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MICROFOSSIL-LIKE OBJECTS IN METEORITES

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SUMMARY

A comprehensive survey is presented of five years work on the question of whether the so-called "organized elements" found in carbonaceous meteorites represent remains of extraterrestrial life.

INTRODUCTION

A number of meteorites are characterized by inclusions of small, globular, glassy or radially crystallized aggregates (chondrules) in a finely crystalline matrix. These are the chondrites. Among them there is a group of nineteen which are known to be carbonaceous chondrites. All of these were observed falling. After several investigators had shown chemically that these chondrites contain organic matter, such as fatty acids, hydrocarbons, vanadyl porphyrins and optically active lipids, CLAUS and NAGY (1961) reported that they had found, embedded in the Orgueil and the Ivuna meteorites, so-called "organized elements", which probably are microscopic-sized organic particles, morphologically resembling unicellular microfossils. It is interesting to note that there is general agreement among meteorite investigators, that the meteorite parent body contained water and had a low-temperature history. The carbonaceous meteorites consist, below their fused crusts, of clay-type minerals, carbonates, gypsum, magnetite, elementary sulphur, magnesium sulphate and organic matter. Some contain as much as 20% water (most of which have deuterium/hydrogen ratios wholly different from terrestrial waters) and 6–7% organic matter.

ORGANIZED ELEMENTS

CLAUS and NAGY (1961) observed five types of organized elements. Four of these resemble species of terrestrial dinoflagellates or chrysomonads which live only

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in water, but despite this similarity they are not identical with any known terrestrial species. Most are small, circular forms, some are cylindrical. Morphological characteristics include structures which look like double cell walls (sometimes sculptured), spines, furrows, pores and flagella-like formations. The dimensions of the bodies vary between 4 and 30 μ.

The fifth type of the organized elements is entirely dissimilar in its morphology to known terrestrial forms. It is generally hexagonal, with three of the surfaces being considerably thicker than the others; these serve as the bases of three thick, tubular protrusions. The organized element is surrounded by a structureless halo.

Several of the organized elements appeared to undergo "cell division". Constrictions occurred in the middle portions of elongated bodies in one form of this phenomenon, proceeding toward the interior and suggesting the formation of two "daughter" bodies. Several organized elements showed distortion and rupture of the walls. Often the interior appeared to be spilling out through the fractured walls (CLAUS and NAGY, 1961).

ADVOCATES AND OPPONENTS

The publication of the paper by CLAUS and NAGY (1961) aroused a storm of controversy, causing communications of both support and protest to appear. Reimer (personal communication, 1961, to CLAUS et al., 1963), STAPLIN (1962), Skuja (personal communication, 1962, to CLAUS et al., 1963), PALIK (1962, 1963a) and CHOLNOKY (1963) examined the same meteorite sample as did CLAUS and NAGY (1961, 1962b), and confirmed or partly confirmed the conclusions reached by the latter two. BRIGGS and KITTO (1962) found that the Mokoia meteorite contains complex organic microstructures of extraterrestrial origin, but they were unable to reach a conclusion as to whether these are of a biogenic or an abiogenic origin. TIMOFEJEW (1962, 1963) extracted from the Mighei chondrite forms which he regards as fossils of a dinoflagellate appearance. ROSS (1963) examined another sample of the Orgueil meteorite, from the collection of the British Museum, and found microstructures which he considered as being of biological origin and most likely indigenous to the meteorite. Engels (personal communication to UREY, 1962a), working with still another sample of that meteorite, isolated pellicles resistant to hydrofluoric acid. Furthermore, also BERNAL (1962) and UREY (1962a, b, 1965) are inclined to believe that the organized elements are organic remains indigenous to carbonaceous meteorites.

Some opponents (e.g., FITCH et al., 1962; MUELLER, 1962) thought the organized elements to be inorganic in nature, others (e.g., DEFLANDRE, 1962a; GREGORY, 1962; PEARSON, 1962) consider them to be terrestrial contaminants, particularly spores and pollen.

DISCUSSION ON TAXONOMIC NOMENCLATURE

Because the International Code of Botanical Nomenclature does not contain a clause for the naming of extra-terrestrial taxa, CLAUS and NAGY (1962a) made a proposal, which initiated a discussion in which DEFLANDRE (1962b), ROSS (1962), PALIK (1963b), STAPLIN (1963) and VAN LANDINGHAM (1963) took part. Using their own proposed procedure, CLAUS and NAGY (1962b) described nine monotypical genera on the basis of material derived from meteorites; arbitrarily these were classified in the plant kingdom.

It may be questioned whether Claus and Nagy were tactically wise in starting this nomenclature discussion at such an early stage of the study of probable extraterrestrial microfossils. It gave the impression of being too hasty, which was only grist to their opponents's mill. After all, scores of terrestrial palynomorphs are catalogued in petroleum-company files by artificial methods without proper scientific names and descriptions. To a certain extent, the lack of a name does not hamper further research. This would also have been true for the study of the microfossil-like objects occurring in meteorites.

PRESENT STATUS OF THE DISCUSSION

Reviewing the flow of publications which advocates and opponents have together produced on the nature of the organized elements, it seems likely that some of the more complicated organized elements are indeed recent contaminants, viz. pollen grains which had obtained the reported appearance under the influence of the staining techniques that had been used (ANDERS and FITCH, 1962). Also the filaments described by PALIK (1962) may be contaminants. Some of the more simple objects, however, are presumably indigenous to the meteorite (Fig.1).

Since the objection was made that these simple forms may very well be artifacts rather than fossils (FITCH and ANDERS, 1963), NAGY et al. (1962, 1963a) carried out several other kinds of investigations on them, including electron-probe X-ray microanalyses of several of the organized elements. The latter revealed that some of these objects are mineralized with iron (probably limonite), chlorine and/or nickel, while others are fossilized with silicates. When the mineral constituents were removed with hydrochloric or hydrofluoric acids, particles remained with low average atomic numbers and no elements heavier than sodium. This suggests that their composition is most probably that of carbonaceous material. This indicates that carbonaceous material had been fossilized by minerals in much the same way that is observed in the case of terrestrial microfossils (UREY, 1965). Consideration of the fine morphology of the objects, physical and chemical tests, staining with biological stains, and further evaluation of contaminations, produced additional evidence that microstructures found in the Orgueil and three other

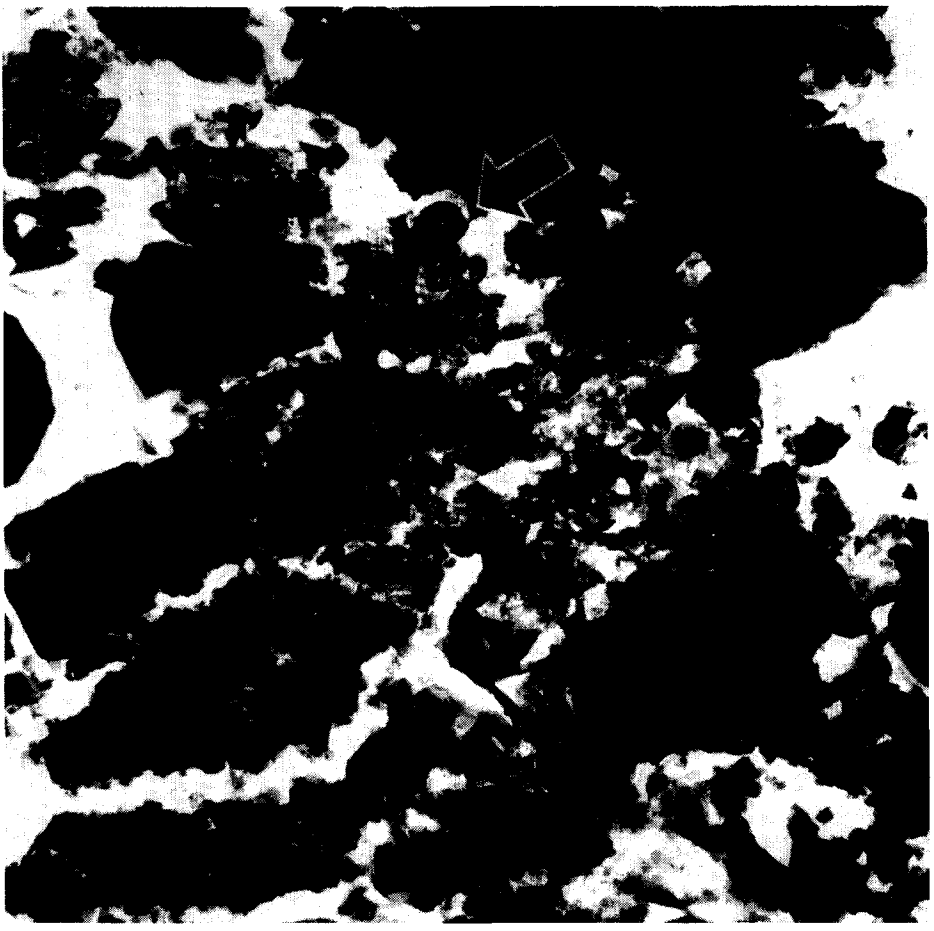

Fig.1. Section through a fragment of the Orgueil meteorite, showing an "organized element" (at arrow). The section was made in the LKB Ultramicrotomy Laboratory, Stockholm; magnification about ×20,000.

chondrites are presumably of biogenic origin and indigenous to the meteorites (CLAUS et al., 1963). Also the examination of ultra-violet ultramicro-absorption spectra of the organized elements, both before and after acid leaching suggests that these objects are not recent terrestrial biological contaminants (NAGY et al., 1963b). Similar results were obtained from both thin sections and powdered samples.

Although the battle smoke around this fascinating problem has not yet cleared away, and it is still too early to indicate any definite conclusion, the position of the "believers" seems to have strengthened. However this may be, appreciation should be expressed about the careful and thorough way in which Nagy and his group deal with the objections raised against their observations and conclusions.

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