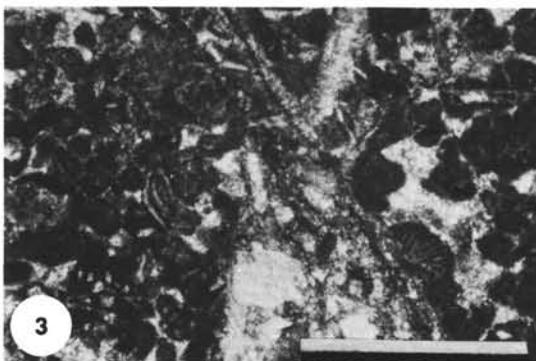
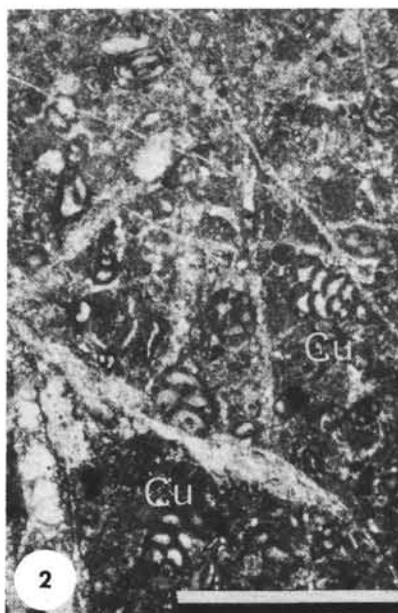


PLATE 3

(Scale bars represent 1 millimeter.)

- Figure 1 Micritic limestone with *Chrysalidina* (Ch) *Vabulammina* aff. *picardi* Henson (V). Hole 127, Core 18, piece 4.
- Figures 2, 3 Limestone as above with *Chrysalidina*. Hole 127, Core 18, piece 4.
- Figure 4 Limestone as above, with *Vabulammina* aff. *picardi* Henson. Hole 127, Core 18, piece 4.

PLATE 3

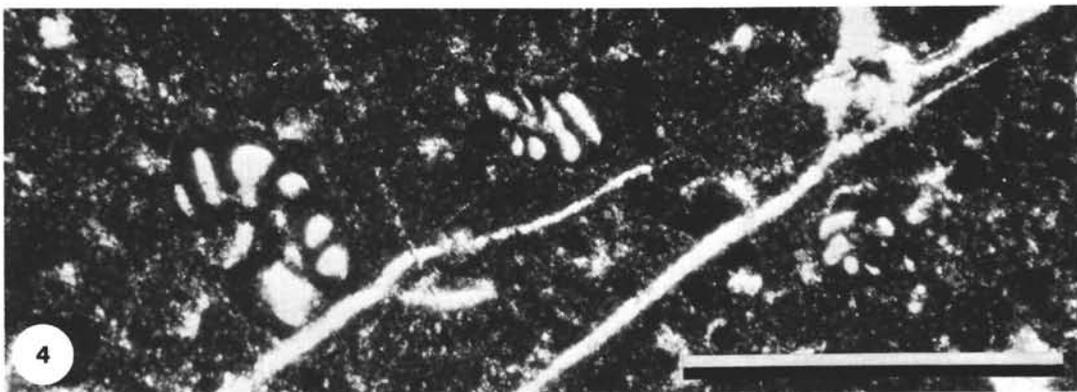
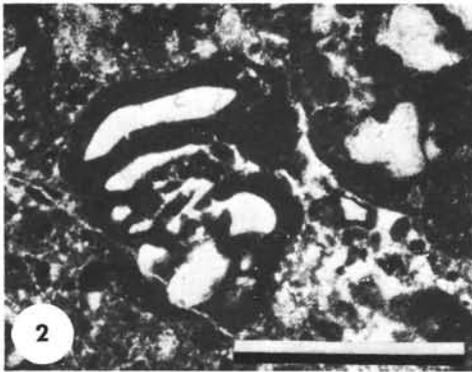
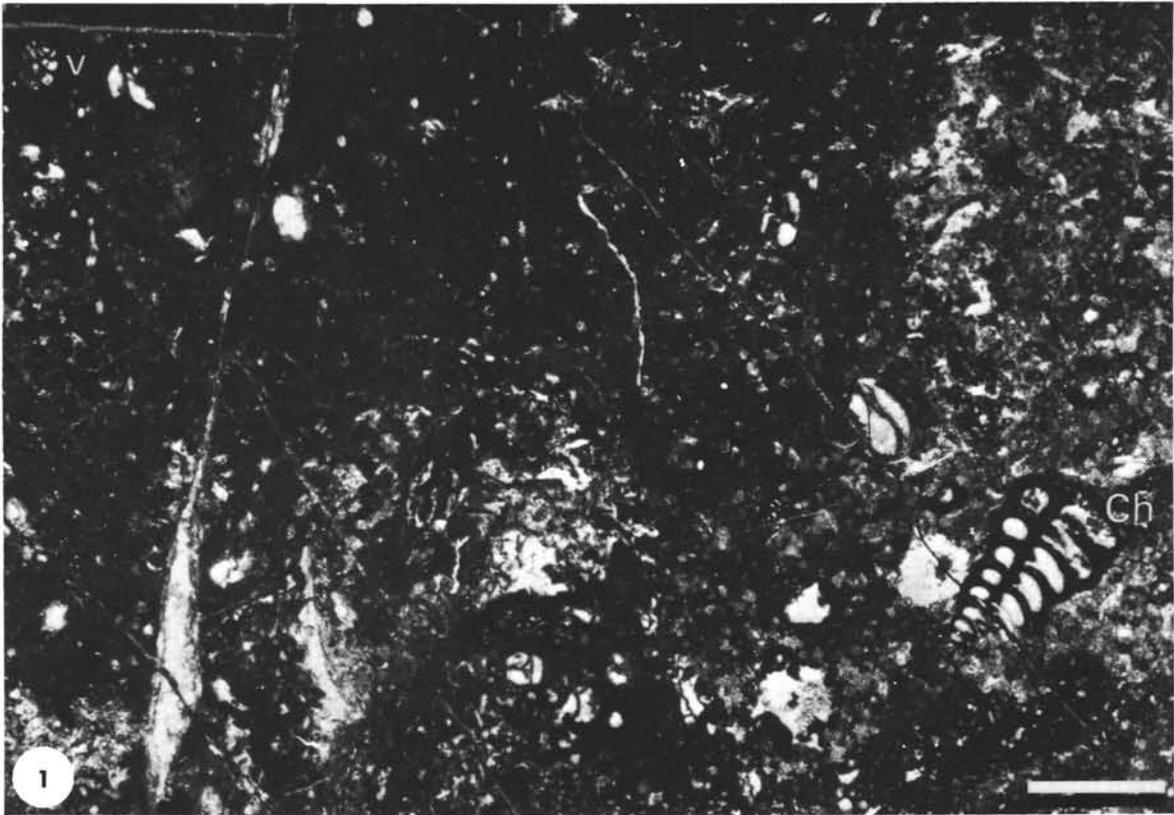


PLATE 4

(Scale bars represent 1 millimeter.)

- Figure 1 Micritic limestone with *Chrysalidina* (Ch) *Nezzazata* gr. *simplex* Omara (N) *Bacinella irregularis* Radoicic (Ba) *Boueina?* (B). Hole 127A, Core 4.
- Figure 2 Limestone as above, with *Orbitolina*. Hole 127A, Core 4.
- Figure 3 Limestone as above, with *Chrysalidina*. Hole 127A, Core 4.
- Figure 4 Limestone as above, with *Hensonella cylindrica* Elliot. Hole 127A, Core 4.

PLATE 4

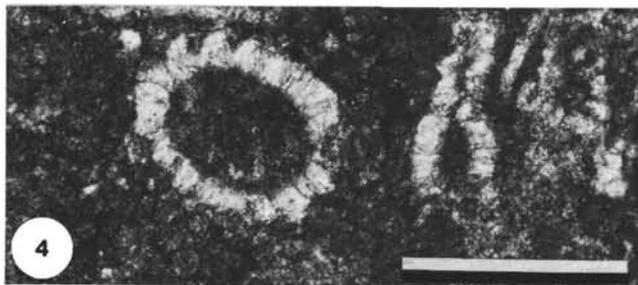
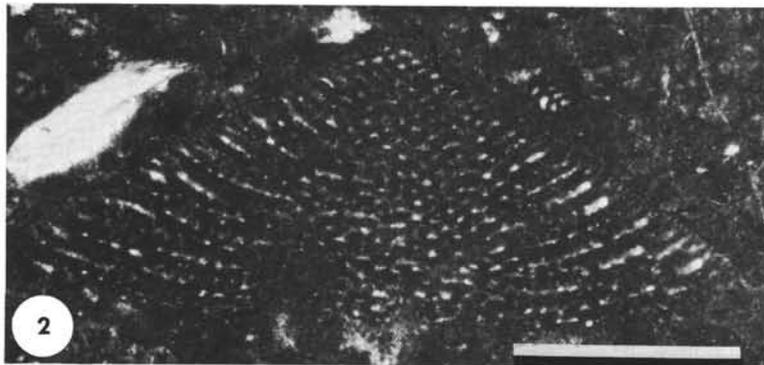


PLATE 5

(Scale bars represent 1 millimeter.)

- Figure 1 Micritic limestone with *Orbitolina* (O) *Chrysalidina* (Ch). Hole 127A, 4-CC.
- Figure 2 Biomicritic limestone with *Orbitolina* (O) *Cuneolina* cf. *laurentii* Sart. & Cresc. (Cu) Miliolidae. Hole 127A, Core 5, piece 2. (part of Figure 3).
- Figure 3 As above with *Orbitolina* (O) *Cuneolina* etc. Hole 127A, Core 5, piece 2.
- Figure 4 Limestone as above with *Valvulammina* aff. *picardi* Henson. Hole 127A, Core 5, piece 2.
- Figure 5 Limestone as above with *Sabaudia minuta* (Hofker). Hole 127A, Core 5, piece 2.

PLATE 5

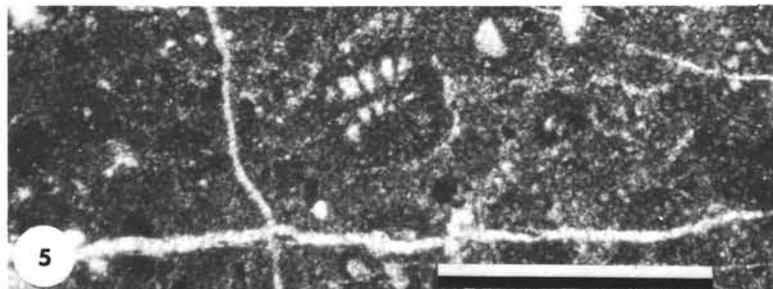
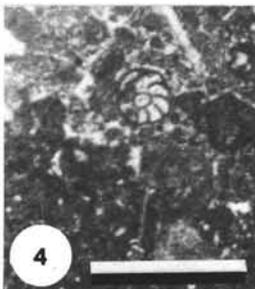
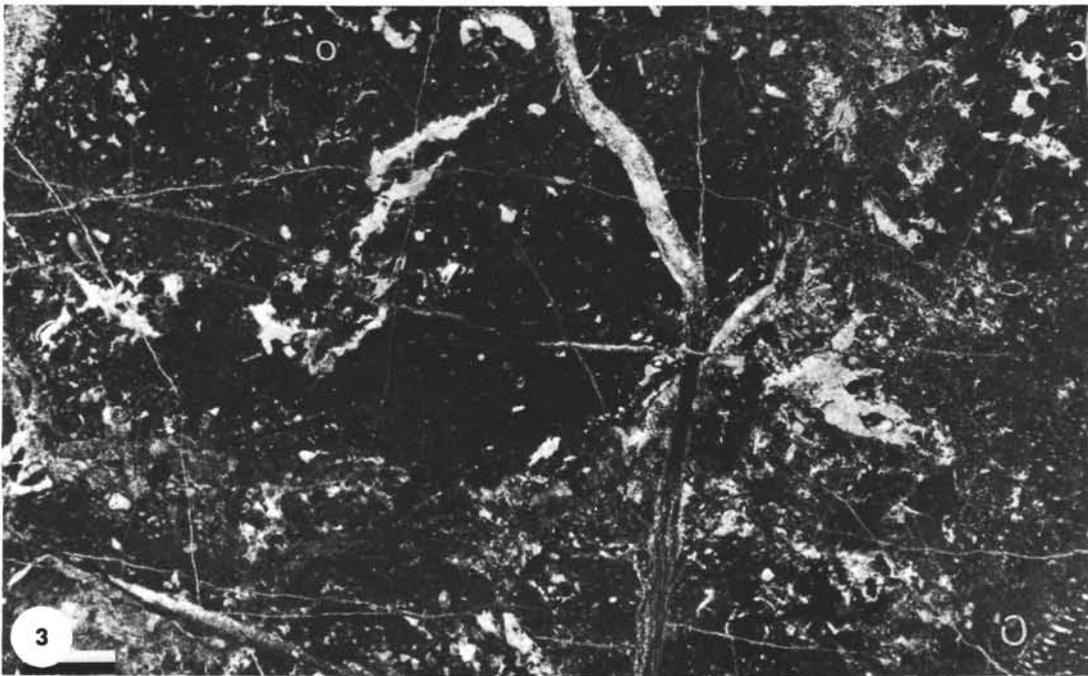
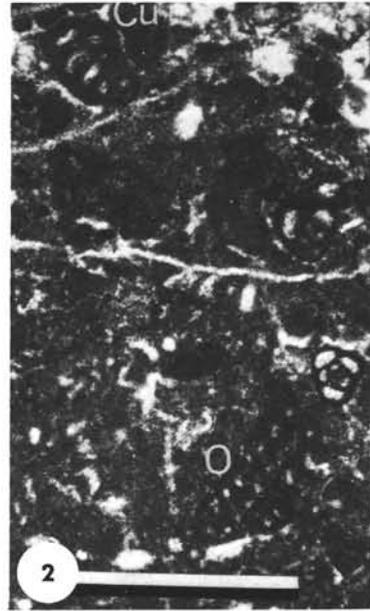
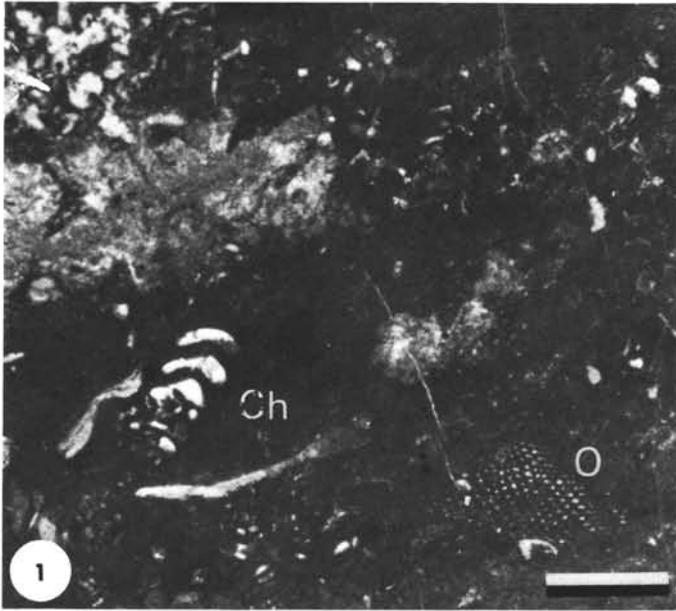


PLATE 6

(Scale bars represent 1 millimeter.)

- Figure 1 Biomicrite with *Nezzazata* gr. *simplex* Omara. Hole 127A, Core 5, piece 2.
- Figure 2 Limestone as above with *Vahvulammina* aff. *picardi* Henson. Hole 127A, Core 5, piece 2.
- Figures 3-6 Limestone as above with *Orbitolina*. Hole 127A, Core 5, piece 2.

PLATE 6

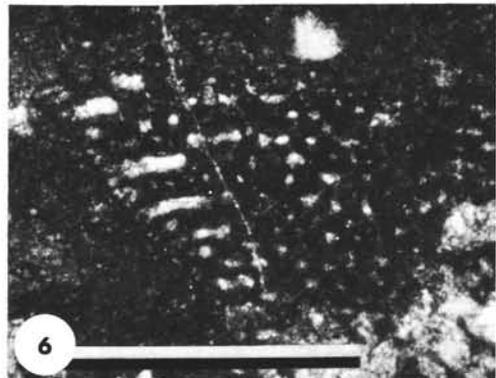
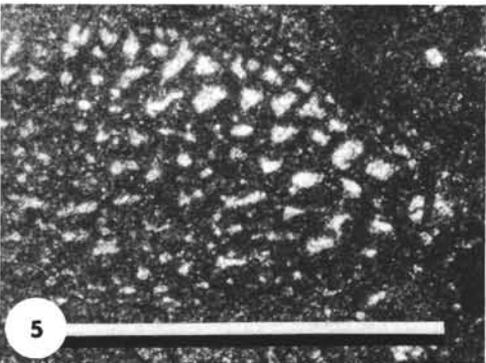
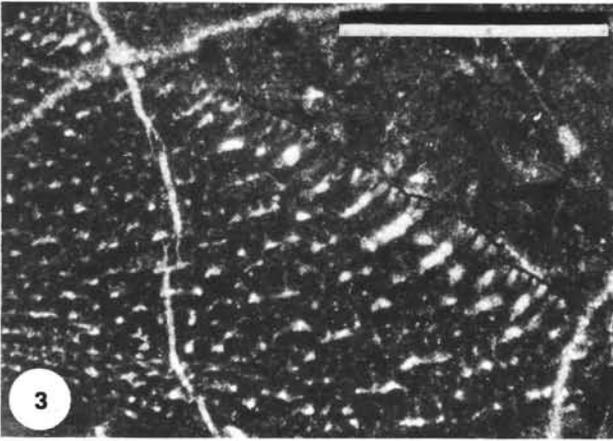
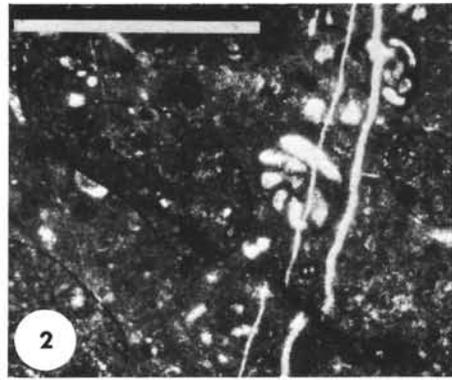
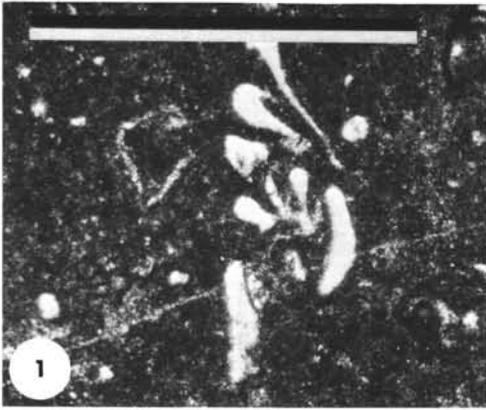


PLATE 7

(Scale bars represent 1 millimeter.)

- Figure 1 Pebble of Cretaceous biomicrite embedded in Orbulina-Globigerina marl. Hole 127B, Core 1, piece 1.
- Figure 2 Limestone pebble as above with *Valvulammina* aff. *picardi* Henson. Hole 127B, Core 1, piece 1.
- Figure 3 Limestone pebble in *Orbulina-Globigerina* ooze as above. Hole 127B, Core 1, piece 1.

PLATE 7

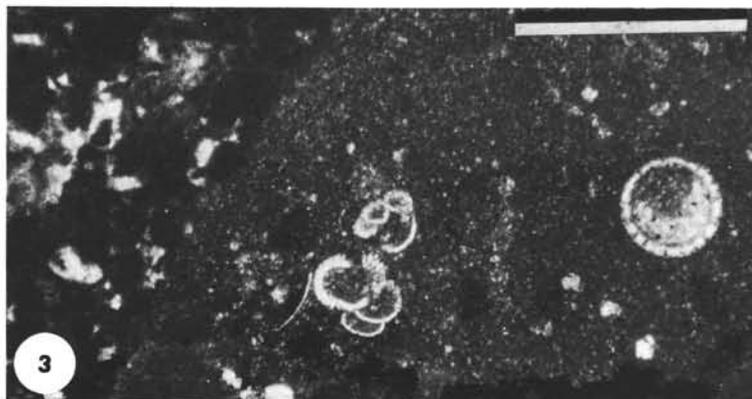
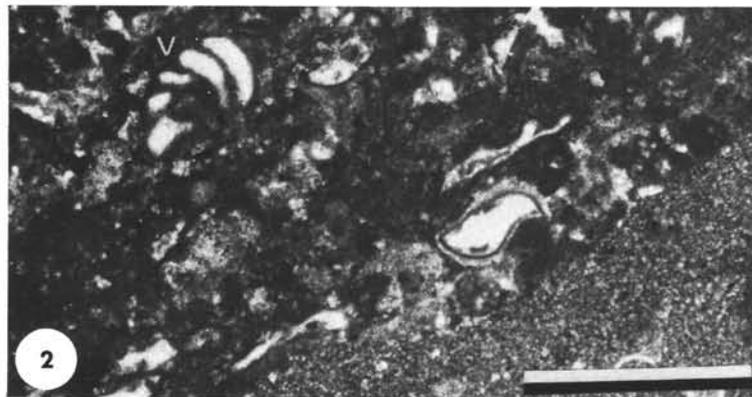
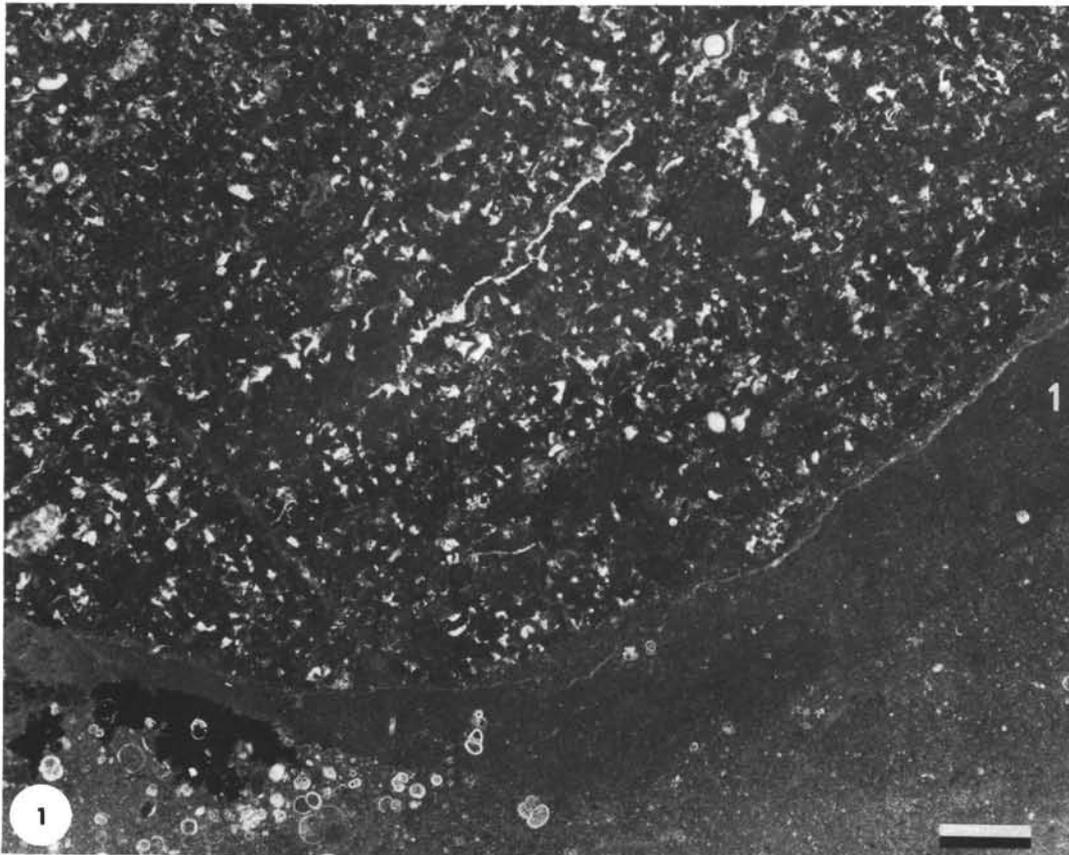


PLATE 8

(Scale bars represent 1 millimeter.)

- Figures 1-3 *Orbitolina*-bearing micrite. Hole 127B, Core 1, piece 2.
- Figure 4 Angular fragments of fractured dolomite and dolomitic limestone, components of a breccia with a matrix of *Orbulina-Globigerina* marl. Hole 127B, Core 1, piece 3.

PLATE 8

