Pakistan Journal of Hydrocarbon Research
Vol.2,No.2(July 1990),P.67-84, 3 Figs, 1 Table, 10 Plates

Foraminiferal Zonation of Upper Goru Formation – Bawani Area, Kirthar Range

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ABSTRACT

Fine grained sedimentary strata of Upper Goru formation of Middle Cretaceous age in the Bawani area, southern Kirthar range has yielded rich planktonic foraminifera indicating deep marine deposition. Two profiles in the area, sampled at an interval of 10m, have shown five distinct planktonic foraminiferal zones. Two zones are of Late Albian while the other three are of Cenomanian stage. These zones are (1) *Rotalipora cushmani* Borstti(1962), (2) *R. reicheli* Bolli (1966), (3) *R. brotzeni* Lehmann(1966), (4) *R. appenninica* Bronnimann (1952) and (5) *R. ticinensis* Dalbiez (1955).

The study has shown that the sequence is interestingly a rare case in the Cretaceous , exposed with a seemingly continuous sedimentation without any recognizable hiatus. The planktonic/ benthonic ratio 100:1 indicates an open sea fully marine environment. The zonal scheme applied is after Robaszynski and Caron(1979).

INTRODUCTION

This paper presents the results of a foraminiferal study based on 23 samples of Goru formation from Bawani area, eastern Balochistan (Figure 1). The samples were collected in 1989 during the field trip to coastal area where a well exposed sequence of marine sedimentary rocks from Cretaceous-Miocene is present.

The samples collected from the sequence are mainly greenish grey to olive grey shale, partly reddish brown due to weathering. Some belemnites were also found in the lower part of the shale.

The major objective of the study is to build a planktonic foraminiferal zonation of the Upper Goru formation in the southern Indus basin, where the formation contains oil and gas producing horizons in more than 40 fields.

Material

Thirty four samples were collected by an HDIP-BGR party during a field work in the area in February, 1989. The samples were collected at an interval of 10m of fresh sediment. Two parallel sections were sampled at a distance of 250m.

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Preparation

About 250 gms of each sample was soaked in hydrogen peroxide (H_2O_2) and water for 10-12 hours. A few drops of ammonia (NH_4OH) were added to neutralize the acidic reaction. The samples were washed on a 90um sieve. Washed residues were dried at 60-80°C and treated in an ultrasonic bath for 15 minutes to clean the fossils. Then material was finally washed and dried.

Determination of Foraminifera

Foraminifers were picked from the washed residues and planktonic foraminifers were identified after Robaszynski and Caron (1979), Bolli (1985) and benthics after Loeblich & Tappan (1988) and Jenkins & Murray (1989).

Illustrations

The Scanning Electron Microscopic (SEM) photographs of some well preserved planktonic foraminifera were taken at Bundesanstalt fur Geowessenschaften und Rohstoffe (BGR), Hannover, Germany and some benthics were photographed at National Institute of Health, Islamabad. These photographs are illustrated on Plates 1-10.

Previous Work

There is a dearth of published literature on the micropaleontology of the Cretaceous deposits of Pakistan. Some of the significant contributions are mentioned below.

Nagappa(1959) discussed the biostratigraphy of Cretaceous-Eocene succession in Pakistan in which he referred a few index planktonic foraminifera species of the Upper Cretaceous age. Haque (1962) described some Late

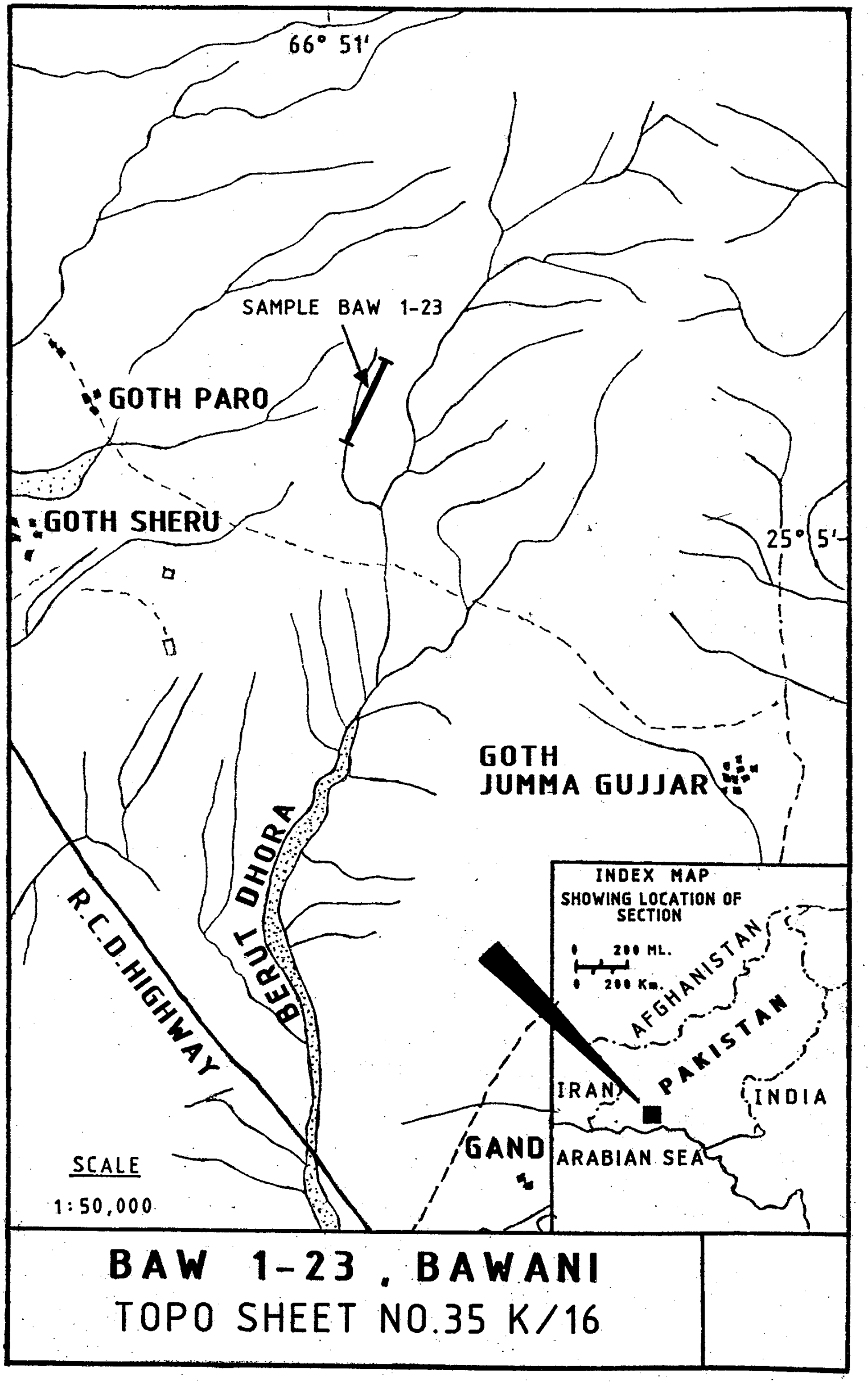


Figure 1— Location map of the study area.

Cretaceous fauna from southern Indus basin. Kureshy(1970) discussed the Mesozoic and Tertiary boundary in Pab Range and Gaj River section of Pakistan.

Kureshy(1972a&b) described the Cretaceous planktonic foraminifera from Gaj River section. Dorreen(1974) discussed the Cretaceous and Tertiary boundary of Gaj River section based on foraminifers.

Kureshy(1976) developed the correlation of planktonic foraminiferal zonation of Cretaceous in Pakistan with that of Bolli(1959). In the present study the the planktonic foraminiferal zonation is updated according to Robaszynski and Caron(1979).

Generalized Stratigraphy

The oldest rock unit in the area is Upper Goru formation of Middle Cretaceous and the youngest formation is Gaj formation of

Miocene age (Shah, 1977). General stratigraphy of the region is shown in Figure 2. Stratigraphic succession in the study area is quite disturbed due to tectonic set up near the tripple junction, therefore most part of the Upper Cretaceous, whole Paleocene and Early Eocene are missing due to folding and thrusting.

BIOSTRATIGRAPHY

The samples are quantitatively rich in planktonic foraminifers. The stratigraphic distribution of about 25 planktonic and benthonic foraminifera are shown in Figure 3. From Figure 3 it is inferred that the upper most part of the section (sample nos. 1-7) is of Late Cenomanian (*Rotalipora cushmani* zone) stage. Only one sample (no. 8) shows traces of *Rotalipora reicheli* which indicates Middle Cenomanian stage. Sample nos. 9-11, on the basis of the first appearance of *Rotalipora brotzeni,* are assigned to Early Cenomanian stage. On the basis of the first occurence of *Rotalipora appenninca* in sample no. 18, the horizon from sample nos.12-18 is placed in the upper most part of the Albian stage. Sample nos. 19-23 are placed in the Late Albian due to the presence of *Rotalipora ticinensis*.

The description of these zones are as follows:

1. *Rotalipora cushmani* Zone (sample nos. 1-7)
Category: Total range zone
Age: Middle to Late Cenomanian
Author: Borsetti(1962)
Description: Interval of total range of *Rotalipora cushmani.*

Other assemblage: *Hedbergella planispira, H. delrioensis, H.simplex, Rotalipora gandolfi, R. brotzeni, R. greenhorensis, Praeglobotruncana stephani, Pg. gibba, Globigerinellonides ultramicra, Schackoina cenomana, Gumbelitria cenomana.*

2. *Rotalipora reicheli* Zone (sample no. 8)
Category: Total Range Zone
Age: Early to Middle Cenomanian
Author: Bolli (1966)
Definition: Interval of total range of *Rotalipora reicheli.*
Other assemblage: *Rotalipora brotzeni, Praeglobotruncana gibba, Planomalina buxtorfi.*

3. *Rotalipora brotzeni* Zone (sample nos. 9-11)
Category: Interval Zone
Age: Early Cenomanian
Author: Lehmann (1966)
Definition: Interval from first occurence of *Rotalipora brotzeni* to first occurence of *Rotalipora reicheli*.
Other assemblage: *Hedbergella simplex, H. planispira, H. delrioensis, Planomalina buxtorfi, Praeglobotruncana gibba, Pg. delrioensis, Pg. stephani, Rotalipora appenninica.*

4 *Rotalipora appenninica* Zone (sample nos. 12-18)
Category: Interval Zone
Age: Late Albian
Author: Bronnimann (1952)
Definition: Interval from first occurence of *Rotalipora appenninica* to first occurene of *R. brotzeni.*
Other assemblage: *Planomalina buxtorfi, Biticinella breggiensis, Rotalipora ticinensis, Ticinella roberti, T.raynaudi, T. madecassiana, Hedbergella planispira, H. trocoidea, H. delrioensis, H. simplex, Praeglobotruncana delrioensis, Pg. gibba, Pg. stephani, Globigerinelloides bentonensis, G. ultramicra.*

5 *Rotalipora ticinensis* zone (sample nos. 19-23)
Category: Interval Zone
Age: Late Albian
Author: Dalbiez (1955)
Definition: Interval from the first occurence of *Rotalipora ticinensis* to the first occurence of *R. appenninica.*
Other assemblage: *Ticinella primula, T. roberti, T. raynaudi, T. madecassiana, Biticinella breggiensis, Hedbergella trocoidea, H. planispira, H. simplex, H. delrioensis.*

The comparison of zonation with Bolli (1966) and Robaszynski and Caron (1979) is shown in Table 1.

The occurence of *P. buxtorfi* in sample nos. 4-9 of Cenomanian age is confusing. It may be possible that *P. buxtorfi* in this area ranges into Cenomanian.

Period	Epoch		Formation	Lithology	Description
TERTIARY	PLIO PLEIST		SIWALIK GR.		Sandstone, Shale, Conglomerate. Continental out wash deposit 0 - 4618 m
	MIOCENE		GAJ Fm.		Shale, Sandstone, Limestone-gray-red variegated Sandstone and dirty gray detrial Limestone. Marine to non-marine 50 - 700 m
	OLIGIOCENE		NARI Fm.		Sandstone, Shale, Limestone - fine grained to Conglomeratic Sandstone interbedded with sandy limestone, Shale & calc Sandstone. 150 - 1820 m
	EOCENE	LATE	KIRTHAR Fm.		Limestone & Shale – Light colored generally hard massive but locally rubbly to nodular limestone interbedded Shale - 15 - 1270 m
		MIDDLE			
		EARLY	GHAZIJ Fm.		Shale, Sandstone, Limestone – gray to olive green silty shale with fine to coarse grained argilloceous Limestone in the lower part. mostly marine. 160 m
	PALEOCENE		DUNGHAN Fm.		Limestone, Shale, marl, Sandstone - dark gray to brown Limestone with olive shale black spots (bioturbation) 300 m
			KHADRO Fm.		Sandstone, Shale, Limestone - thin bedded fine Sandstone, Basalt, 67 - 180 m
CRETACEOUS		LATE	PAB SS		Sandstone - Light buff, brown, gray, locally quartzitic. Marine. 240 - 600 m
			FORT MUNRO		Limestone, gray to black, thick bedded, sandy in the upper part, argillaceous band in the lower part. marine. 90 - 248 m
			MOGHAL KOT		Limestone, Siltstone, Sandstone - gray Calcareous Siltstone scattered argillaceous Limestone band. marine. 160 - 900 m
			PARH Ls.		Limestone - Pale, gray, white, hard, porcellaneous, conchoidal fracture, well bedded, Marine. 268 - 600 m
		MIDDLE	GORU Fm.		Limestone & Shale - upper part inter-bedded Parh type Limestone and Calc. Siltstone & Shale Lower part gray, gray-green Siltstone with interbedded argillaceous Limestone and Sandstone. 60 - 3670 m
		EARLY	SEMBAR Fm.		Silty Shale, Limestone - dark olive-gray to black, silty fissile shale, nodular black siltstone, Sandy Limestone, belemnite common 133 - 262 m
JURASSIC		LATE	TAKATU Ls.		Limestone - gray to grayish brown, massive. 0 - 850 m
		MIDDLE	SHIRINAB Fm. ANJIRA Member		Limestone - dark gray thinly bedded limestone thin shale interbeds. Marine. 100 - 400 m
			SHIRINAB Fm. LORALAI LS.		Limestone - dark gray to black, medium to thickly bedded with minor scattered thin Shale interbeds. Marine. 170 - 650 m
		EARLY	SHIRINAB Fm. SPINGWAR Member		Limestone & Shale - dark gray to black, thickly bedded fine crystalline limestone & interbedded Shale or highly argillaceous limestone - Marine. 700 - 1900 m Lower portions with sandstone intercalations

Figure 2— Generalized Stratigraphy of the Kirthar Range (after Williams, 1959).

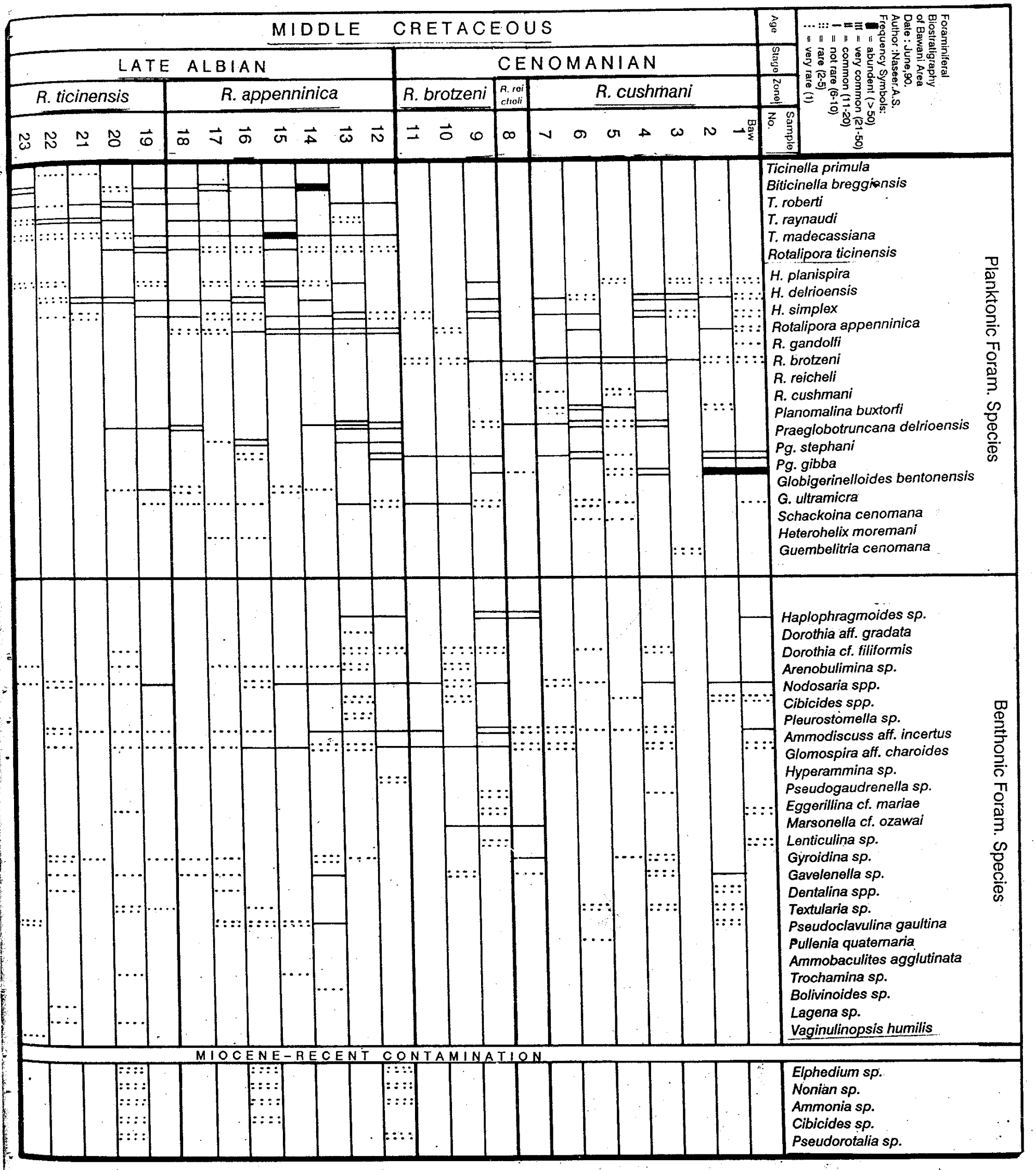


Figure 3— Stratigraphic distribution of foraminifera.

DISCRIPTION OF PLATES

PLATE 1

All specimens from Sample Baw-20.

1-2 *Pseudoclaulina gaultina carinata*, x100

3 *Ammodiscus cretaceus* x100

4 *Glomospira charoides* x240

5 *? Textularia sp.* x200

6 *Ammodiscus ? sp.* x260

7-8 *Trochamina ? sp.* x180

9 *Vernenillinoids ? sp.* x300

PLATE 2

All specimens from Sample Baw-20.

1 *Coryphostoma ? sp.* x200

2-4 *Haplophragmoides ? sp.* x180

5 *? Lenticulina sp.* x220

6 *? Gyroidina sp.* x220

7 *Dentalina solita* x300

8 *Elphedium sp.* (Miocene) x120

PLATE 3

All specimens from Sample Baw-14.

1-3 *Biticinella breggiensis* (GANDOLFI), 1942

4-7 *Globigerinelloides sp. aff. G. bentonensis* (MORROW), 1939

PLATE 4

All Specimens from Sample Baw-14.

1-3 *Rotalipor appenninica* (RENZ), 1936

4-6 *Ticinella ? sp. aff. T. raynaudi* (SIGAL), 1966

PLATE 5

All Specimens from Sample Baw-14

1-3 *Hedbergella planispira* (Tappan), 1940

4-6 *Hedbergella simplex* (Morrow), 1940

PLATE 6

All Specimens from Sample Baw-14

1-2 *Hedbergella cf. delrioensis* (CARSEY), 1926

3-4 *Praeglobotruncana stephani* (GANDOLFI), 1942

5 *Rotalipora cf. appenninica* (RENZ), 1936

PLATE 7

All specimens from Sample Baw-1

1-3 *Rotalipora brotzeni* (SIGAL), 1948

4-6 *Hedbergella delrioensis* (CARSEY), 1926

PLATE 8

All specimens from Sample Baw-1

1-3 *Praeglobotruncana gibba* (KLAUS), 1960

4-6 *Praeglobotruncana stephani* (GANDOLFI), 1942

PLATE 9

All specimens from Sample Baw-1

1 *Rotalipora brotzeni* (SIGAL), 1948

2 *Rotalipora cf. gandolfi* (LUTERBACHER & PREMOLI), 1962

3-5 *Globigerinelloides ultramicra* (SUBBOTINA), 1949

PLATE 10

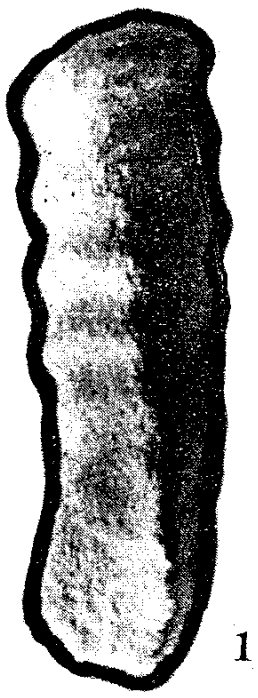
All specimens from Sample Baw-23

1-2 *Planomalina buxtorfi* (GANDOLFI), 1942

3-4 *Rotalipora ticinensis* (GANDOLFI), 1942

5-6 *Ticinella madecassiana* (SIGAL), 1966.

PLATE 1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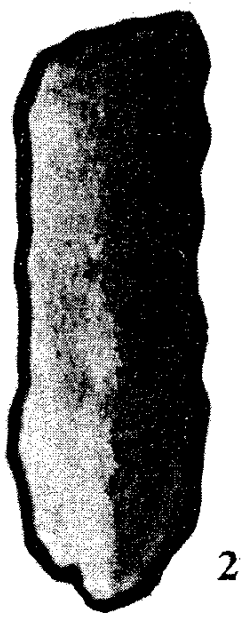
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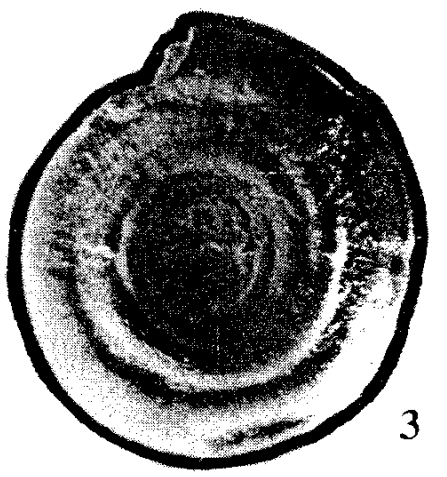
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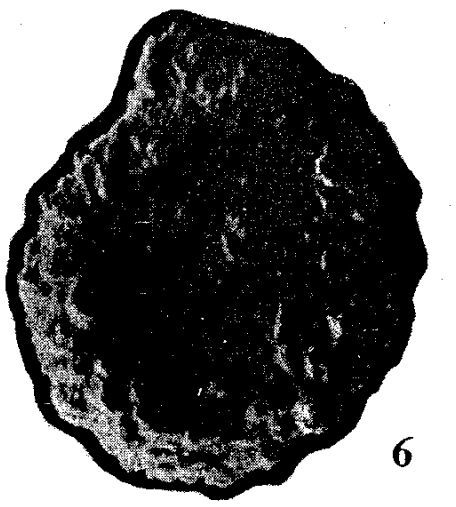
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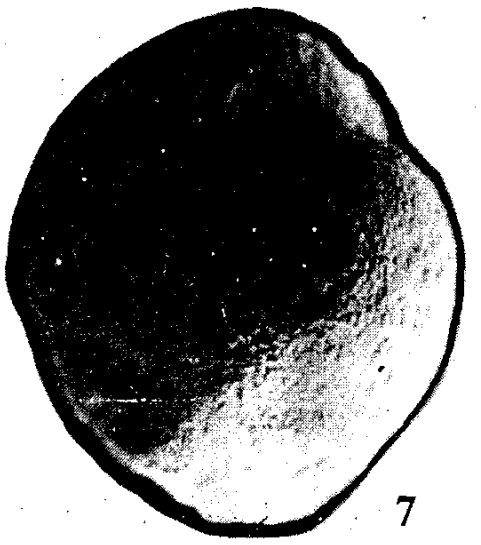
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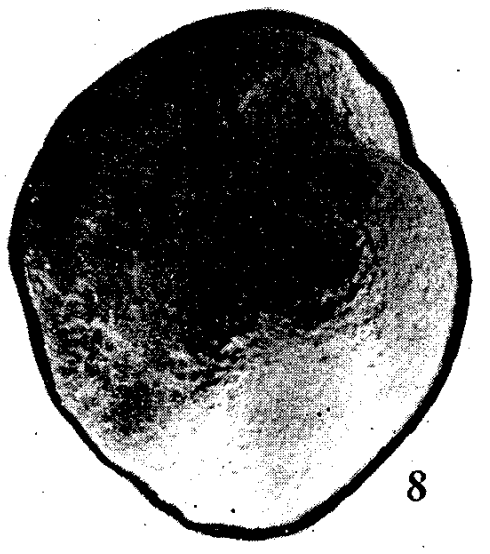
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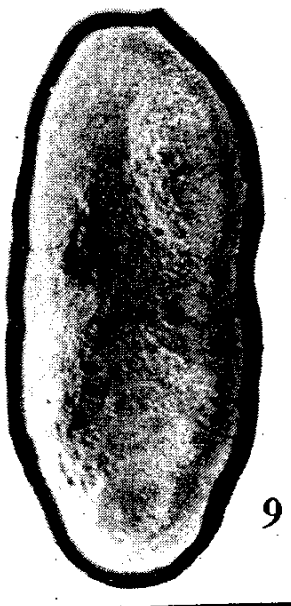
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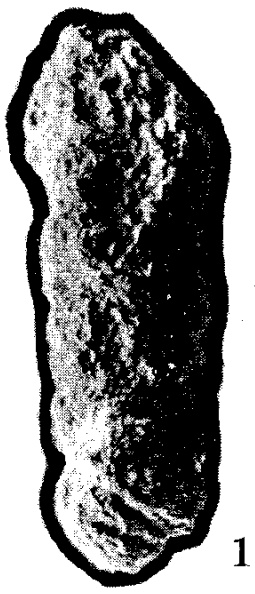
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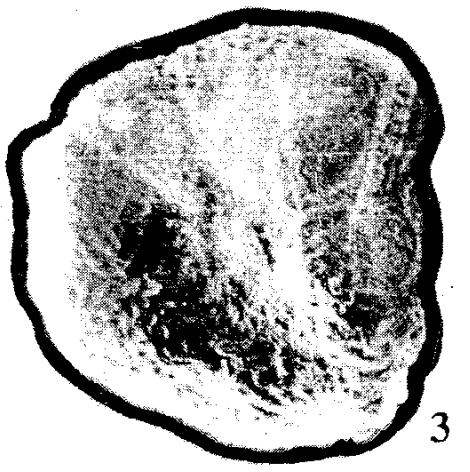
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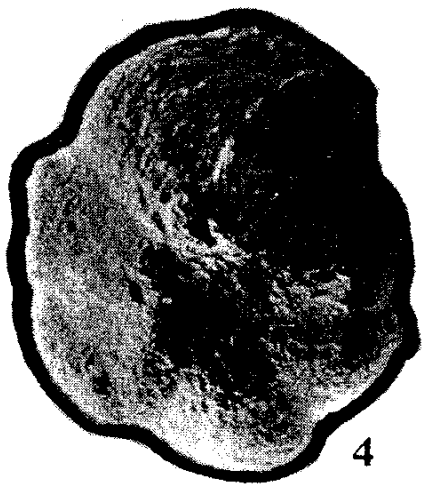
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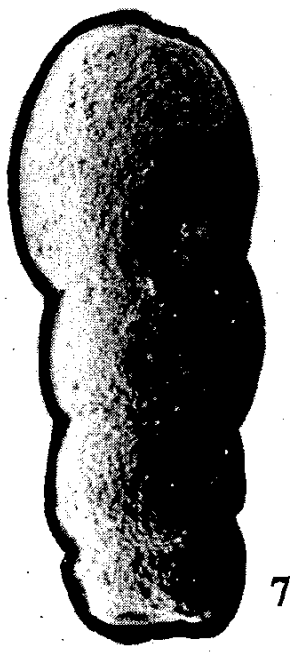
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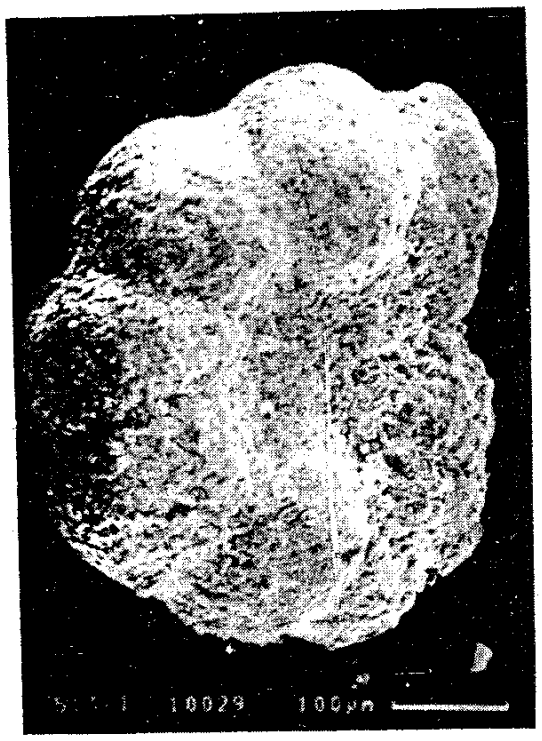

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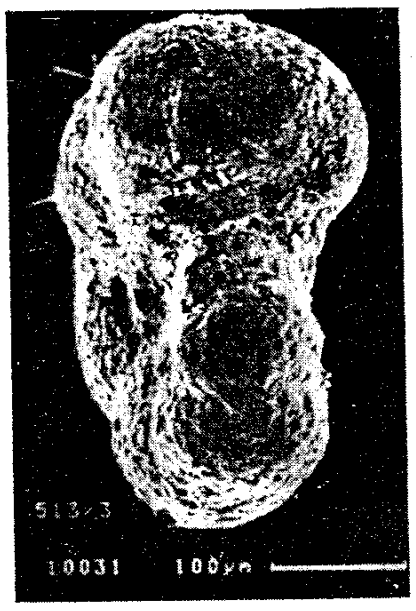

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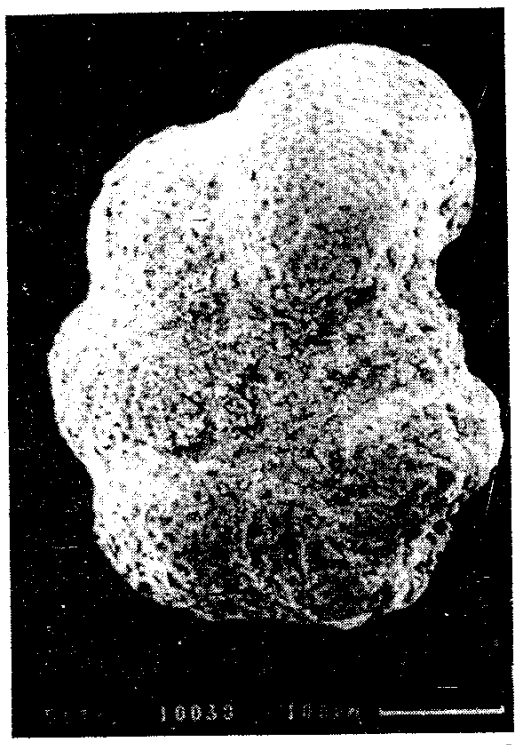

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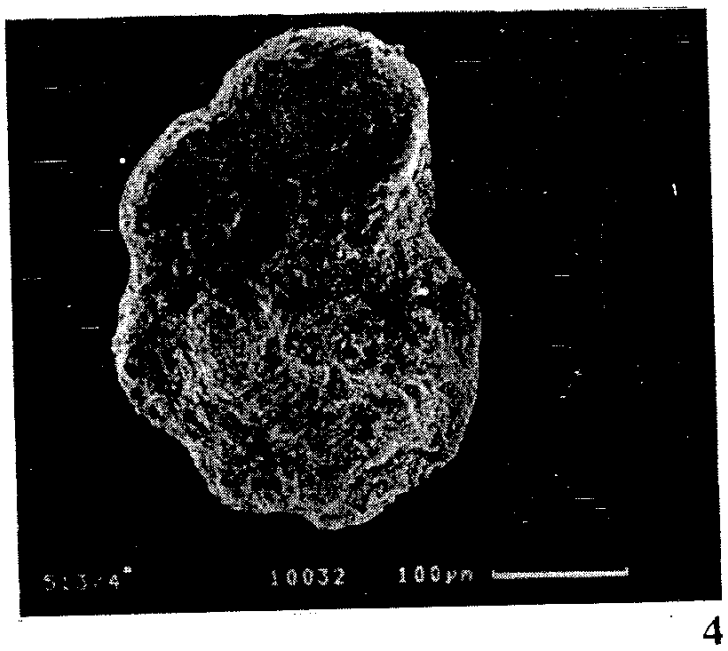

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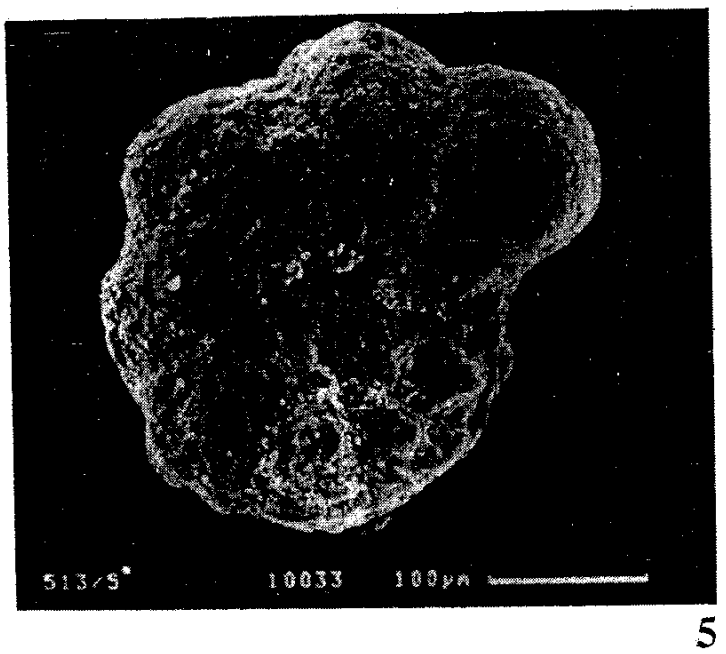

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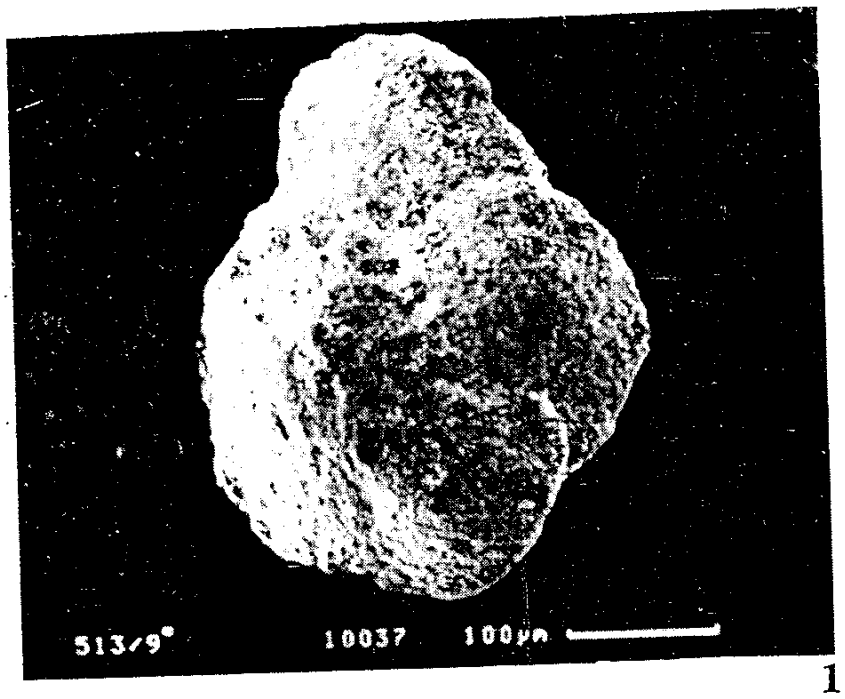

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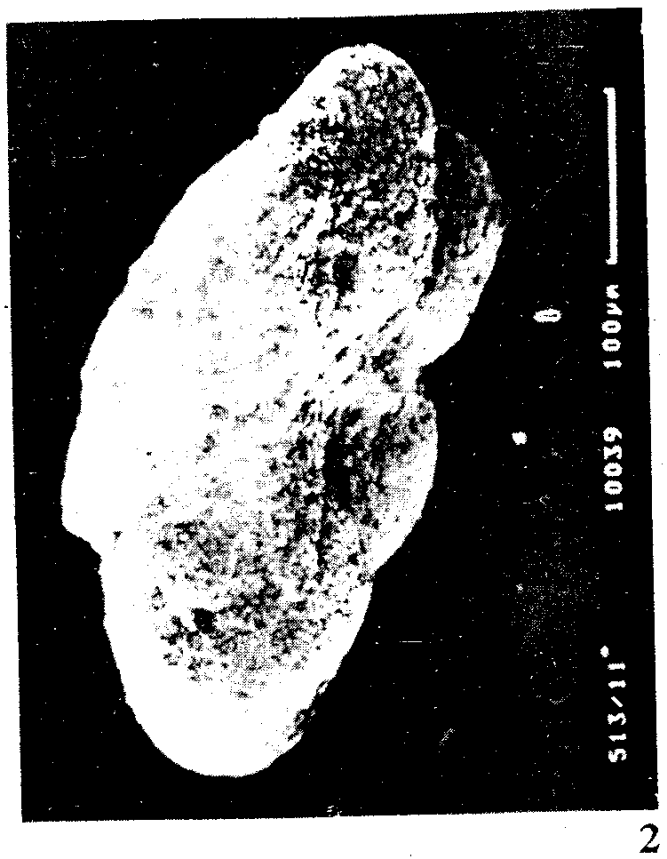

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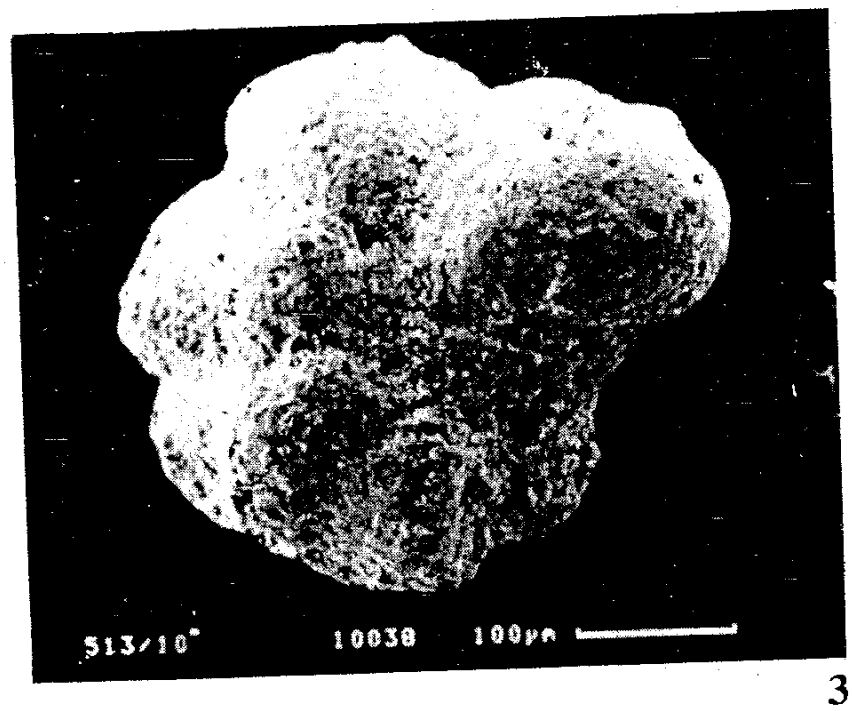

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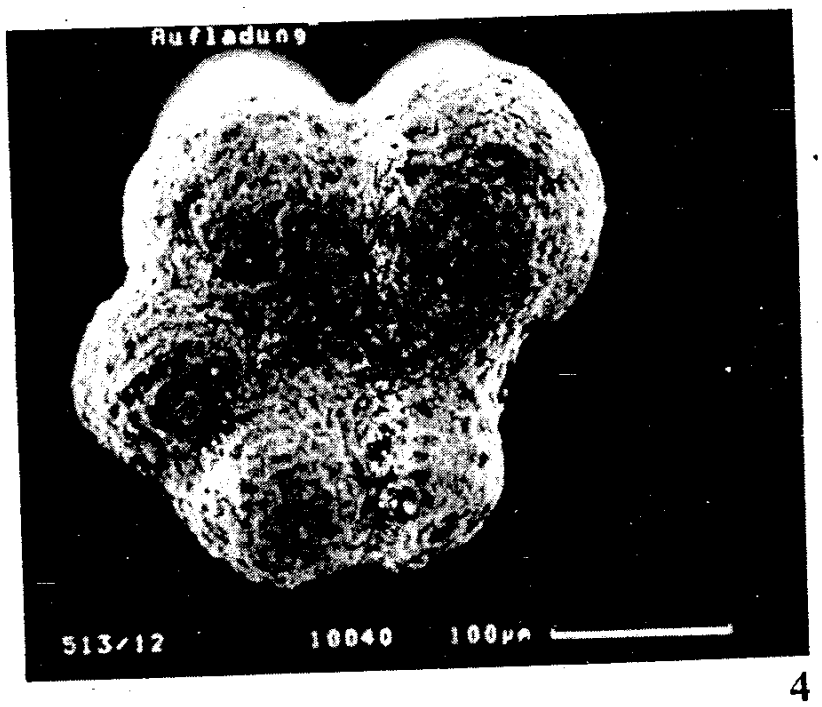

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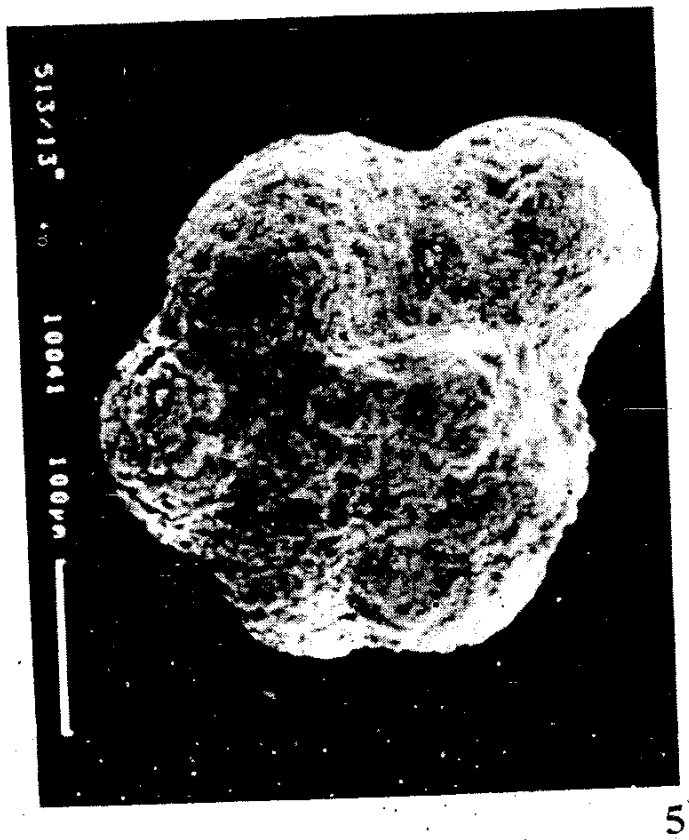

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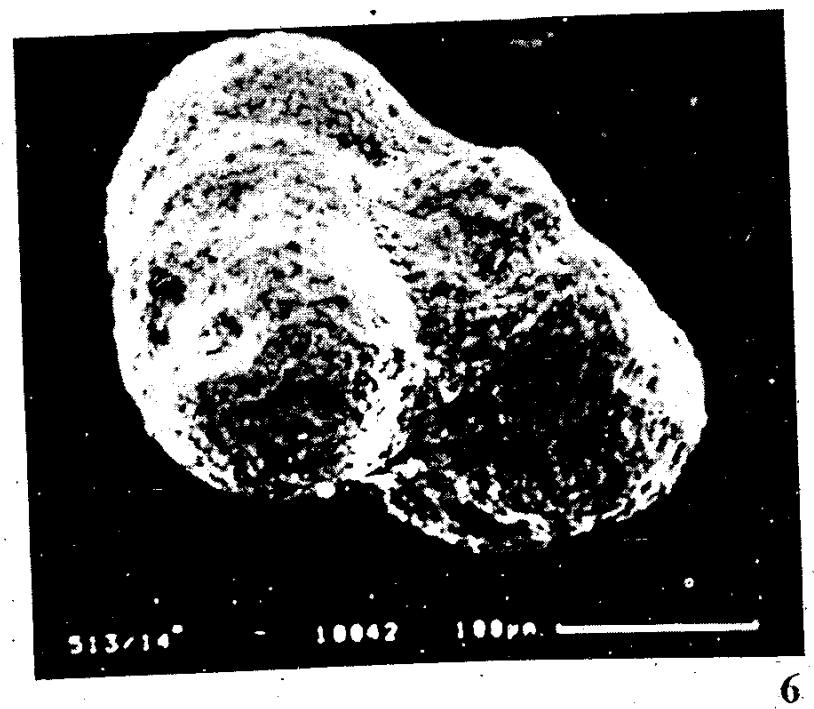

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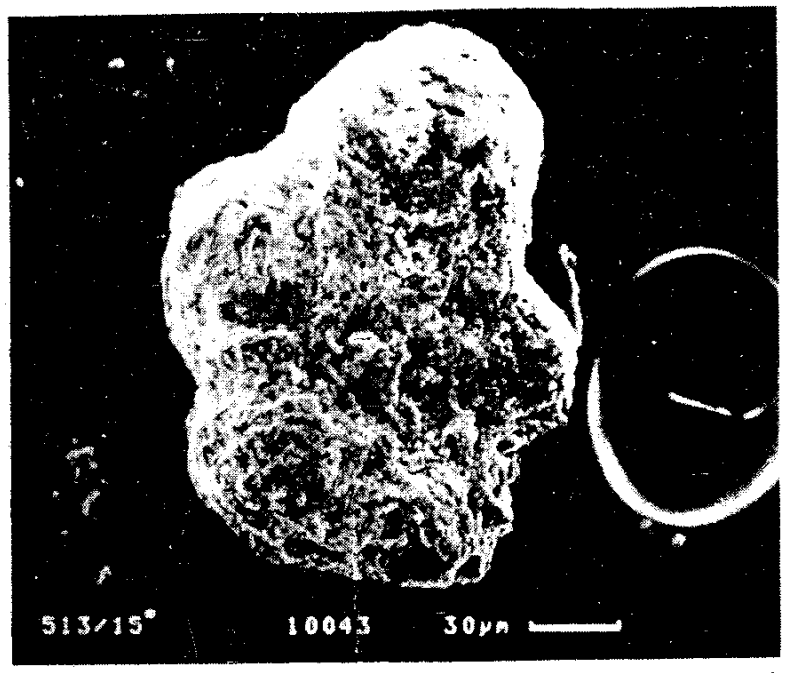

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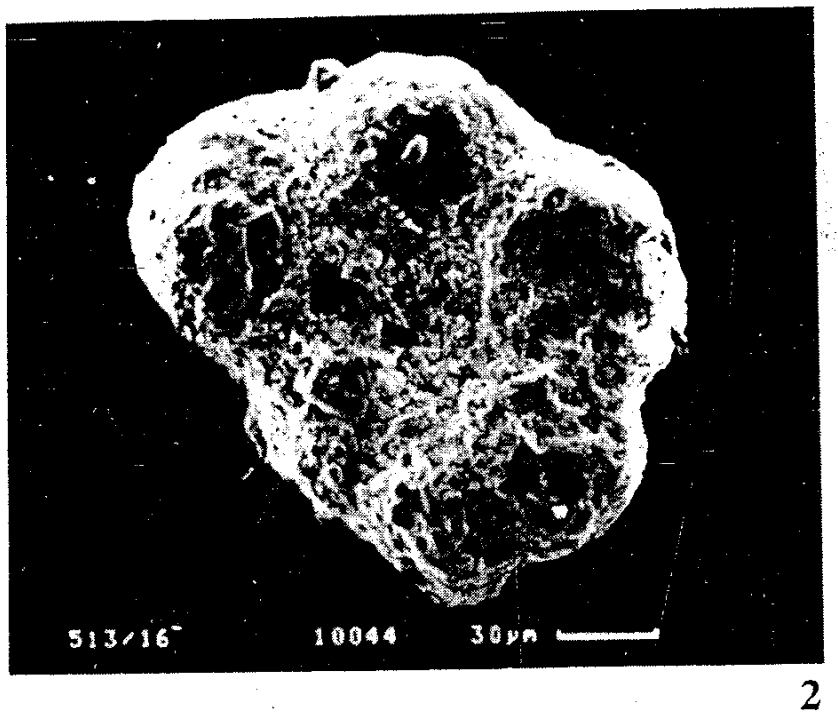

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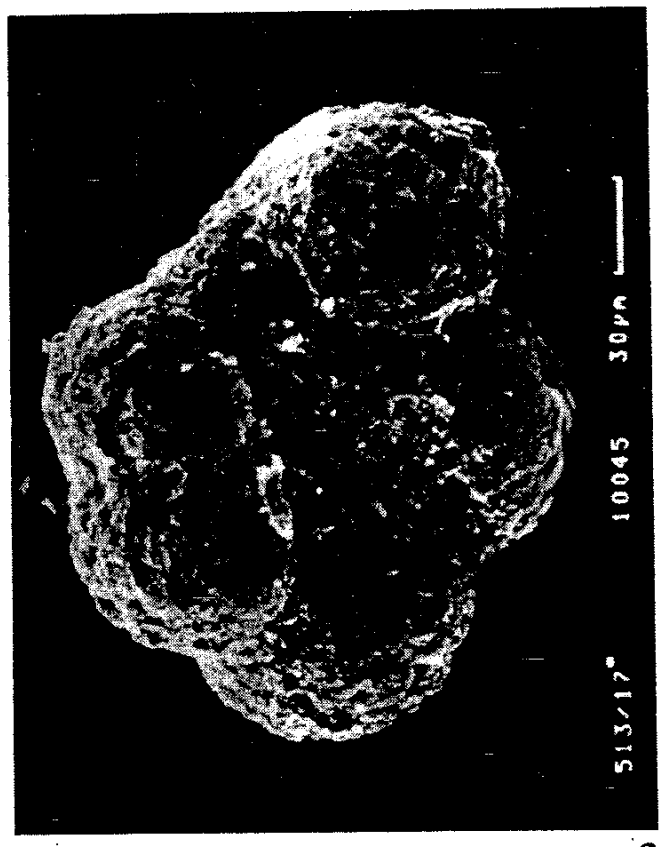

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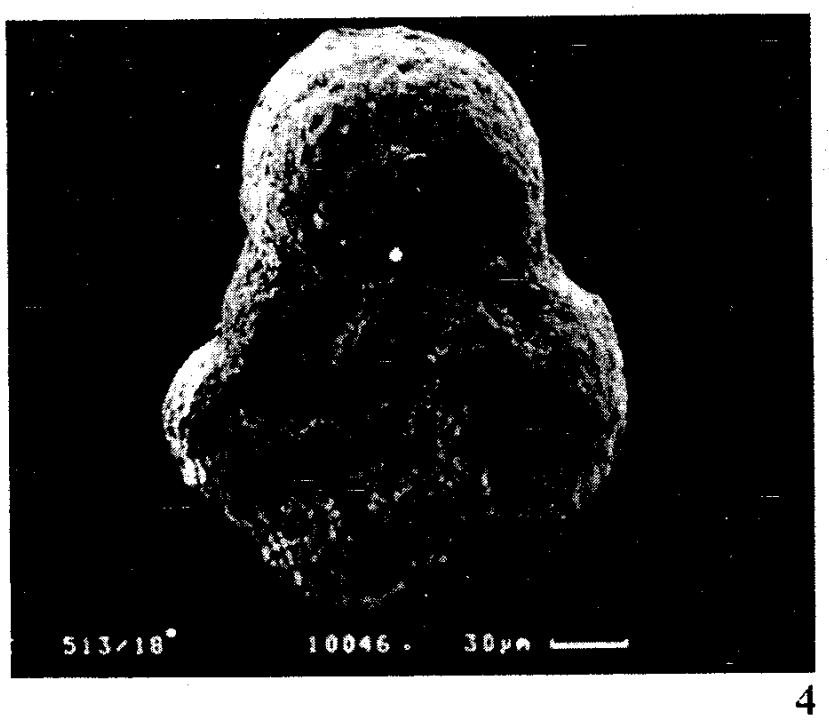

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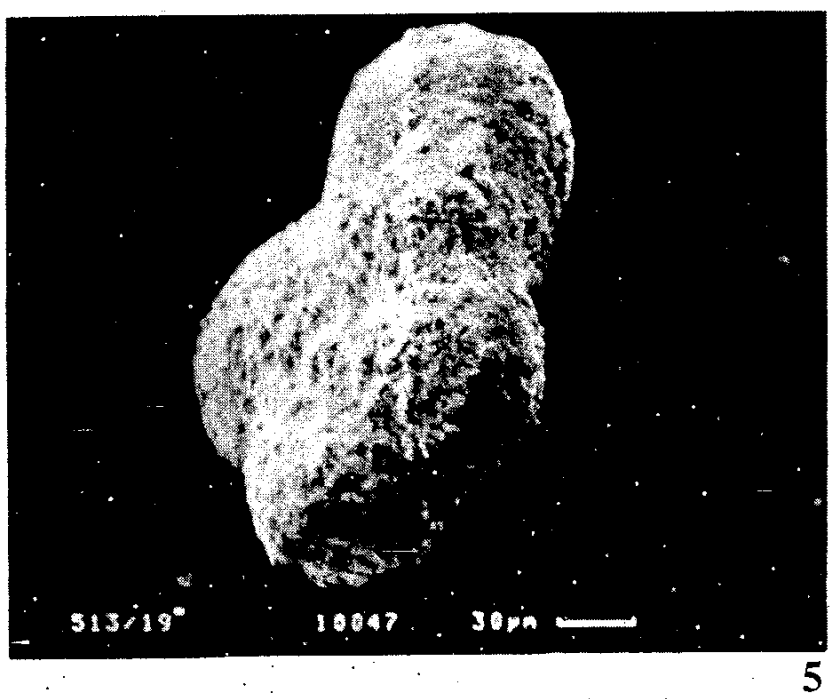

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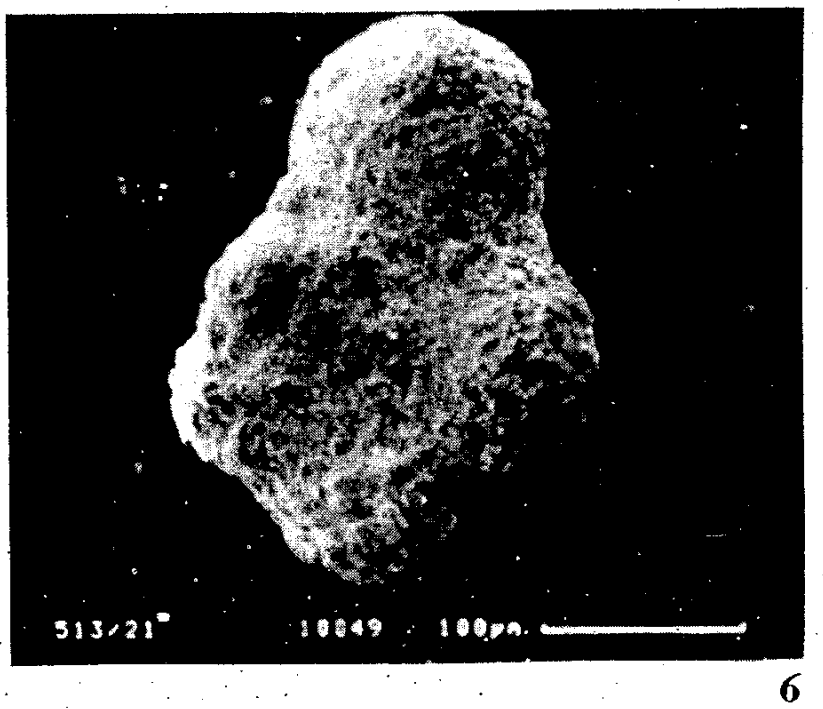

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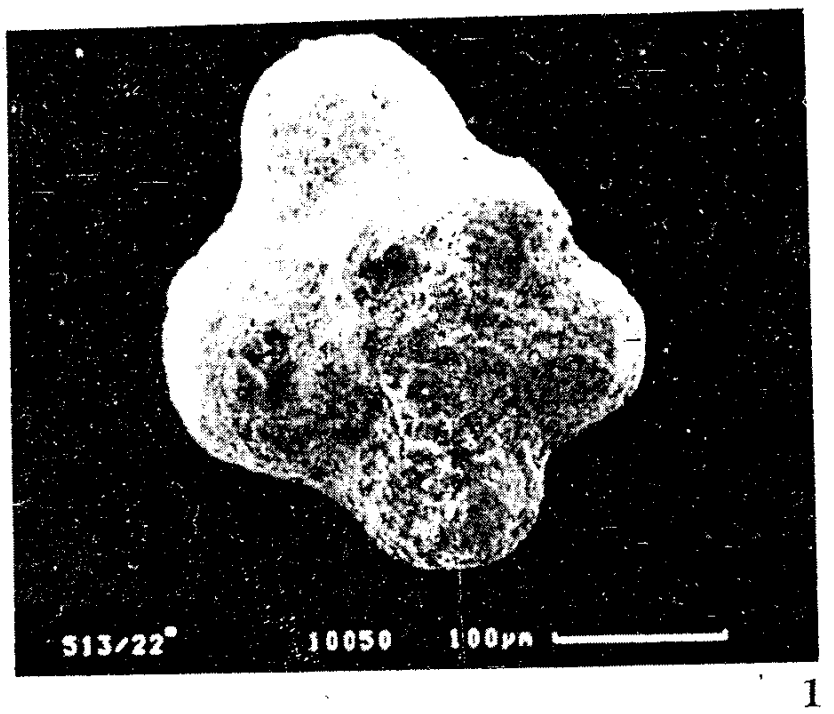

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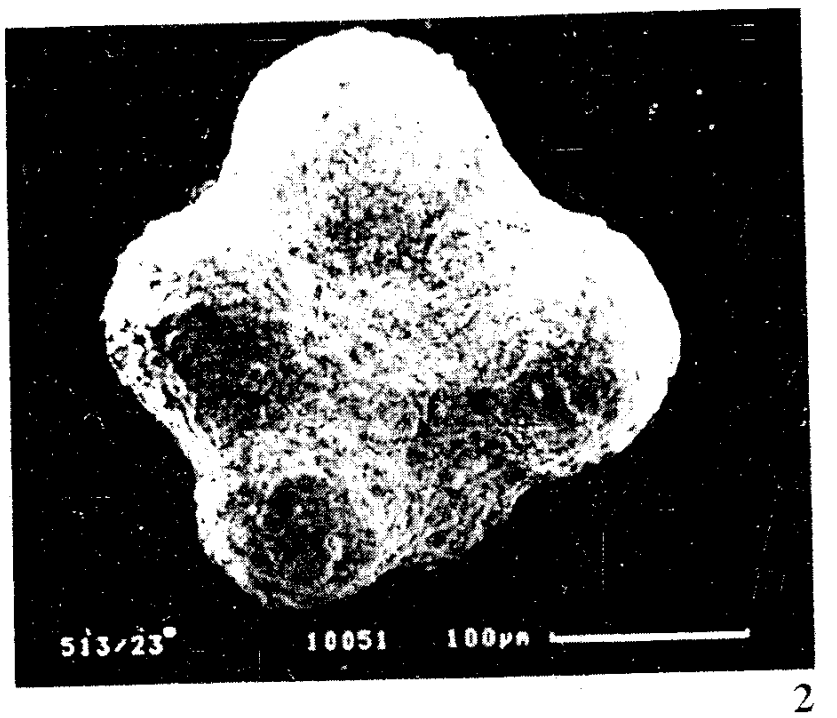

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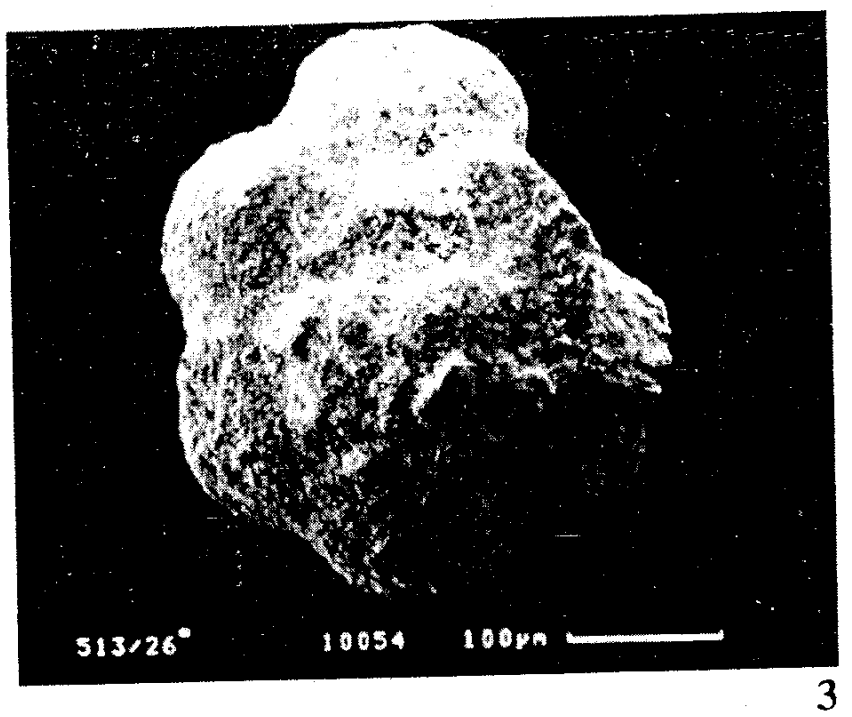

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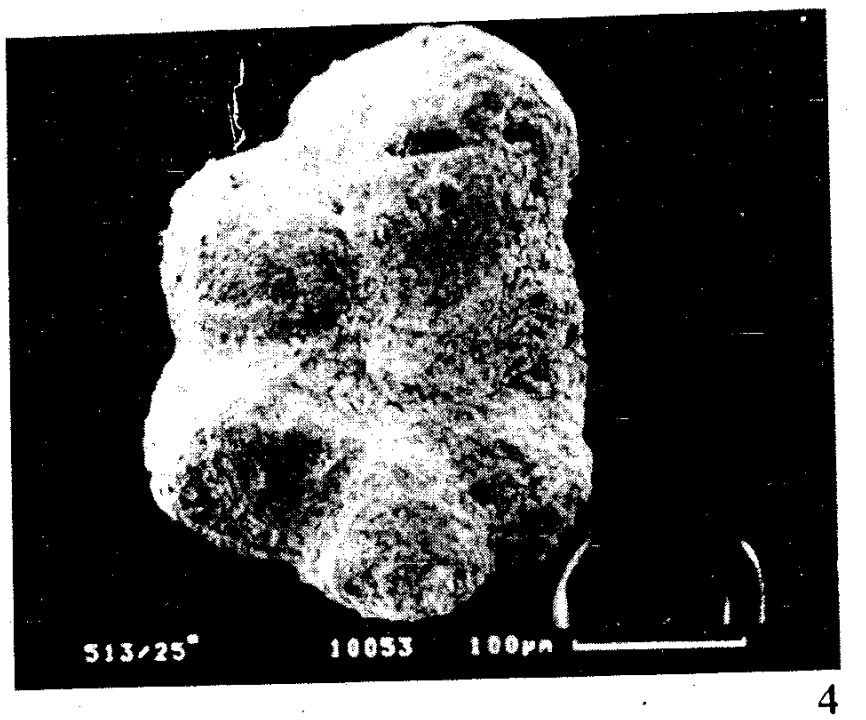

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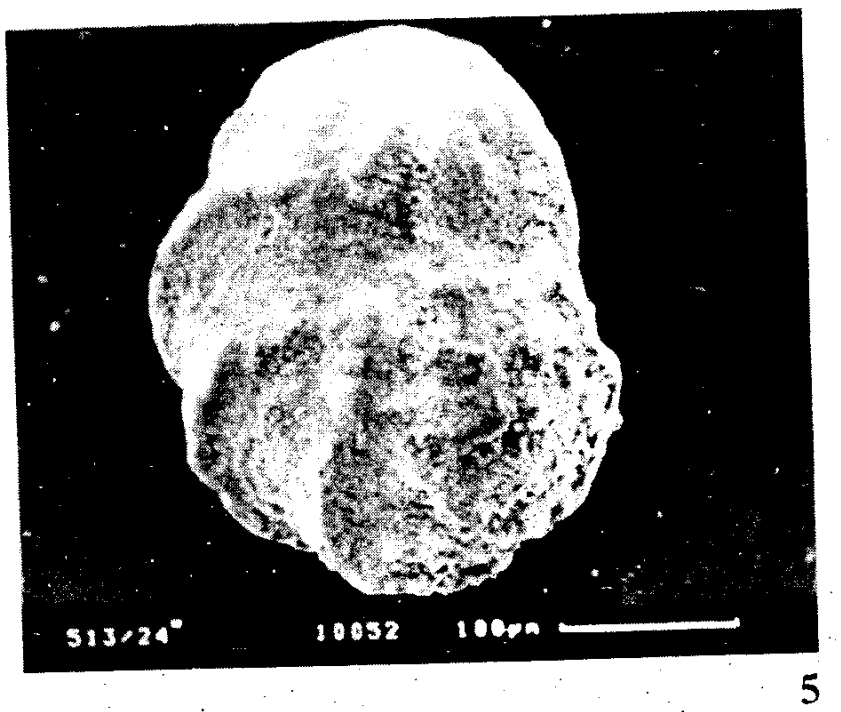

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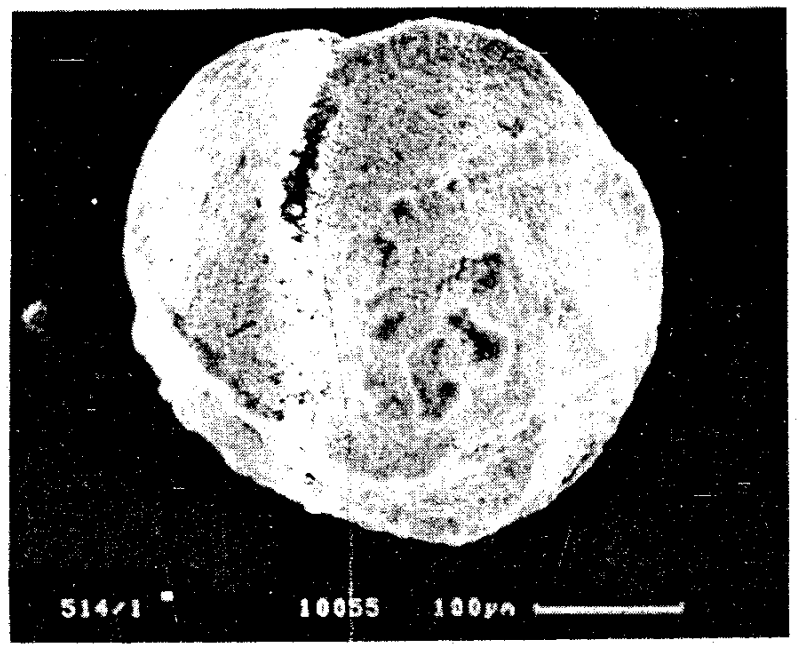

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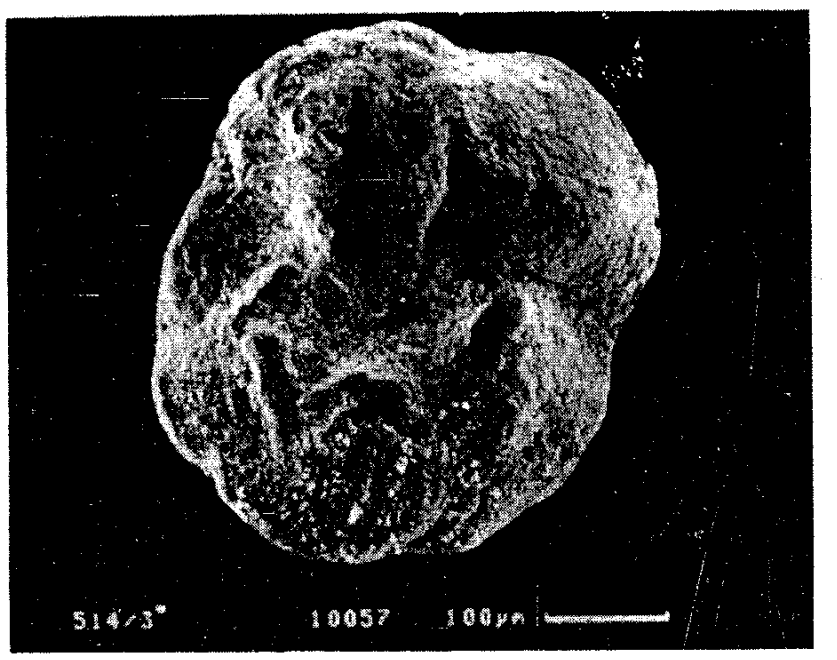

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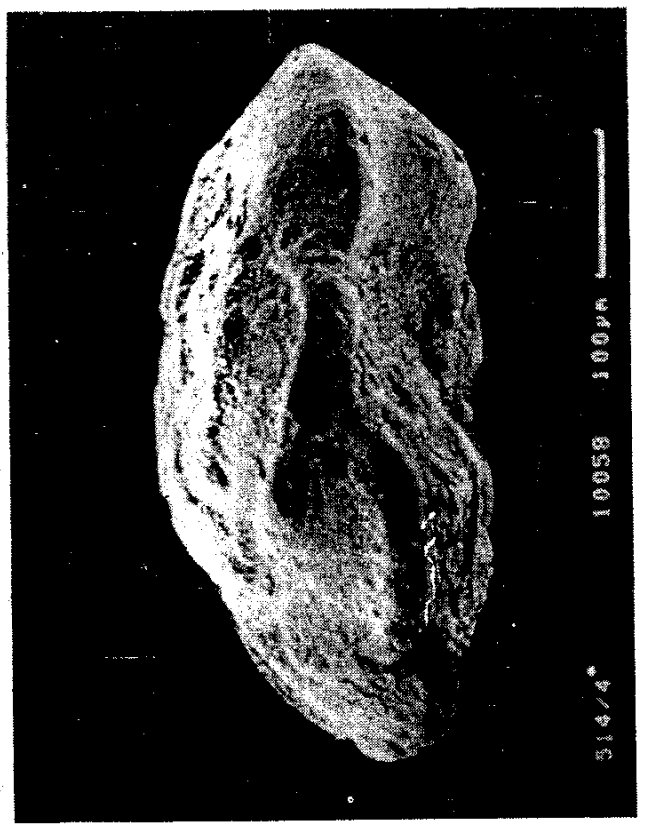

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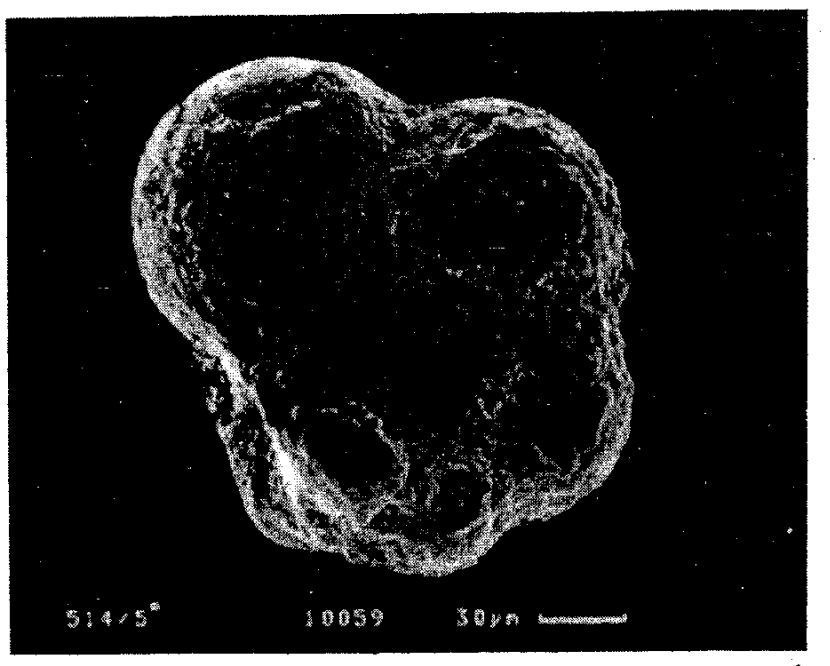

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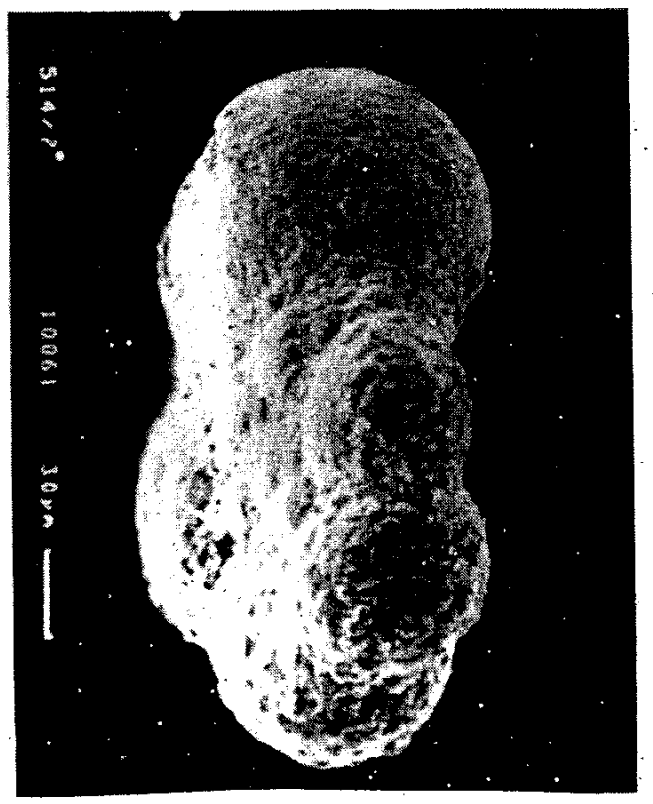

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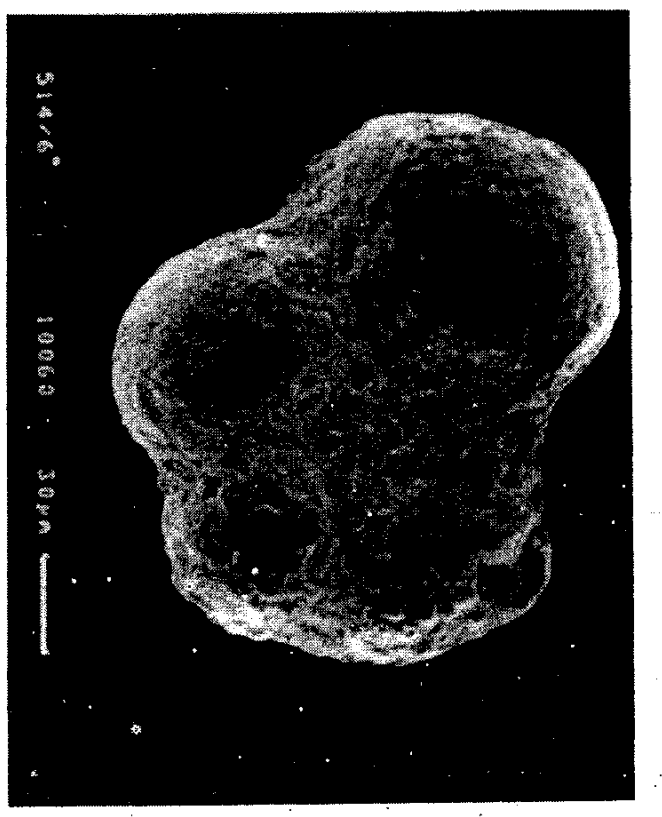

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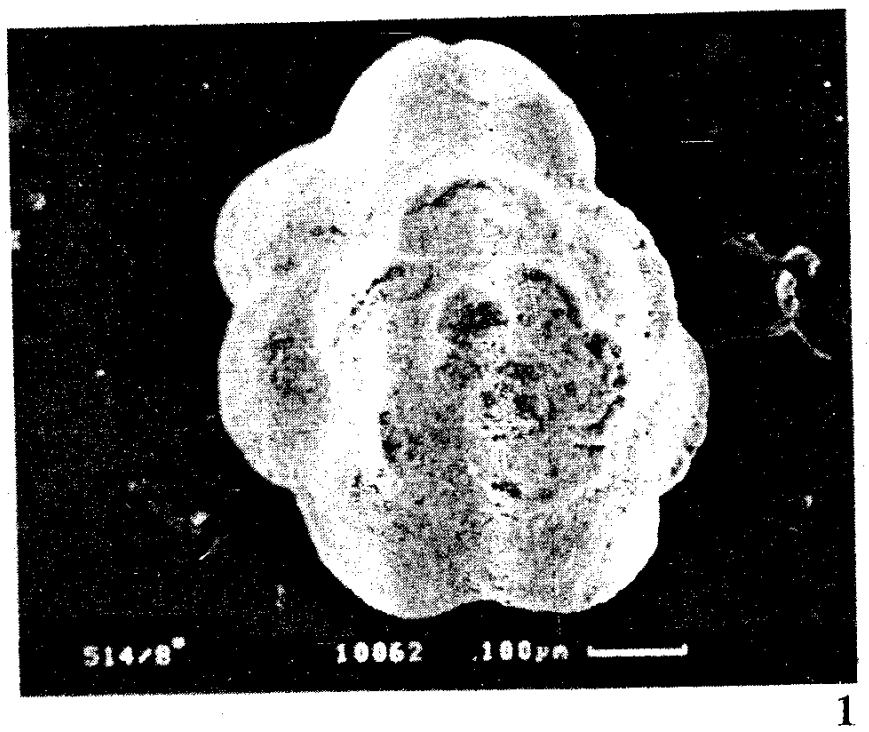

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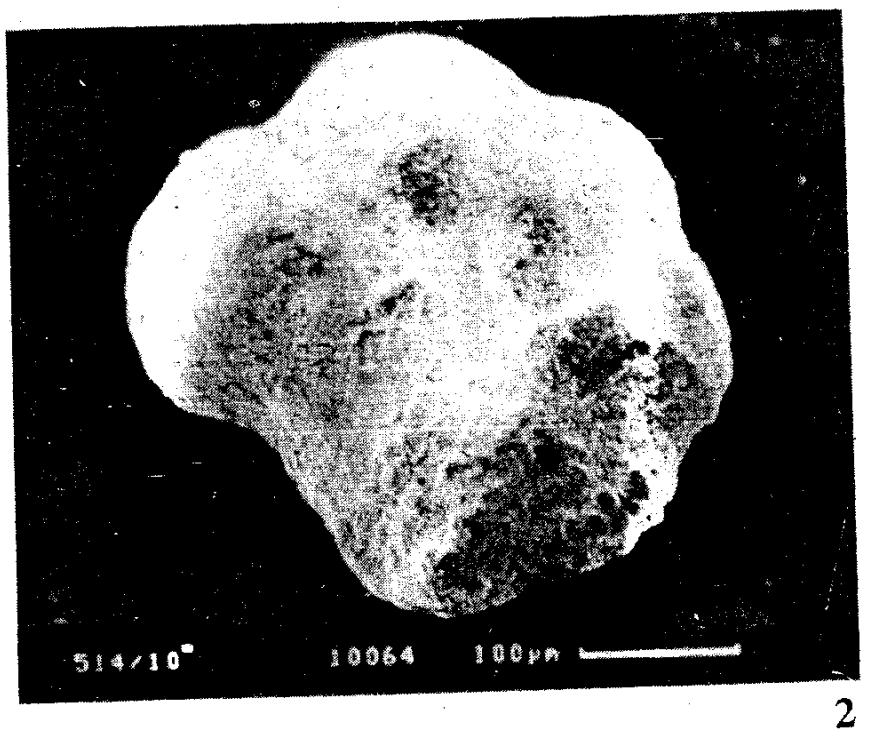

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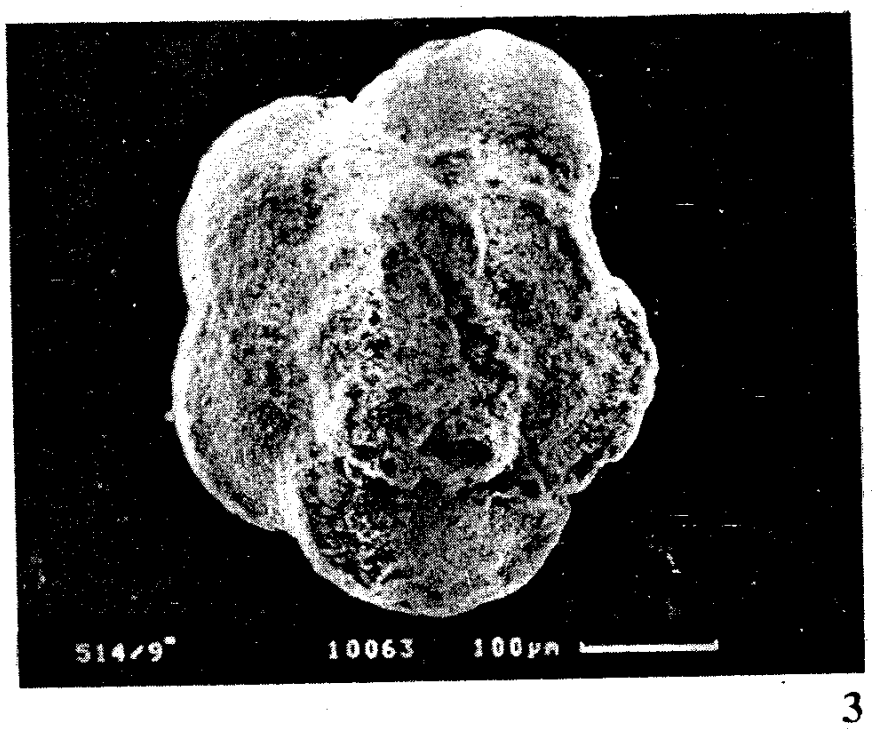

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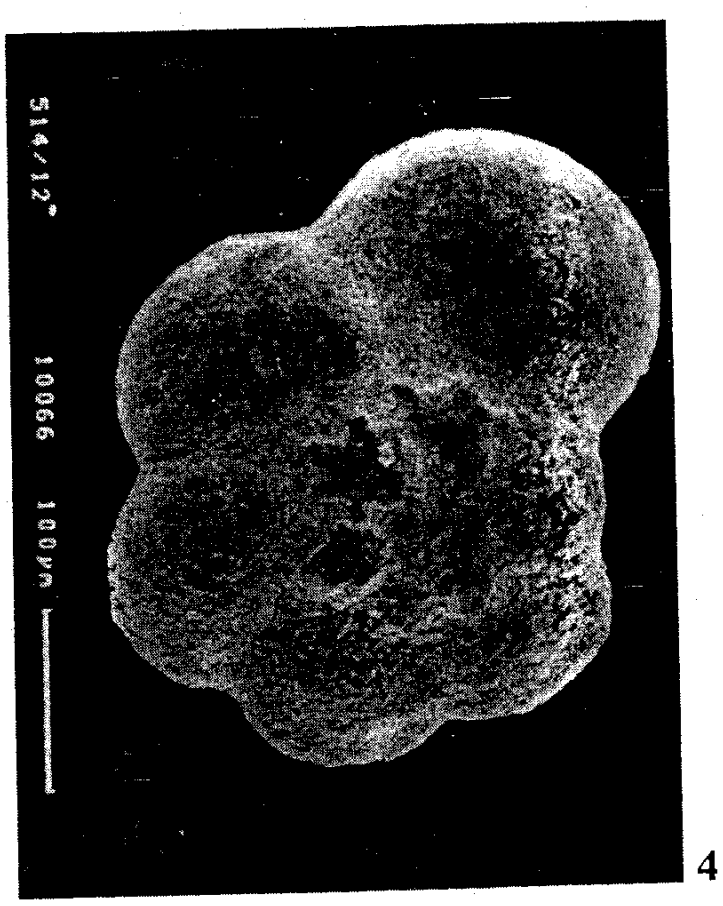

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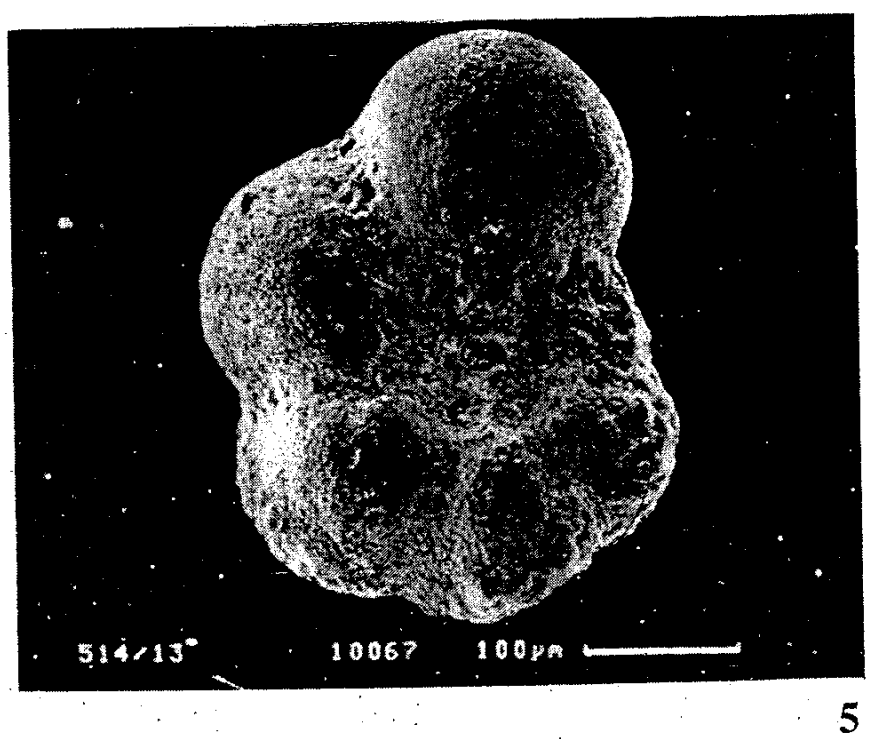

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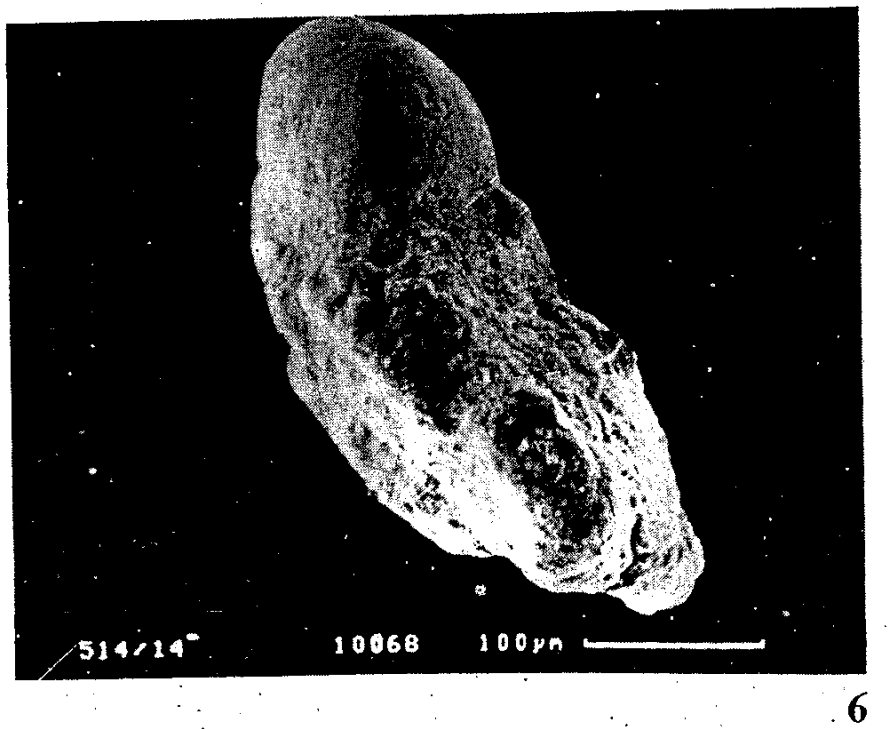

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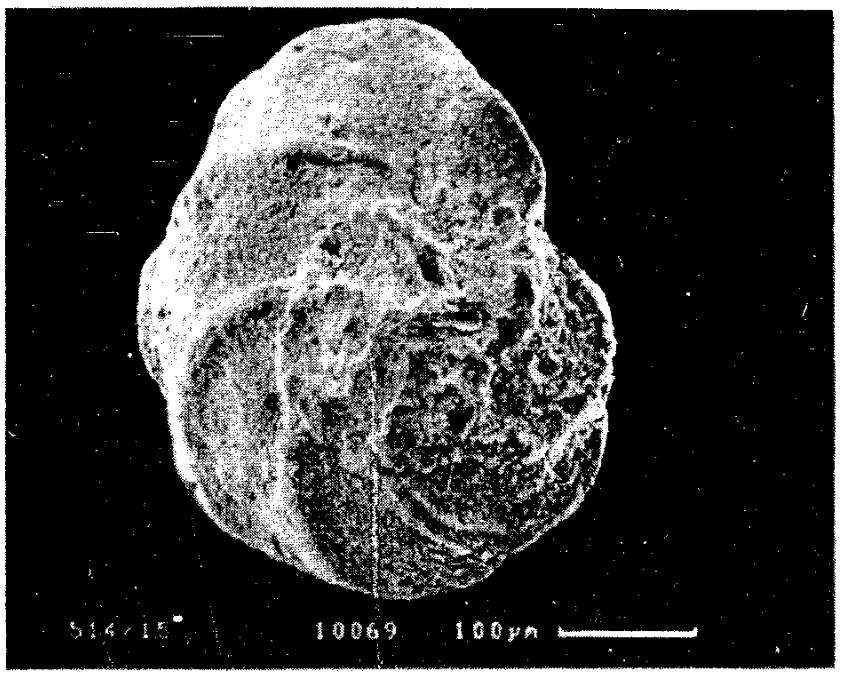

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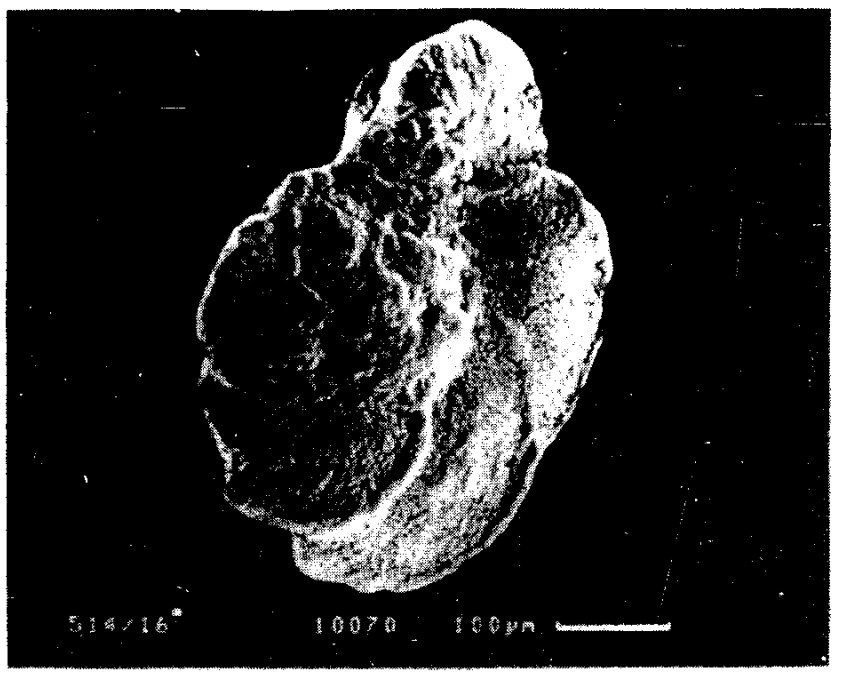

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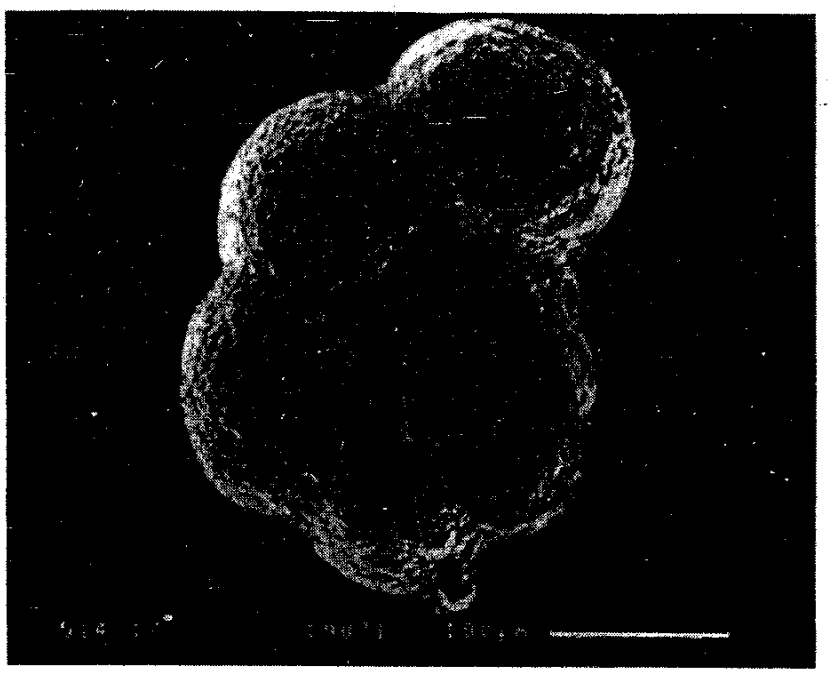

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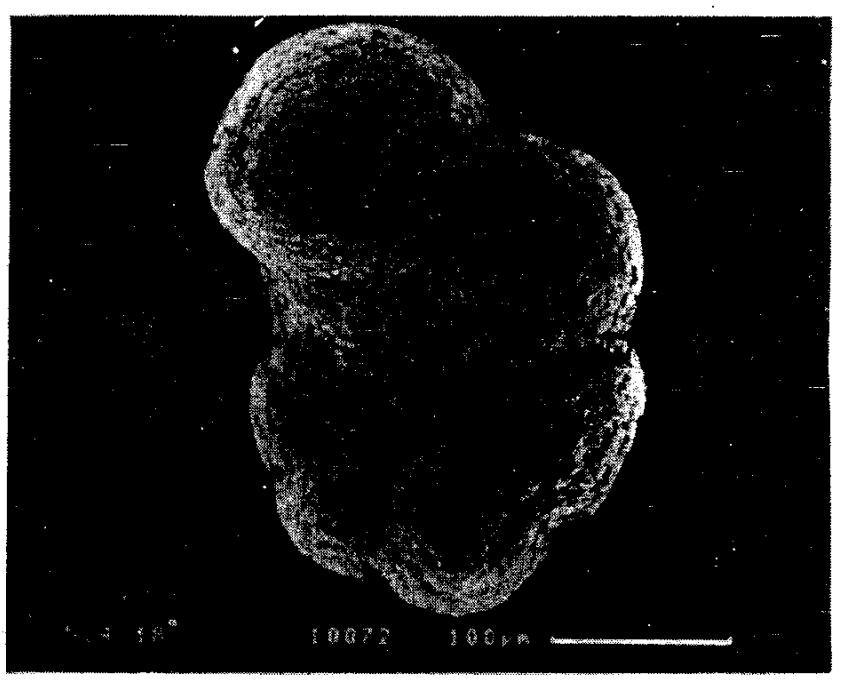

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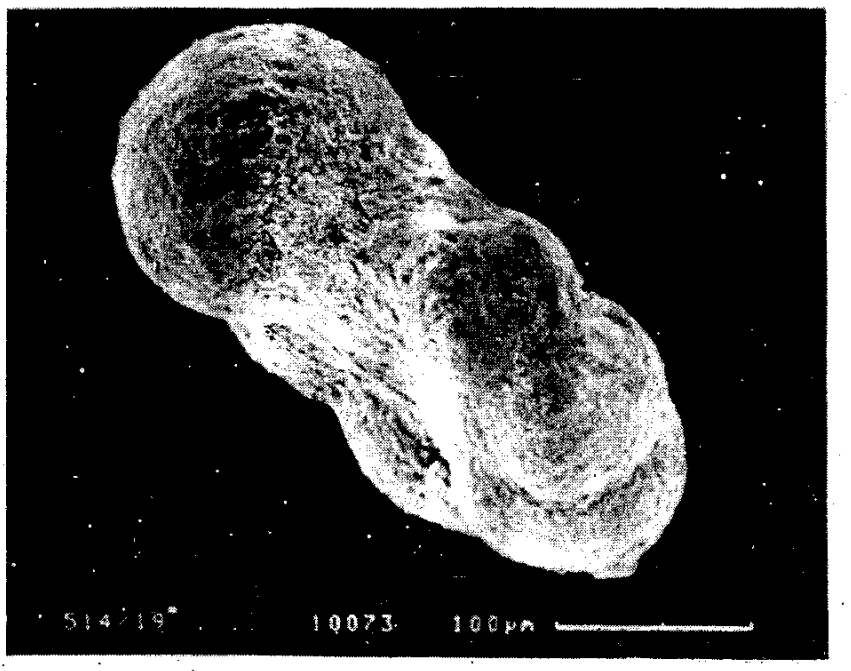

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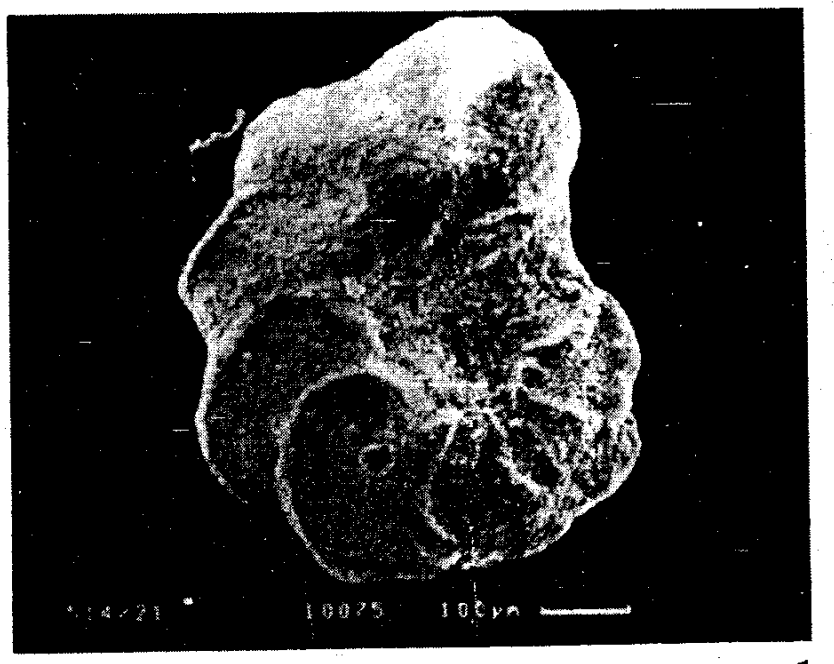

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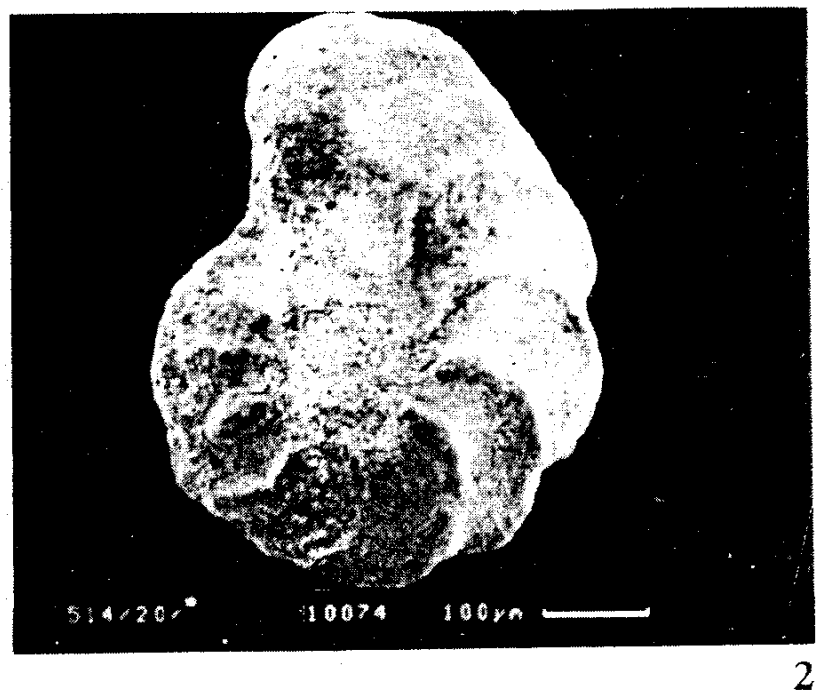

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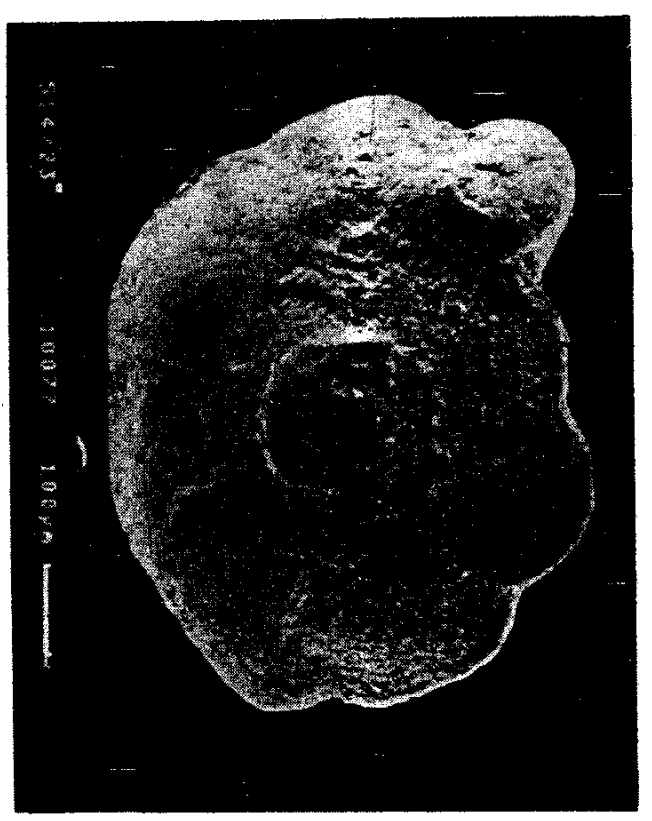

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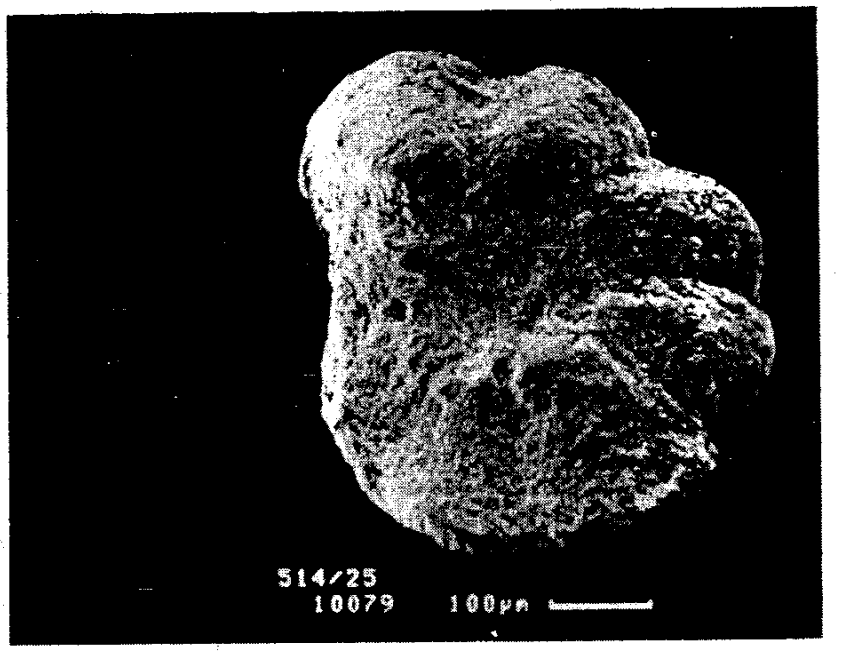

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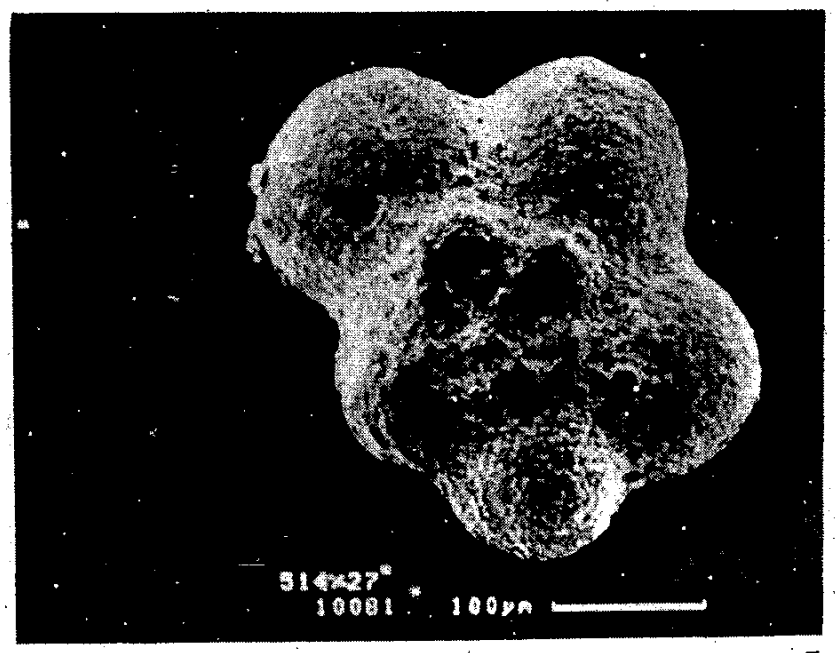

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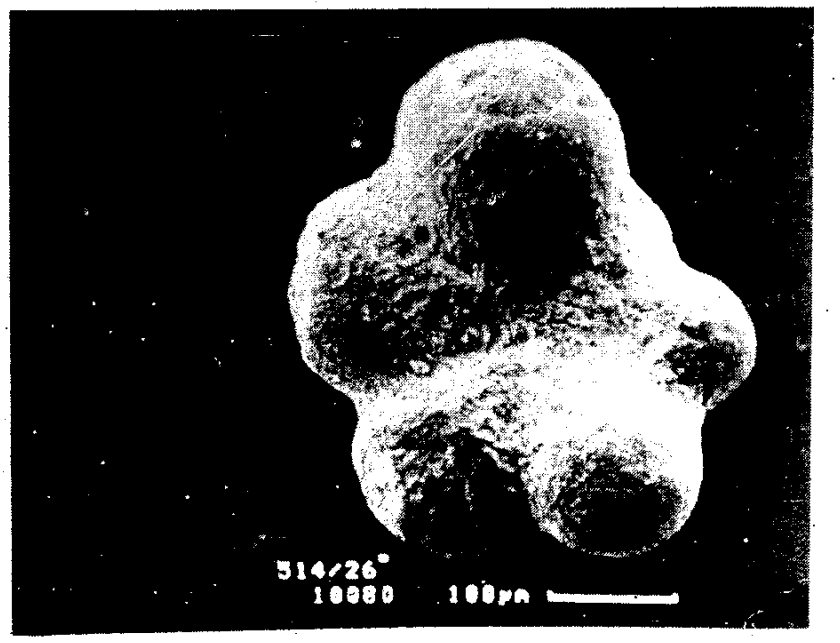

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Table 1. Correlation of Middle Cretaceous planktonic foraminiferal zones of Pakistan.

Stage m.y.	Bolli (1966)	Robaszynski and Caron (1979)	Planktonic Foraminiferal Zones of Pakistan
90 Cenomanian	*R. cushmani*	*R. cushmani*	*R. cushmani*
	R. reicheli	*R. reicheli*	*R. reicheli*
	R. brotzeni	*R. brotzeni*	*R. brotzeni*
94 Albian	*R. appenninica*	*R. appenninica*	*R. appenninica*
	R. ticinensis	*R. ticinensis*	*R. ticinensis*
105	*Ticinella roberti*	*R. subticinensis*	
		Biticinella breggiensis	

PALEOECOLOGY

Benthic Foraminifers

Indications of the paleoenvironment are mostly derived from the presence of benthic foraminiferal genera and species, and the ratio of plankton and benthos. The later one is 100:1 (sample nos. Baw-1, Baw-12, Baw-23), this gives a reliable measure for the distance from the coastline. In this case the environment may have been far from the coastline, therefore a fully marine open environment is deduced. The present benthic foraminiferal fauna contains many species and genera which are well known from deep sea deposits of the other areas, and are assigned to flysch type of sediments (Marlotti, 1988). From DSDP drilling in the Indian Ocean, similar fauna (*Pseudoclavulina sp., Arenobulimina sp., Dorothia spp.*) is described by Karsheninnikov(1973) and Scheibnerova (1974). The paleoenvironment estimated by comparison with these fauna is bathyal to abyssal (2000-3000 m water depth) probably near the CCD (calciam carbonate dissolution depth) which is confirmed by the rare occurrence of calcareous benthic foraminiferal tests.

Planktonic Foraminifers

The keeled genera (*Rotalipora, Planomalina, Praeglobotruncana*) are abundantly present in all the samples. It is believed that these genera indicate a depth greater than 100 m (Mark Leckie, 1987).

CONCLUSION

On the basis of planktonic foraminiferal study the Upper Goru formation is divided into five zones from Late Albian to Cenomanian in the Kirthar region. In the lower Indus basin the Upper Goru formation is a potential source rock and also a cap rock for oil and gas. It is hoped that this zonation will provide a better stratigraphic control for correlation in this region. Further detailed biostratigraphic studies in the area may throw a light on tectonic movement in this region. So far the tectonic position of these Middle Cretaceous deposits at the edge of southern Kirthar region is not clear and requires a detailed mapping of the area.

Generally however,one could imagine a similar style of tectonics as described for the younger Tertiary strata along

the Makran area as"accretionary wedges",pushed ashore from greater depths by the force of the northward moving Indian plate (Farah & DeJong, 1979).

ACKNOWLEDGEMENT

The authors are grateful to Mr. Hilal A. Raza, Director General HDIP for the permission to publish this paper. We are thankful to Dr. Asrar M. Khan for critical reading of the manuscript. Our special thanks are also due to Mrs. Zumra & Mr. Ikram-ul-Haque of National Institute of Health, Islamabad for SEM microphotographs.

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