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Precambrian and Cambrian Cherts in Northwestern Tasmania

By

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Abstract The SEM study of the Precambrian and Cambrian cherts from northwestern Tasmania, Australia, discriminates three discrete morphological types in the constituting material. The first one, associated with the Smithton Dolomite in the Smithton Trough, consists of oval-shaped chitinozoan-like microorganisms. The second type, involved in the Barrington Chert of the Dial Range Trough, consists exclusively of unspecified microspherules, and the last from the Barrington Chert mainly of siliceous sponge spicules. The first and second types are possibly of Precambrian in age, and the last of Cambrian. The two types of the Barrington Chert occur as exotic boulders, blocks and rootless slabs within mudstone matrix in northwest coast. From the descrimination of chert constituents and mode of occurrence, it is concluded that a part of the Barrington Chert is allochthonous to the Cambrian argillaceous matrix.

Introduction

Paleozoic and Mesozoic cherts are composed mainly of siliceous skeletons such as radiolarians, sponge spicules, and/or diatom shells. The cherts formed in pelagic environment are characteristic of accretion complex of orogenic belt. However, the origin of Precambrian chert has long been a controversial problem, particularly the source of silica and the mode of occurrence. In northwestern Tasmania, Australia, late Precambrian and Cambrian rock sequences are developed exclusively in two narrow troughs. The western one is called the Smithton Trough, extending from near Smithton on the far northwest coast to about 50 km southward within the Precambrian Rocky Cape Block (GEE, 1968). The eastern one, meridional belt flanked by the Rocky Cape Block to the west and the Forth Block to the east, is the Dial Range Trough situated south of Ulverstone on the northwest coast (BURNS, 1964). Within both troughs chert and siliceous mudstone are associated closely with dolomite and/or greenstone (WILLIAMS, 1978). Those siliceous sedimentary rocks are important for investigation on the problem of the Precambrian and Cambrian chert formation. Scanning electron microscopic study discriminates at least three morphological types in the constituting material of the cherts from the two troughs. In this paper the three different types of chert are described and the mode of occurrence of them are discussed.

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Chert in the Smithton Trough

Within the Smithton Trough the Smithton Dolomite with a quartzose sandstone and a conglomerate layer at the base accumulated with an angular unconformity on the folded Rocky Cape Group which consists of a thick pile of unmetamorphosed orthoquartzite and siltstone (SPRY, 1964; GEE, 1971). The Smithton Dolomite is composed mainly of stromatolite-bearing dolomite and oolitic limestone with intercalations of chert and carbonaceous mudstone, succeeded by dolomite breccia of late Precambrian in age (GRIFFIN and PREISS, 1976). These formations are followed by low-grade metamorphosed mafic volcanics (e.g. WILLIAMS, 1978; HASHIMOTO, *et al.*, 1981) and mudstone-sandstone alternation containing late Middle Cambrian trilobite (JAGO, 1971). Chert specimens of the Smithton Dolomite were collected along the Arthur River and near Trowutta (Fig. 1).

The chert does not have so dense and vitreous appearance but varies in colour. It is commonly grey to dark grey in colour. In thin section the chert consists of crypotocrystalline and chalcedonic quartz and contains various amount of clayey and opaque materials, but no detrital clastic grains and no carbonate mineral are included. A quarter or more of the cherts examined include abundant oval-shaped microorganisms (Plate 1–1). These have tear- and flask-shaped outlines and internal structures (Plate 1–2), suggesting that their interiors have been initially hollow, though filled with secondary precipitation of chalcedonic quartz. Such structural features are clearly shown under crossed polars (Plate 1–3). The size of the microorganisms ranges from 40 to 120 microns in length and from 30 to 80 microns in width. A short and narrow neck like operculum is observed in some forms (Plate 1–4), but more detailed examination is required for isolated ones from the chert. All of the aboral poles are rounded and have no pointed end. Apparently attached forms rarely occur but chains, composed of more than two shells, are not recognized.

SEM images of the cherts etched by HF solution show not only three-dimensional shapes of the microfossils but also remarkable abundance of them (Plate 1–5, 6). All the shells lack ornamentation which characterizes some Paleozoic chitinozoans (JENKINS, 1970). The shape and size of the shells are similar to chitinozoan-like microfossils from the carbonaceous shales of the late Precambrian Chuar Group (750 ± 100 Ma) in the Grand Canyon, Arizona (BLOESER *et al.*, 1977) and from the late Precambrian dolomite (approximately 600 Ma) of Jabal Rockham, southeast of Medinah, Arabian Shield (BINDA and BOKHARI, 1980). Lithologic characters at these localities show contrasting sedimentary environments; shaly facies far away from shore at Grand Canyon and shallow-water facies of carbonate sequence including oolitic and stromatolitic dolomite at Jabal Rokham. The chert of the Smithton Dolomite including similar microfossils may favour the latter condition, but it was formed under condition without any continental influence because of including no terrigenous

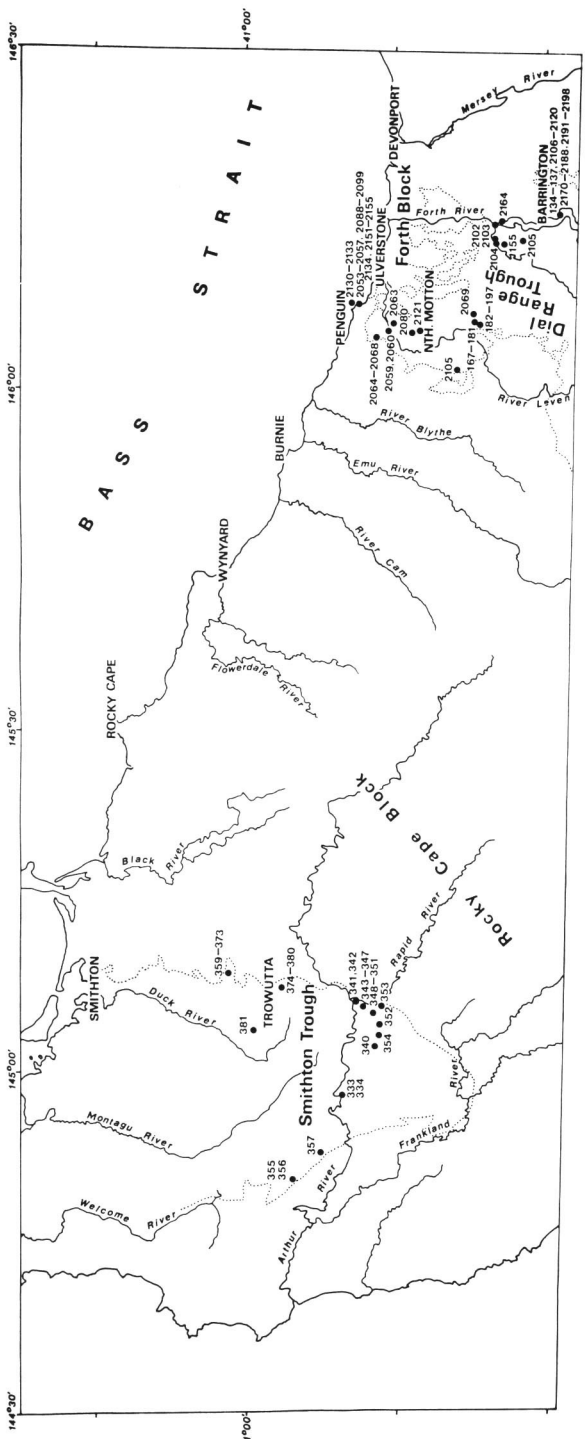

Fig. 1. Index map showing sample localities.

material.

Chert in the Dial Range Trough

According to BURNS (1964) Cambrian sequence filling the Dial Range Trough begins from the Robster Creek Volcanics consisting of acid and intermediate rocks. The volcanics are followed by the Cateena Group of sandstone and mudstone sequence having several horizons of keratophyre, with fossils indicating Middle Cambrian age. The Barrington Chert is considered to overlie the Cateena Group with unconformity, but stratigraphic relation at the base of the chert unit is obscured by fault. The chert is associated usually with the Motton Spilite. Upon these chert and mafic volcanics, clastic sequence containing keratophyric rocks named the Radford Creek Group follows. The Cambrian Dial Range sequence was closed with the deposition of the Beecraft Megabreccia which is possibly gravity down-sliding product of semi-indurated material from the nustable flanks of the Dial Range Trough into unconsolidate clastic material, corresponding to a disturbance to terminate Cambrian age.

Specimens of the Barrington Chert were collected in two areas, along the River Leven and the Forth River (Fig. 1). The chert from the former is associated with the Motton Spilite and the latter one with mudstone. The chert is usually thin bedded, light grey to black in colour but in some cases white to milky white. The chert shows deformed sturctures including isoclinal recumbent folds of exposure order and frequently has post-consolidation brecciation textures. In the latter case angular clasts of cherts are cemented by cherty material, and terrigenous substances of any kinds are entirely excluded therein.

The chert is microscopically composed of cryptocrystalline to microcrystalline quartz with small amounts of clay and opaque minerals. No terrigeneous material is included in the chert. Minute transparent spherules or thin rod-like remains, probably representing microfossils, are sometimes observed. Most of them are composed of chalcedonic quartz. They are morphologically quite different from the oval-shaped ones of the Smithton Trough. SEM study of the chert from the Dial Range Trough shows that the original constituting material has been retained even after recrystallization. Two discrete morphological types are discrened in the constitutents of the chert. One is the chert consisting of siliceous sponge spicules and the other of taxonomically unspecified microspherules.

The chert consisting of siliceous spicules is similar to those of late Paleozoic and Mesozoic in the morphology of constituting material. In thin sections rod-like remains and radiolarian-like skeletons are occasionally found and distinguished from surrounding matrix (Plate 2–1). On the etched surface of the chert, however, abundant spicules are exposed (Plate 2–2, 3, 4) and their interstices are filled with thin spicules or spines (Plate 2–5, 6). In volumetric proportion, the spicules are the most abundant and the radiolarian-like skeletons are suboradinate. Among the spicules, thick ones can be easily recognized in thin sections but fine ones hardly observed.

These spicules are considered to have been derived from siliceous sponges because of their similarity in shape and size. The larger ones are possibly megascleres serving to form sponge framework and the smaller ones to be scattered within body part. The radiolarian-like skeletons are minute egg- or peanut-shaped and their interiors are usually filled up with fibrous silica with concentric structure. The microscopic observations show that the chert consists of spicules, fine spines, radiolarian-like remains, and surrounding matrix possibly of secondarily precipitated silica derived from solution of those microfossils. This is supported by the experimental study using recent siliceous sponge spicules under hydrothermal condition. In the experiments, silica was newly formed as filling matrix in early diagenetic process (SAITO and IMOTO, 1978).

Main mineral composition of the chert consisting of microspherules is the same as those of the spiculite chert and of the chert from the Smithton Trough. In thin section a lot of transparent microspherules are observed in the dark-coloured specimens (Plate 3–1, 2). In lighter-coloured ones such a morphological difference is entirely indistinguishable. No terrigeneous material is contained. The chert has commonly thin laminations and each lamina is composed mainly of the microspherules. This sedimentary texture indicates that the microspherules have accumulated as individual particles like clastic grains and have not been secondarily formed at later diagenesis. Each microspherules, especially of larger size, have internal concentric structures (Plate 3–3, 4), suggesting that their interior part have been initially hollow and been filled with silica of secondary precipitation. Although the origin of the microspherules is unknown, the internal structure is no doubt a key to the preference.

SEM micrographs of the HF-treated surfaces of the chert clearly demonstrate external forms and mode of aggregation of the microspherules (Plate 3–5, 6). Each microspherule is composed of very fine-grained equigranular xenomorphic quartz due to later recrystallization (Plate 3–7). IMOTO and SAITO (1973) reported another type of microspherulitic chert from the Precambrian Gunflint Chert, collected at Silbley, Port Arthur, Ontario, Canada. The microspherules of the Gunflint Chert, however, are larger than those described here and consist of radiating blades showing recrystallization structure. Such features are different in appearance from those of the chert in the Dial Range Trough. In size and shape, the microspherules resemble those reported as microorganisms or microflora from the Gunflint Chert (BARGAHOORN and TYLER, 1965; CLOUD, 1965). If both of them would be same or similar to each other, the microspherulitic chert from the Dial Range Trough might be of Precambrian in age.

Mode of occurrence of the cherts in the Dial Range Trough

The cherts of two different types are discriminated in the Barrington Chert developed within the Dial Range Trough. For further explanation of the mixed occurrence of them, mode of their geologic occurrence was surveyed at Barren Knob, Devils Gate, west of Barrington and along the shoreline at Lodders Point, northwest

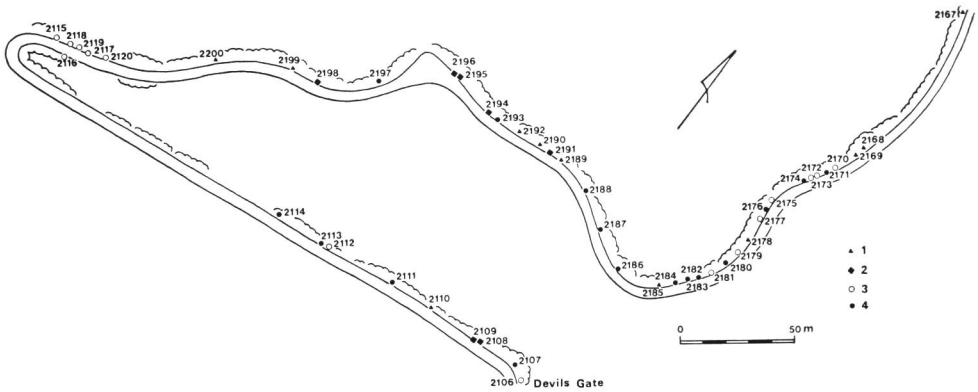

Fig. 2. Route map at Devils Gate showing sample localities. 1: mudstone, 2: chert consisting mainly of spicules, 3: chert consisting of microspherules, 4: unspecified chert.

coast between Penguin and Ulverstone (Fig. 1).

At Devils Gate the Barrington Chert crops out along the road-cut to the Devils Gate Power Station. As shown in Fig. 2, both of the spiculite and microspherulitic cherts are developed together with mudstone. Although stratigraphic relation between them is still uncertain because of faulting and folding, some cherts occur as blocks in mudstone. This suggests that it is in doubt whether the relation between the chert and mudstone are in normal sedimentary contact or not.

An almost continuous exposure of the Cambrian sedimentary sequence accumulated in the Dial Range Trough is along the shore of Bass Strait, between Penguin and Ulverstone (Fig. 1), where it is occupied by the Cateena Group, the Barrington Chert, the Motton Spilite, the Teatree Megabreccia and the Beecraft Megabreccia (BURNS, 1964). The distribution of the Barrington Chert is limited within near Lodders Point, west of Ulverstone. Figure 3 is a sketch map showing the occurrence of the cherts and the greenstones having pillow structures at Lodders Point. The cherts occur as exotic blocks and rootless slabs within mudstone, in which a lot of blocks of greenstone, probable Precambrian iron ore, and sandstone are also contained. Such occurrence indicates that the Cambrian sequence developed in this area, not only the megabreccia but also the chert and greenstone, is a sort of chaotic sediment which was initially formed as a mass-transported deposit due to a gravity sliding. The cherts as well as greenstones have been originally formed under the condition without any continental influence, and are allochthonous to the argillaceous matrix. The mode of occurrence of the cherts and greenstones strongly suggests that after consolidation they incorporated with the soft terrigenous material into such chaotic sediment as sedimentary melange formed in convergent boundary.

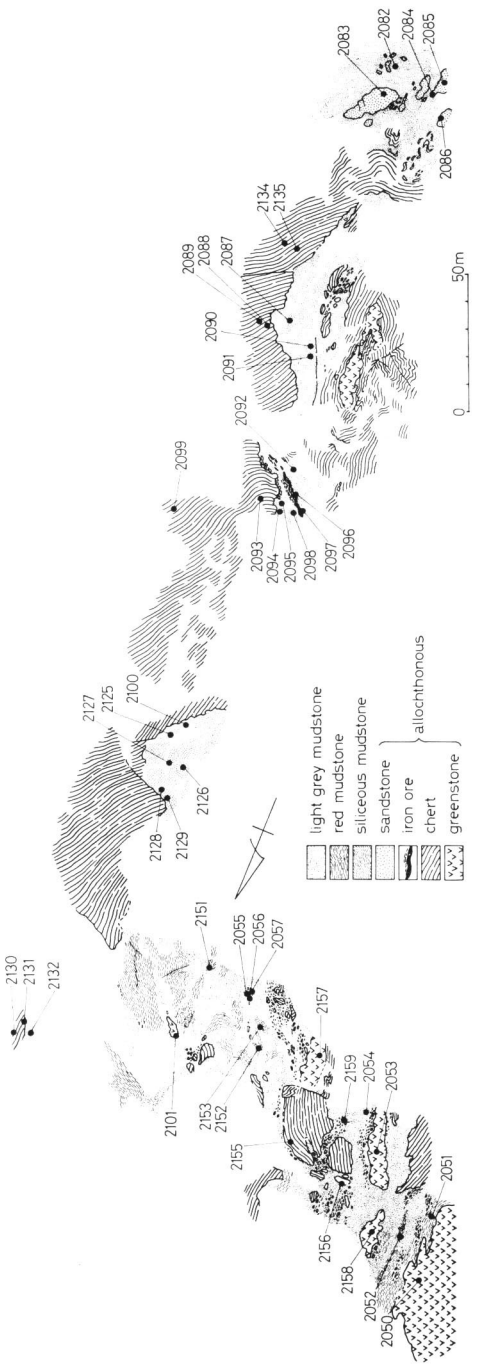

Fig. 3. Sketch map showing the mode of occurrence of the cherts and greenstones at Lodders Point, west of Ulverstone.

Concluding Remarks

The late Precambrian chert associated with the Smithton Dolomite in northwestern Tasmania consists entirely of minute oval-shaped particles. They are considered to be organic, possibly chitinozoan-like microorganisms, though taxonomically unspecified. In the Barrington Chert two different types of cherts are included, one consisting of siliceous sponge spicules and radiolarian-like tests and the other of unspecified microspherules. The former is of Cambrian in age but the latter probably of Precambrian. All of the cherts were originally deposited under the condition without any continental influence because no clastic detrital grains are contained in them. These cherts and greenstones having pillow structures occur as exotic blocks and slabs in mudstone matrix. Hence, it is concluded that they are allochthonous to the argillaceous matrix.

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Explanation of plates

Plate 1

Cherts of the Smithton Dolomite. Scale bars indicate 100 microns.

1. Thinly-laminated chert consisting of oval-shaped chitinozoan-like microfossils.
2. Well-preserved microfossils showing tests and internal hollow.
3. Internal hollow filled with secondarily precipitated chalcedonic quartz (crossed polars).
4. A microfossil with an aboral rounded end and a narrow neck probably showing an operculum.
5. SEM image of a HF-etched surface of the chert.
6. SEM image of the chitinozoan-like microfossils showing their external form without ornamentation on tests.

Plate 2

The Barrington Chert at Devils Gate. Scale bars indicate 100 microns.

1. Transparent spherules and rod-like remains indicating relatively thick sponge spicules.
2. SEM image of the HF-treated surface of the chert consisting of thick siliceous sponge spicules.
3. A radiolarian-like remain filled with secondarily precipitated silica and spicules.
4. Spicules showing tube structure.
5. Abundant fine spines in surrounding matrix.
6. Enlargement of fine spines.

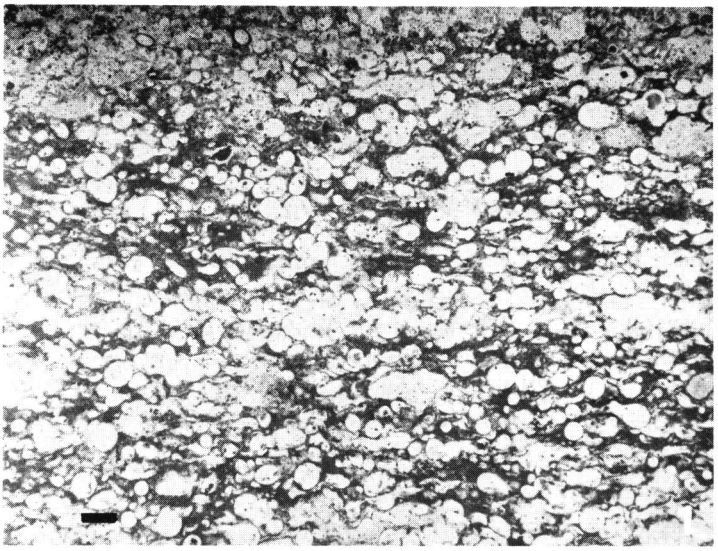
Plate 3

The Barrington Chert at Barren Knob, Lodders Point and Devils Gate. Scale bars indicate 100 microns in 1 to 5 and 10 microns in 6 and 7.

1. Laminae consisting of light- and dark-coloured parts both of which contain transparent microspherules.
2. Enlargement of the light-coloured part.

3 & 4. Well-preserved microspherules showing concentric internal structure.

5. SEM image of the HF-treated surface of the chert consisting of microspherules.
6. Enlargement of microspherules showing the external forms.
7. Equigranular xenomorphic quartz of the microspherule.

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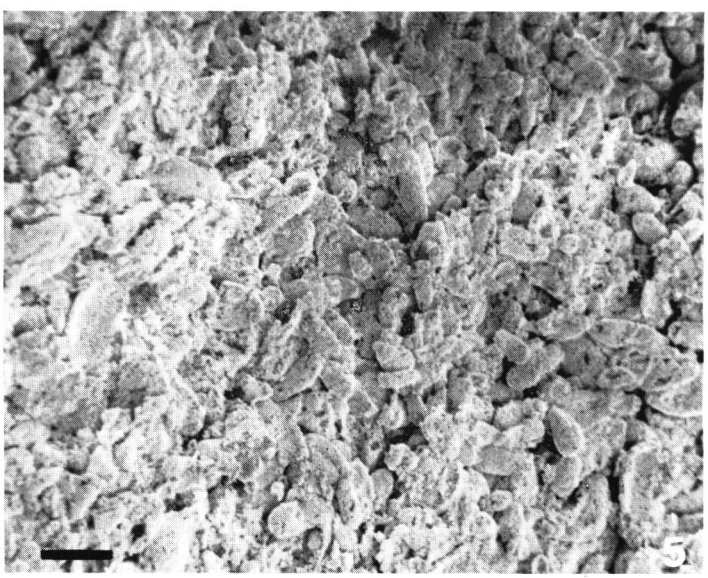
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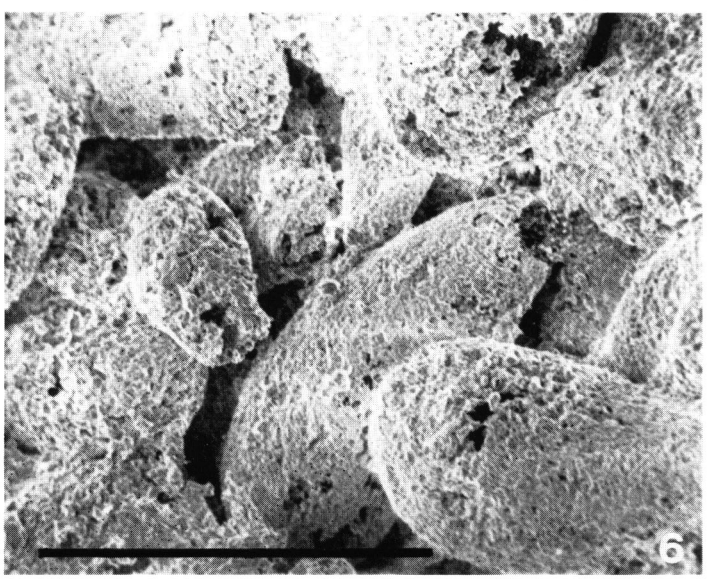
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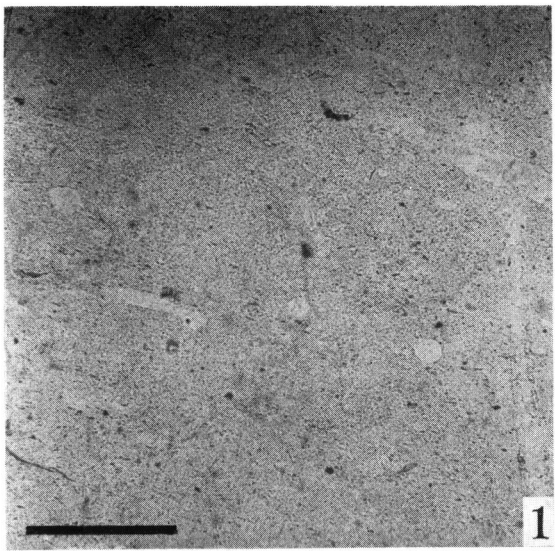
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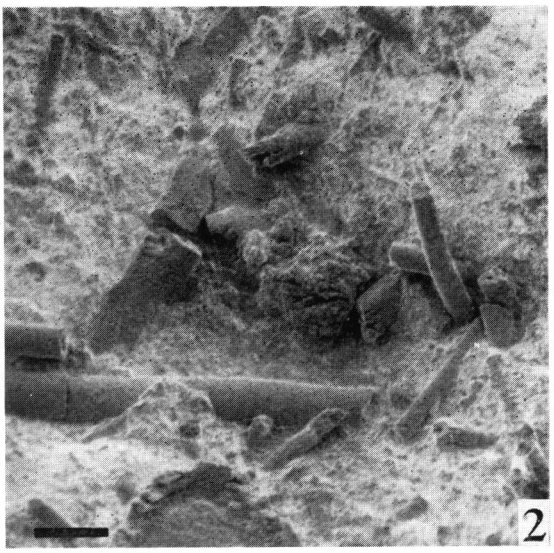
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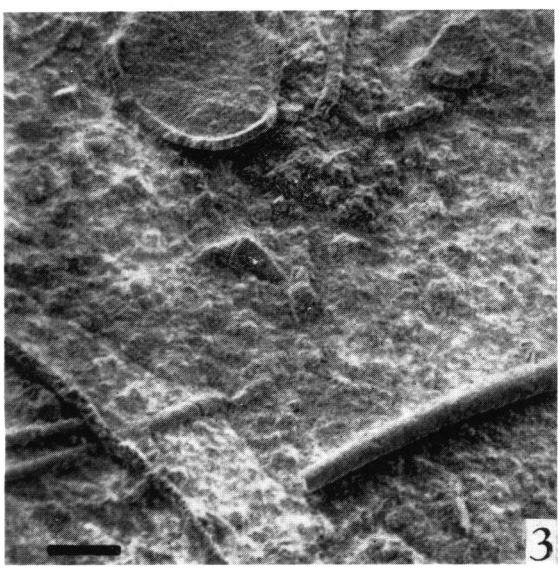
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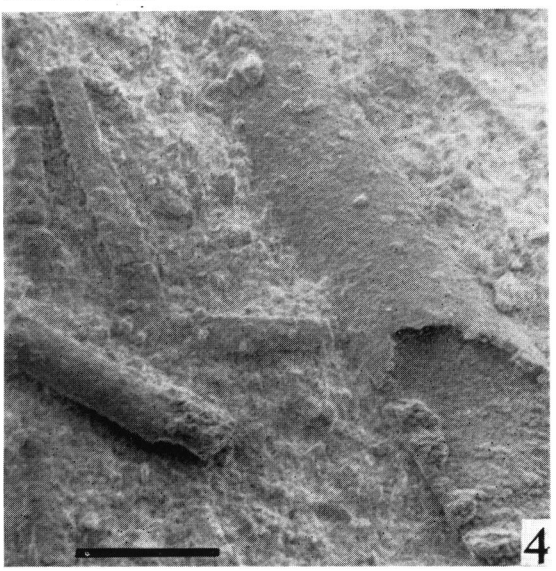
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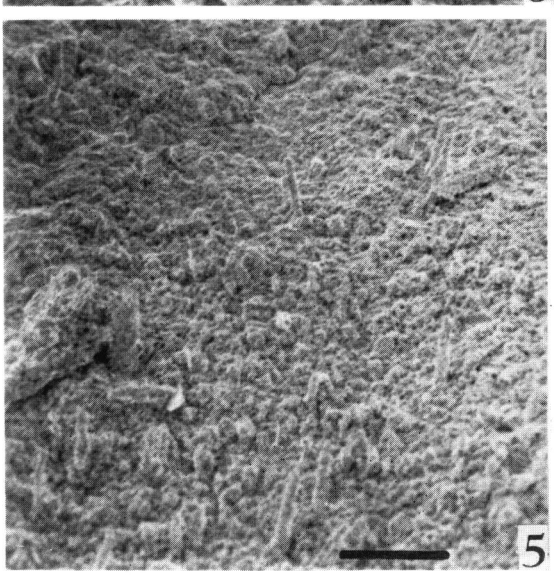
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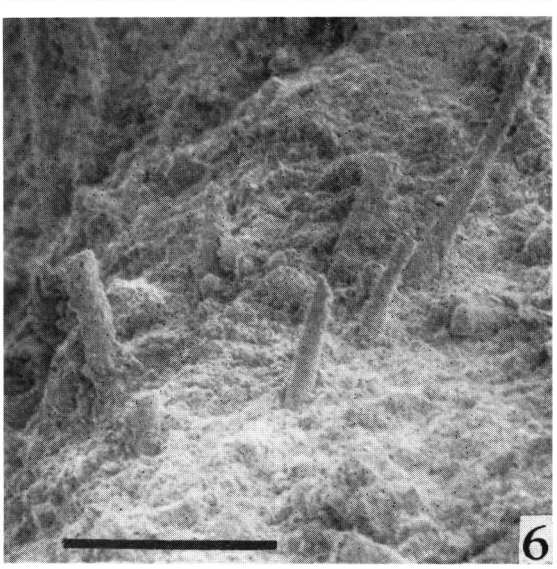
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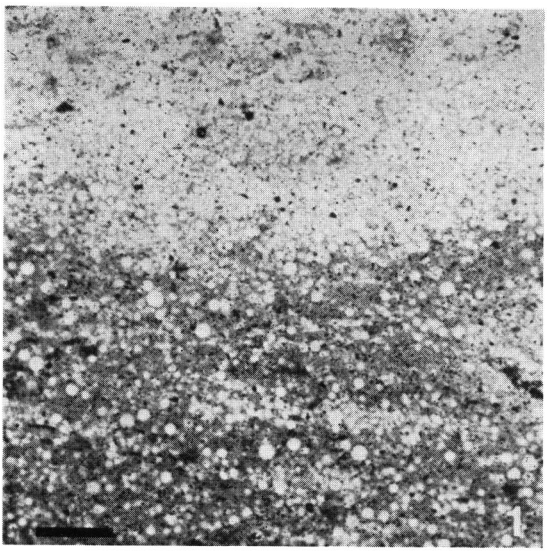
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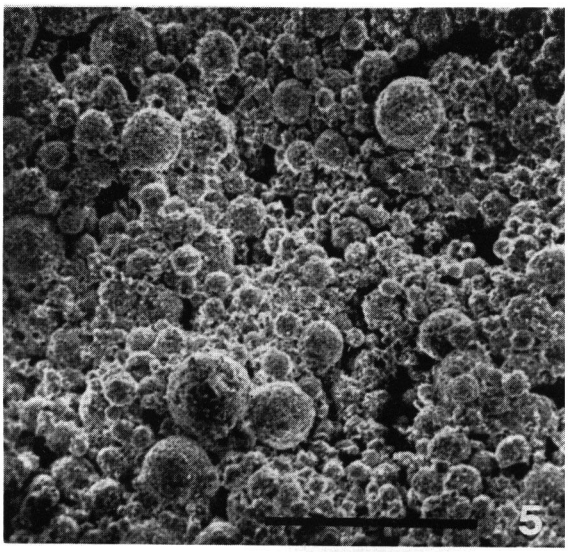
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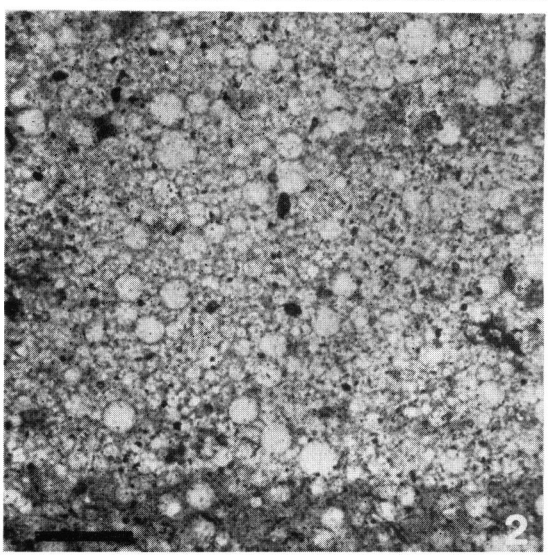
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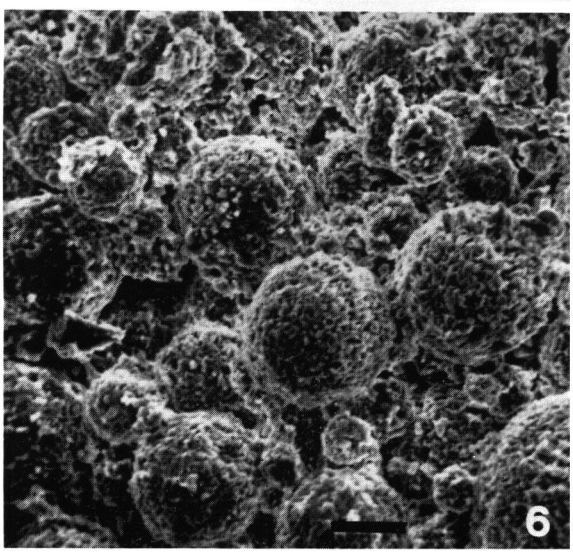
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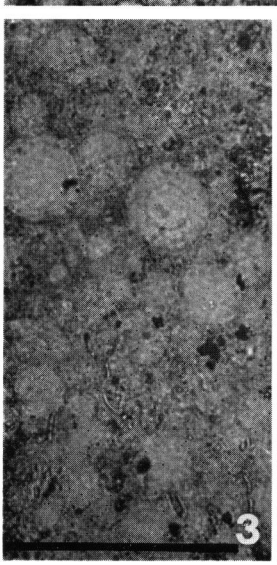
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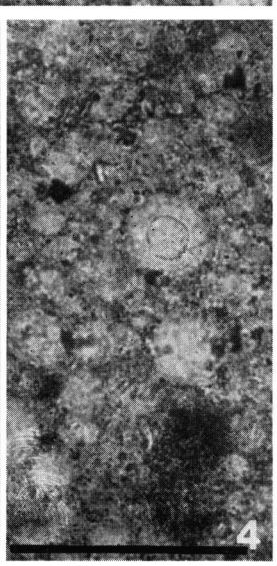
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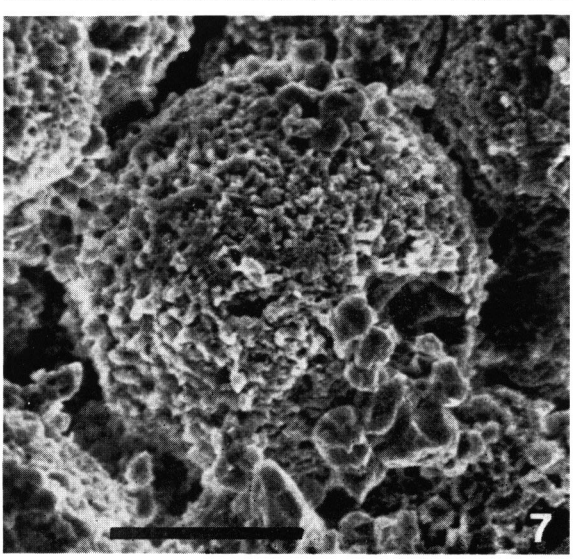
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