MINDRE MEDDELELSER

X-RAY DIFFRACTOMETER INVESTIGATIONS OF A RADIATE AND A GRANULATE FORAMINIFERA

By

HANS JØRGEN HANSEN*)

Abstract

By use of an x-ray diffractometer it is shown that the crystals of the shell of the radiate calcitic foraminifera *Polymorphina* sp. are orientated with the basal pinacoid parallel to the wall surface, which contrasts with the structure in the granulate calcitic foraminifera *Melonis scaphum* (FICHTEL and MOLL) where the crystals of the shell are orientated with the cleavage rhombohedron (1014) parallel to the wall sufface.

Introduction

The initial studies dealing with wall structure of foraminifera were published by WOOD (1949) who distinguished in hyaline calcitic foraminifera between radiate and granulate wall structure. The former was characterized by a black cross when seen between crossed nicols (fig. 1). This phenomenon was explained as being due to the optical orientation of the crystals of the wall, having their c-axes perpendicular to the test surface. The granulate structure was described as having a random optical orientation (fig. 2). TOWE and CIFELLI (1967) clearly demonstrated that in the granulate test the optical axes of the crystals are never perpendicular to the surface of the shell. This they explained was because rhombohedra formed crystal faces parallel to the test surface.

The present study was made in order to clarify the question of how calcite crystals in granulate and radiate foraminifera are orientated.

Method

For this investigation a Philips x-ray diffractometer was used with a Cu Kα – radiation selected by a curved crystal NaF monocromator. The beam width was 1° and a proportional counter was used. Since the amount of material which could be obtained was extremely small resulting in a small x-ray reflection, a quartz plate was used for mounting, as it gave a very low background. This resulted in a few well-defined peaks, but which did not coincide with any of the calcite peaks.

As representative for the radiate calcitic forms five specimens of a rather large recently collected *Polymorphina* sp. () 1 mm) from the Kattegat were chosen. The specimens were gently crushed between two glass plates and only the very small and nearly plane fragments were picked out under a binocular microscope. These fragments were mounted very close together on the quartz plate. The weight of the material used was less than 0.1 mg.

As representative for the granulate forms specimens of *Melonis scaphum* (FICHTEL and MOLL) recently collected in the Kattegat were chosen. In order to get nearly plane pieces of the tests the two youngest chambers of 14 specimens were broken off under the binocular microscope. The distal face of *M. scaphum* is relatively plane in its central area. The small plane fragments of this central area were mounted close together on the quartz holder.

For comparison, a non-orientated calcite powder was run in the diffractometer.

*) Geological Institute. University of Copenhagen.

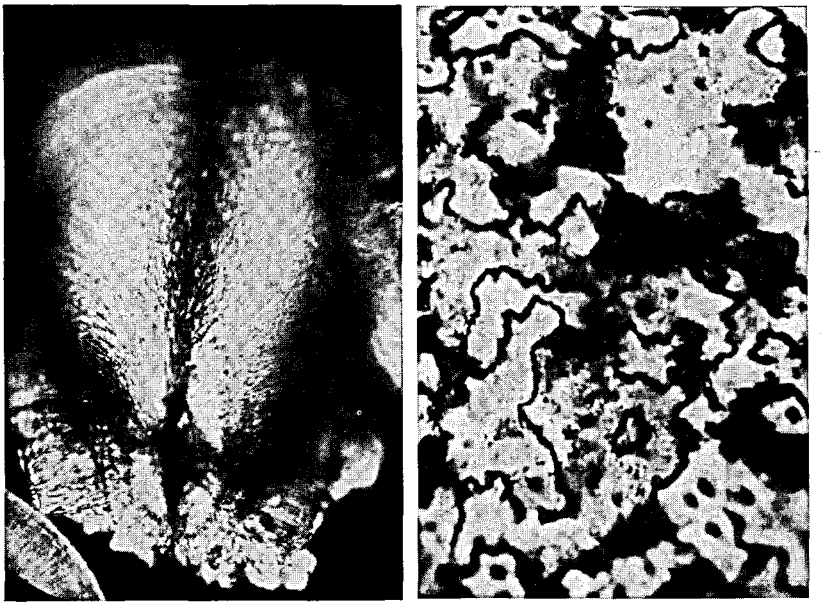

Fig. 1. Radial extinction of a fragment of a recent *Polymorphina sp.* from the Kattegat. Crossed Nicols. × 395.

Fig. 2. Granular extinction of a fragment of the recent *Melonis scaphum* (FICHTEL and MOLL) from the Kattegat. Crossed Nicols. × 1550.

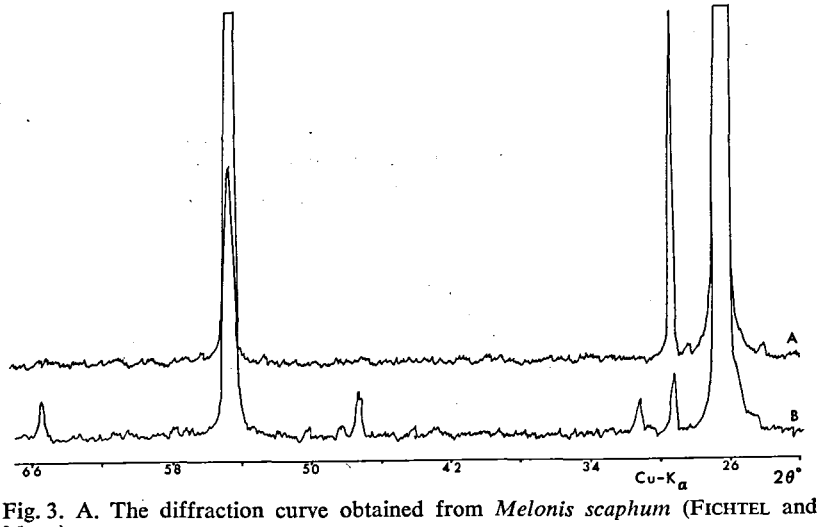

Fig. 3. A. The diffraction curve obtained from *Melonis scaphum* (FICHTEL and MOLL).
B. The diffraction curve obtained from *Polymorphina* sp.
The peacks at about 26° and 53° are caused by the quartz holder.

Results

Polymorphina sp.

The diagram B (fig. 3) shows the x-ray diffraction curve based on less than 0.1 mg material of *Polymorphina* sp.. The peak at 29.°4 ~ 3.035Å is according to the ASTM catalogue the rhombohedron ($10\bar{1}4$) (i.e. the cleavage rhombohedron in the structural setting of BRAGG, 1914). The basal pinacoid reflection (0006) is found at 31.°4 ~ 2.84Å and the (00012) reflection is found at 65.°6 ~ 1.422Å. The peak at 47.°5 ~ 1.91Å is due to the rhombohedron ($10\bar{1}8$). The intensities of the different reflexes are recorded in table I. When comparing the relative intensities of the reflexes obtained from the non-orientated calcite powder and from fragments of *Polymorphina* sp. it should be borne in mind, that the fragments are not perfectly plane.

Accordingly one should expect reflexes from crystallographical faces having an orientation close to the basal pinacoid. This may explain the presence of the reflex ($10\bar{1}8$). It would require an angle of 27° from the vertical arrangement of the optical c-axes to get reflection from ($10\bar{1}8$) face. This deviation is within the range to be expected as the fragments were not perfectly plane. Correspondingly the intensity of the basal reflection (0006) is 55 times higher, and the basal reflection (00012) 65 times higher, than should be expected from the non-orientated calcite powder. This indicates that the orientation of the Calcite crystals in the test of *Polymorphina* sp. is extremely good, and that the test surface is parallel to the crystallographical base (0001).

Table I. Comparison between the x-ray diffraction results obtained from analysis of non-orientated calcite powder, the radiate calcitic *Polymorphina* sp., and the granular calcitic *Melonis scaphum*.

hkil	d Å	Cukα 2θ	A	B	C	D	E
$10\bar{1}2$	3.860	22.7	20	0	0	0	0
$10\bar{1}4$	3.035	29.4	1690	13.5	13.5	80	80
0006	3.144	31.4	6.5	7.5	0	0	0
$11\bar{2}0$	2.495	36.0	39	0	0	0	1.8
$11\bar{2}3$	2.285	39.4	45	0	0	0	2.1
$20\bar{2}2$	2.095	43.2	54	0	0	0	2.5
$10\bar{1}8$	1.913	47.5	130	10.5	1	0	6.1
$11\bar{2}6$	1.875	48.5	40	0	0	0	1.9
$21\bar{3}1$	1.626	56.4	9	0	0	0	0
$21\bar{3}2$	1.604	57.4	17	0	0	0	0
$10\bar{1}.10$	1.587	58.1	3	0	0	0	0
$20\bar{2}8$	1.518	61.0					
$21\bar{3}4$	1.525	60.7	39	0	0	0	18
$11\bar{2}9$	1.510	61.4					
$21\bar{3}5$	1.973	62.9	5.5	0	0	0	0
$30\bar{3}0$	1.440	64.7	16	0	0	0	0
000.12	1.422	65.6	12	9	0	0	0

Column A shows the intensities recorded in counts per second from the non-orientated calcite powder.

Column B shows the intensities recorded in counts per second from the radiate calcitic *Polymorphina*.

Column C shows the intensities to be expected from B if Polymorphina had been built of random orientated calcite crystals, and if ($10\bar{1}4$) had the same intensity per gram in specimen A and B.

Column D shows the intensities recorded in counts per second from the granulate calcitic *Melonis scaphum*.

Column E shows the intensities to be expected if *Melonis scaphum* had been built of random orientated calcite crystals and if $(10\bar{1}4)$ had the same intensity per gram in specimens A and D.

Melonis scaphum (FICHTEL and MOLL, 1798)

The amount of material from this species was about 0.01 mg. The x-ray diffraction curve (diagram A, fig. 3) showed only one peak. It represents the rhombohedron $(10\bar{1}4)$ at 29.°4 $\sim$ 3.035Å. No other reflection was distinguishable from the very low background. This clearly indicates that the crystallographical orientation of the calcite crystals in the granulate species *M. scaphum* is so arranged that the rhobohedron $(10\bar{1}4)$ is parallel to the test surface. In table I the intensities of the reflexes to be expected in case the orientation had been random has been calculated. It is evident from these figures that the orientation of the crystals in this granulate species is very good.

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